The revealed secrets of classical electrodynamics

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The internet provides much information about Tesla's energy technology (in general) and overunity devices (in particular) that have been kept a secret for the citizens of this planet for almost a century. Officially, the longitudinal electric Tesla waves, electrostatic energy flow and electrodynamical overunity devices, are nonexistent. Yet more and more people are convinced these phenomena exist. What seems missing is a consistent mathematical theory that offers a rational explanation for this very important technology. There are many ideas and most of them are not expressed in an exact mathematical form or do not have a clear relation with existing theories. On the other hand, the accepted scientific theories do not offer an explanation either. The Swiss electrical engineer Andre Waser and I recently published a paper about an extension of classical electrodynamics with an extra scalar field, which enabled us to define a new class of longitudinal vacuum waves, the power flow vector of these waves, electrostatic energy flow, and an extra longitudinal Lorentz force component.

In our paper we used the biquaternion calculus in order to express very efficiently our electrodynamics with extra scalar field, but it is also possible to express the theory in the usual vector and scalar equations. Vector and scalar operators are more common to most readers, and therefore I present the theory in this form first and further on in biquaternion form. My name is Koen van Vlaenderen, and I am a Dutch Electrical engineer.

The scalar field: a 7th field component

Oliver Heaviside reduced Maxwell's equations to a few vector/scalar equations of 6 field components. Heaviside did not like the concept of electromagnetic potentials, because these potentials are unphysical and abstract in comparison with the measurable fields. Yet the potentials are very useful in order to simplify many calculations and for the prediction of new physical effects, such as the Aharonov-Bohm effect. In this web site it is shown that extra scalar field terms (that are defined in terms of the electromagnetic potentials) can be added to the Maxwell/Heaviside field equations of Classical Electro-Dynamics (CED). Then we can predict new physical effects, such as a new longitudinal vacuum wave. The scalar field is introduced in the spirit of Oliver Heaviside, who stressed the importance of fields, and of James Clerc Maxwell, who predicted vacuum waves by adding a new displacement current term to the Ampère law.

First we define the fields in terms of the electromagnetic potentials Φ and $\mathbf{A}$.

$$-\nabla\Phi - \partial_t \mathbf{A} = \mathbf{E} \quad \text{the electric field} \tag{1}$$
$$\nabla\times\mathbf{A} = \mathbf{B} \quad \text{the magnetic field} \tag{2}$$
$$-\varepsilon_0\mu_0\, \partial_t\Phi - \nabla\cdot\mathbf{A} = S \quad \text{the scalar field, a seventh field component} \tag{3}$$

The inhomogeneous potential wave equations and two extra vector identities ($\nabla\cdot\nabla\times\mathbf{A} = 0$ and $\nabla\times\nabla\Phi = \mathbf{0}$)

$$\varepsilon_0\mu_0\, \partial_t^2\Phi - \nabla^2\Phi = \rho/\varepsilon_0 \tag{4}$$
$$\varepsilon_0\mu_0\, \partial_t^2\mathbf{A} - \nabla^2\mathbf{A} = \mu_0\mathbf{J} \tag{5}$$

can be rewritten into the Maxwell/Heaviside field equations with extra scalar field terms

$$\nabla\cdot\mathbf{E} - \partial_t S = \rho/\varepsilon_0 \quad \text{Gauss' law} \tag{6}$$
$$\nabla\cdot\mathbf{B} = 0 \tag{7}$$
$$\partial_t\mathbf{B} + \nabla\times\mathbf{E} = \mathbf{0} \quad \text{Faraday's law} \tag{8}$$
$$\nabla\times\mathbf{B} + \nabla S - \varepsilon_0\mu_0\, \partial_t\mathbf{E} = \mu_0\mathbf{J} \quad \text{Ampère's law} \tag{9}$$

Mathematically, the Maxwell/Heaviside field equations are incomplete without the scalar field terms, and that is another reason to add a 7th field component to the theory. But the most important reason is the prediction of "new" scalar field effects, and according to many (including Nikola Tesla) these effects are evident and have been observed already. This means a modification of Gauss' law and Ampère's law.

Some scholars, such as Constantin Meyl, theorize about the *dual* electromagnetic potentials belonging to magnetic monopoles and magnetic currents, but there is no physical evidence for magnetic monopoles and magnetic currents! Such theories lead to a non zero divergence of the magnetic field and to a modification of Faraday's law. As far as I know, magnetic monopole effects have not been observed, therefore such theories are unphysical. As shown on this web site, one can derive a more general electrodynamics by defining an extra scalar field component in terms of the usual (non-dual) electromagnetic potentials that belong to electric charge and electric currents.

Broken gauge symmetry of Classical Electrodynamics

Usually it is assumed that $S = 0$, and this is called the Lorenz gauge condition. This results into the Maxwell/Heaviside field equations in differential form, that are invariant with respect to a potential gauge transformation. One reasons: "as a consequence of potential gauge freedom, the divergence of the magnetic potential and the time derivative of the electric potential can be chosen freely, for instance $-\varepsilon_0\mu_0\,\partial_t\Phi = \nabla\cdot\mathbf{A}$ which is the same as choosing $S = 0$". Since the usual Maxwell/Heaviside equations and the gauge freedom are also a *consequence* of the assumption $S = 0$, it is apparent that this is circular reasoning. The conclusion that $S = 0$ can not be based on a circular argument, but it must be based on the results of experiments.

The equations (6) - (9) are no longer invariant with respect to a potential gauge transformation. This can be called a broken gauge symmetry. In the electro weak theory and the standard theory, massless scalar bosons are introduced (Higgs boson and Goldstone boson) as a consequence of spontaneous breaking of gauge symmetry. Since CED is the first gauge symmetric theory, it is very strange that no one has tried before to formulate CED with broken gauge symmetry.

A classical Aharonov Bohm (AB) effect

The AB effect is a quantum mechanical effect that is about inducing a phase shift in the phase of an electron wave (described by wave function ψ) by an external non-rotational magnetic potential $\mathbf{A} = \nabla\chi$, where χ is a scalar function. The phase shifted wave function ψ' is expressed as: $\psi' = \psi \exp(i\chi)$. The AB effect does not involve electric or magnetic fields, and the effect cannot be shielded by a Faraday cage. Some authors assume that the AB effect can be described as a classical electrodynamical effect, but in general this effect cannot be explained without considering the non-classical wave nature of particles. However, a special case of AB effect might also be a classical effect. If χ is a *periodic* function (for instance, a wave solution), then the phase shift in the particle wave is also periodic, and this means that the *frequency* of the particle wave has been altered by the non-rotational magnetic potential. An altered frequency is equivalent to an altered kinetic energy, because of the Planck relation. In other words: a periodic scalar function χ induces a longitudinal force that alters the kinetic energy of a moving electron. Suppose that χ is the solution of a wave equation, then $\nabla\cdot\nabla\chi$ cannot be zero, and therefore the divergence of the magnetic potential $\nabla\cdot\mathbf{A}$ cannot be zero. Let also be $\Phi = -\partial_t\chi$ then $S = -\varepsilon_0\mu_0\,\partial_t\Phi - \nabla\cdot\mathbf{A} = \varepsilon_0\mu_0\,\partial_t^2\chi - \nabla^2\chi$ which is an inhomogeneous wave equation that depends on scalar field S. The historical Aharonov-Bohm experiment is such that the divergence of the magnetic potential is zero, therefore function χ cannot be a wave solution, and only a phase shift has been observed. If the phase shift of the quantum wave function can also be a a frequency shift, then this means that the Maxwell/Heaviside theory is also *classically* incomplete. Therefore a classical theory is needed that predicts a new longitudinal electrodynamical force that can change the kinetic energy of charges, and this is one of the reasons for introducing the scalar field. In the next chapters it will be shown that the scalar field gives rise to a new longitudinal electrodynamical force. This force might explain for instance the observed non-shieldable force field as a result of a discharge of electrons from a superconducting material, see Impulse Gravity Generator, by E. Podkletnov and G. Modanese.

The retarded and advanced potentials

Well known solution of the equations (4) and (5) are the retarded potentials, Φ_{ret} and $\mathbf{A}_{ret}$ and the advanced potentials Φ_{adv} and $\mathbf{A}_{adv}$. It can be proven that these solutions are not the most general class of solutions, via two steps:

1) The retarded or the advanced scalar field is zero, and this can be proven via Fourier transforms and by using the charge continuity equation.
2) There are potential solutions of (4) and (5), such that the derived scalar field from these potential solutions is not zero, and the derived **E** and **B** fields from these potential solutions are zero.
Some scholars claim that there is no S field because of the conservation of charge. This is not true, because they consider only the retarded and advanced potentials, and these classes of potentials are not all the solutions of (4) and (5).

The induction of scalar fields

The following inhomogeneous field wave equations can be derived:

$$\varepsilon_0\mu_0\,\partial_t^2\mathbf{E} - \nabla^2\mathbf{E} = \mu_0\,(-\partial_t\mathbf{J} - c^2\nabla\rho) \quad (10)$$

$$\varepsilon_0\mu_0\,\partial_t^2\mathbf{B} - \nabla^2\mathbf{B} = \mu_0\,(\nabla\times\mathbf{J}) \quad (11)$$

$$\varepsilon_0\mu_0\,\partial_t^2 S - \nabla^2 S = \mu_0\,(-\nabla\cdot\mathbf{J} - \partial_t\rho) \quad (12)$$

Classically the conservation of charge is assumed to be true, then the scalar field is always a solution of the homogeneous wave equation, see equation (12). However, the conservation of charge is locally violated in the situation of tunneling electrons, therefore the non-classical electron tunneling can be a source for inhomogeneous scalar field S solutions. Another possibility for inducing scalar fields waves: by means of a ***charge density wave*** (CDW). To illustrate this, set fields **E=0** and **B=0** in the Maxwell equations. Considering the fact that S is a wave solution (classically), it follows that charge density ρ and current density **J** are also wave solutions. This theory predicts that charge density waves induce scalar field waves, and that the internal forces in a CDW could be solely a scalar field interaction. It is well known that CDW are present in superconductors. In ordinary room-temperature copper wires, the electron transport has a thermic nature; there is a net movement of electrons and the charge/current density in each wire cross section is constant. Gustaf Kirchhoff already described a century ago in his paper "On the motion of electricity in conductors" the two possibilities for electron transport in conductors: CDWs or thermic movement. This theory of electrodynamics with extra scalar field actually ***predicts*** CDWs, and it would be interesting to look for CDWs in conductors at room temperature.

In most situations the scalar field component $\varepsilon_0\mu_0\,\partial_t\Phi$ is not strong enough to overcome the small factor $\varepsilon_0\mu_0 = 1.11\ 10^{-17}\ s^2/m^2$. Only a rapidly fluctuating source of high voltage, such as a pulsed power system, can induce scalar field effects that are noticeable. Also the other scalar field component, $\nabla\cdot\mathbf{A}$ is not very common, since this scalar field is induced by diverging currents. Usually one expect induced magnetic fields, for example by rotating currents in wires. Since wires are thought of as 1-dimensional objects, one does not expect a diverging current (except for the "undesirable" skin effect). One can use capacitors of large metal surfaces, flat or spherical, in order to create a divergent current. In most modern capacitors currents cannot diverge and therefore cannot induce noticeable scalar fields effects. A fine example of diverging current is Edwin Gray's power tube. In this tube diverging discharges occur from a central axis to an outer cylindrical metal hull. Another example: in Tesla's pancake coil currents diverge from a central point, or converge to a central point, and therefore the pancake coil might also be a source of scalar fields. The divergence factor of currents in a charge/current density wave is non-zero, therefore a CDW might be quite stable via some sort of scalar field self-induction. If one can measure scalar field effects that are no longer predicted by the Maxwell/Heaviside theory (such as a longitudinal electrodynamical force), then we have to accept that S is as real as the electric or magnetic field.

Tesla waves and the Coulomb near field

A new type of vacuum wave solution can be found by setting $\mathbf{B} = \mathbf{0}$.

$$\nabla\cdot\mathbf{E} - \partial_t S = 0 \quad (13)$$

$$\nabla\times\mathbf{E} = \mathbf{0} \quad (14)$$

$$\nabla S - \varepsilon_0\mu_0\,\partial_t\mathbf{E} = \mathbf{0} \quad (15)$$

From these equations two wave equations for the electric field and scalar field can be derived:

$$\varepsilon_0\mu_0\,\partial_t^2 S - \nabla\cdot\nabla S = 0 \quad (16)$$

$$\varepsilon_0\mu_0\,\partial_t^2\mathbf{E} - \nabla\nabla\cdot\mathbf{E} = \mathbf{0} \quad (17)$$

The solution of these wave equations can be described as a longitudinal electro scalar wave (LES wave), or Tesla wave. The energy flow of this wave is likely to be $\mathbf{E}S$, similar to the Poynting vector $\mathbf{P} = \mathbf{E}\times\mathbf{B}$ that represents the energy flow of TEM waves. This will be proven in the next section. Usually the Coulomb field is regarded a non-radiative near field. Whittaker showed that any 1/r scalar potential can be decomposed into a set of potential waves. The modified Gauss' law (with its extra scalar field term) contributes to Whittaker's point of view, and it can be used to define the energy flow associated with the Whittaker waves. The gradient of the Whittaker potential waves are longitudinal electric waves, and the time derivative of the Whittaker potential waves are scalar field waves. Therefore the Whittaker wave decomposition of a Coulomb potential into potential waves gives rise to a hidden $\mathbf{E}S$ energy flow of Tesla field waves. The Coulomb field might be a *radiative* near field, in stead of a static near field. The Tesla wave solution can also be far field waves, just like the usual Hertz TEM wave.

Extended power/force theorems

First it is necessary to introduce a charge/current density gauge transformation:

$$\rho \rightarrow \rho' = \rho + \varepsilon_0 \partial_t S \tag{18}$$
$$\mathbf{J} \rightarrow \mathbf{J}' = \mathbf{J} - 1/\mu_0 \nabla S \tag{19}$$

This transformation transforms the Maxwell/Heaviside equations into the more general field equations (6-9), and it is very similar qua mathematical form to the potential gauge transformation. The time derivative and the gradient of the scalar field can be understood as an additional massless charge/current density in space, which restores the gauge symmetry. The charge/current density transformation can also be applied to generalize the power and force theorems of classical dynamics. These theorems are:

$$\mu_0(\mathbf{J}\cdot\mathbf{E}) = -\tfrac{1}{2}\,\partial_t[\,\varepsilon_0\mu_0 E^2 + B^2] - \nabla\cdot(\mathbf{E}\times\mathbf{B}) \tag{20}$$
$$\mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B}) = \varepsilon_0\mu_0 \big((\nabla\cdot\mathbf{E})\mathbf{E}) + (\nabla\times\mathbf{E})\times\mathbf{E}\big) + (\nabla\times\mathbf{B})\times\mathbf{B} - \varepsilon_0\mu_0\,\partial_t(\mathbf{E}\times\mathbf{B}) \tag{21}$$

Equation (20) is a power flow balance between the power provided by an external source, the change in time of the total field energy, and the energy flow in the form of electro-magnetic radiation. Equation (21) is a force balance between the force applied by an external source, the field stress and the change in time of the momentum of the electro-magnetic radiation. Just like the Maxwell/Heaviside equations can be generalized by the transformations (18) and (19), we can transform the left hand side of equations (20) and (21):

$$\begin{aligned}
\mu_0(\mathbf{J}\cdot E) \rightarrow\ & (\mu_0\mathbf{J} - \nabla S)\cdot\mathbf{E} = \\
& \mu_0\mathbf{J}\cdot\mathbf{E} - \nabla S\cdot\mathbf{E} = \\
& \mu_0\mathbf{J}\cdot\mathbf{E} - \nabla\cdot(\mathbf{E}S) + S\nabla\cdot\mathbf{E} = \\
& \mu_0\mathbf{J}\cdot\mathbf{E} - \nabla\cdot(\mathbf{E}S) + S(\rho/\varepsilon_0 + \partial_t S) = \\
& \mu_0(\mathbf{J}\cdot\mathbf{E} + c^2\rho S) - \nabla\cdot(\mathbf{E}S) + \tfrac{1}{2}\,\partial_t(S^2)
\end{aligned} \tag{22}$$

$$\begin{aligned}
\mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B}) \rightarrow\ & \mu_0(\rho + \varepsilon_0\,\partial_t S)\mathbf{E} + (\mu_0\mathbf{J} - \nabla S)\times\mathbf{B} = \\
& \mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B}) + \varepsilon_0\mu_0\,(\partial_t S)\mathbf{E} - (\nabla S)\times\mathbf{B} = \\
& \mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B}) + \varepsilon_0\mu_0\,\partial_t(S\mathbf{E}) - \nabla\times(S\mathbf{B}) + S(-\varepsilon_0\mu_0\,\partial_t\mathbf{E} + \nabla\times\mathbf{B}) = \\
& \mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B}) + \varepsilon_0\mu_0\,\partial_t(S\mathbf{E}) - \nabla\times(S\mathbf{B}) + S(\mu_0\mathbf{J} - \nabla S) = \\
& \mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B} + \mathbf{J}S) + \varepsilon_0\mu_0\,\partial_t(S\mathbf{E}) - \nabla\times(S\mathbf{B}) - S\nabla S
\end{aligned} \tag{23}$$

Hence, the generalized power and force theorems become:

$$\mu_0(\mathbf{J}\cdot\mathbf{E} + c^2\rho S) = -\tfrac{1}{2}\,\partial_t[\,\varepsilon_0\mu_0 E^2 + B^2 + S^2] - \nabla\cdot(\mathbf{E}\times\mathbf{B} - \mathbf{E}S) \quad (24)$$

$$\mu_0(\rho\mathbf{E} + \mathbf{J}\times\mathbf{B} + \mathbf{J}S) = \varepsilon_0\mu_0\big((\nabla\cdot\mathbf{E})\mathbf{E} + (\nabla\times\mathbf{E})\times\mathbf{E}\big) + (\nabla\times\mathbf{B})\times\mathbf{B} + S\nabla S + \nabla\times(S\mathbf{B}) - \varepsilon_0\mu_0\,\partial_t(\mathbf{E}\times\mathbf{B} + \mathbf{E}S)$$
$$= \varepsilon_0\mu_0\big((\nabla\cdot\mathbf{E})\mathbf{E} + (\nabla\times\mathbf{E})\times\mathbf{E}\big) + (\nabla S + \nabla\times\mathbf{B})\times\mathbf{B} + S(\nabla S + \nabla\times\mathbf{B}) - \varepsilon_0\mu_0\,\partial_t(\mathbf{E}\times\mathbf{B} + \mathbf{E}S) \quad (25)$$

These extended energy/momentum theorems contain many new and interesting terms:
- Applied static charge energy, $c^2\rho S$. This describes the unusual applied power by static charge already mentioned by Tesla, and this term is in agreement with the interpretation of a Coulomb field as a radiative LES wave near field.
- Negative energy flow in the form of longitudinal electro-scalar radiation, $-\mathbf{E}S$, and this is likely the non-Hertzian radiation discovered by Tesla.
- Scalar field energy density, S^2.
- Longitudinal Lorentz force, $\mathbf{J}S$. Longitudinal forces that act on current elements have been researched by Jan Nasilowski and Peter Graneau and Neil Graneau.
- Scalar field stress, $S\nabla S$.
- Magneto-scalar field stress, $\nabla\times(S\mathbf{B})$.

The vector $\mathbf{E}S$ is called the Tesla vector from now on. The scalar field can be thought of as a scalar magnetic field: it acts on currents rather than on static charge, electro-scalar interaction is radiation (just like electro-magnetic interaction), and there are mixed magneto-scalar field stress terms.

In case the scalar field is zero (the Lorentz gauge condition) then the extended power and force theorems take the form of the ordinary (special case) power/force theorems of standard classical electrodynamics.

Force-free charge density waves

There are charge density distribution such that the total force on each charge element is zero, for instance in case $\mathbf{B} = \mathbf{0}$ and $\mathbf{E} = -\mathbf{v}S$. The applied power and force become $\mathbf{F} = \rho(\mathbf{E} + \mathbf{v}\times\mathbf{B} + \mathbf{v}S) = \rho(-\mathbf{v}S + \mathbf{v}S) = \mathbf{0}$, and $W = \mathbf{J}\cdot\mathbf{E} + c^2\rho S = \rho\mathbf{v}\cdot(-\mathbf{v}S) + c^2\rho S = (c^2 - v^2)\rho S$.

By setting $\mathbf{B}=\mathbf{0}$ replacing $\mathbf{E} = -\mathbf{v}S$ in the Maxwell equations, it is possible to derive the following equation: $v = c(\pm \sin(\varphi) - 1)/\cos(\varphi)$, where φ is the angle between the vectors $\mathbf{v}$ and ∇S. The charge density is a wave solution with speed v, such that v can have many values and everywhere the charge density wave is force free. This force-free charge density wave means a predication of superconduction by a classical field theory. Usually superconduction is the consequence of intense cooling of a conductor, such that the conduction electrons are not scattered by the thermic motion of the conductor atoms. In case the electric field forces are compensated by scalar field forces, the dynamic charge in a conductor can become force free, in other words: superconducting. This might lead to superconduction at room temperature. It is not necessary to actively cool the conductor, because the reduction of chaos via compensating scalar field forces is an entirely different mechanism. The field energy flow of this wave is $\mathbf{E}S = -\mathbf{v}S^2$.

The theory of electrodynamics with scalar field, expressed in biquaternion equations

(Bi)quaternion numbers and quaternion calculus were discovered by Rowan Hamilton and is very suitable for expressing 4-vectors or 8-vectors. Typical examples of 4 dimensional physical qualities are time-space, electro-magnetic potential, power-force, energy-momentum. Cornelius Lanczos and Andre Gsponer wrote several papers about applying biquaternion in physics, see for instance the paper of Andre Gsponer: THE PHYSICAL HERITAGE OF SIR W.R. HAMILTON, for further references. There are several options for the syntax of biquaternions, and a very elegant one has been developed by Andre Waser and myself, and it is as follows:

Let a_0 be a scalar, let $\mathbf{A} = (a_1, a_2, a_3)$ be a vector and let $\boldsymbol{i} = (i, j, k)$ be the Hamiltonean vector, where i, j, k are the Hamiltonean numbers. Then the 4-vector (a_0, a_1, a_2, a_3) can be expressed by the quaternion $A = a_0 + \boldsymbol{i}{\scriptstyle x}\mathbf{A} = a_0 + ia_1 + ja_2 + ka_3$. The notation $A = a_0 + \boldsymbol{i}{\scriptstyle x}\mathbf{A}$ has the advantage that we can separate easily the scalar part (a_0) and the vector part (a_1, a_2, a_3) of the quaternion. If a_0, a_1, a_2, a_3 are complex numbers then we speak of a Bi)quaternion which consists of 8 real numbers. The following equations define the calculus of quaternions:

$$A+B = a_0+b_0 + \boldsymbol{i}{\scriptstyle x}[\mathbf{A} + \mathbf{B}] \qquad (26)$$

$$AB = a_0b_0 - \mathbf{A}{\scriptstyle x}\mathbf{B} + \boldsymbol{i}{\scriptstyle x}[b_0\mathbf{A} + a_0\mathbf{B} + \mathbf{A}\times\mathbf{B}] \qquad (27)$$

$$A^* = a_0 - \boldsymbol{i}{\scriptstyle x}\mathbf{A} \qquad (28)$$

The biquaternion gradient, biquaternion potential and biquaternion current are defined by equations 29, 30, 31 (i is the imaginary number, the constant c is the speed of light):

4 gradient $\quad \nabla = i/c\ \partial_t + \boldsymbol{i}{\scriptstyle x}\tilde{N}$ (29)

4 potential $\quad A = i/c\ \Phi + \boldsymbol{i}{\scriptstyle x}\mathbf{A}$ (30)

4 current $\quad J = ic\ \rho + \boldsymbol{i}{\scriptstyle x}\mathbf{J}$ (31)

scalar/electric/magnetic field $\quad F = \nabla A = S + \boldsymbol{i}{\scriptstyle x}[\mathbf{E}/(ic) + \mathbf{B}]$ (32)

Maxwell/Heaviside equation $\quad \mu_0 J = -\nabla^* F = -\nabla^* \nabla A$ (33)

field wave equation $\mu_0 \nabla J = -\nabla\nabla^* F$ (34)

power/force theorem $\mu_0 f = \mu_0 JF = -(\nabla^* F)F = -\nabla^*\nabla A(\nabla A)$ (35)

It is amazingly simple to define the fields (equation 32), the Maxwell/Heaviside equations (equation 33) and the power/force theorems (equation 35). The interested reader can evaluate equations 32, 33, 34 and 35 by applying the product rule 26, and derive the field equations 6, 7, 8, 9, 10, 11, 12 and the power/force theorems 24, 25 . Keep in mind that one biquaternion equations is in fact a compact notation of 2 scalar equations (real scalar equals real scalar and imaginary scalar equals imaginary scalar) and 2 vector equations (real vector equals real vector and imaginary vector equals imaginary vector). For example, we can express the 4 Maxwell/Heaviside equations in one single biquaternion Maxwell/Heaviside equation. Hint: the scalar $-\nabla\nabla^* = (\varepsilon_0\mu_0 \partial_t^2 - \tilde{N}^2)$ is an operator that automatically defines (in)homogeneous wave equations. The most important implication of the biquaternion form is the natural appearance of the scalar field in the equations. The usual electrodynamics equations without scalar field, expressed biquaternions, are more complicated than electrodynamics that includes the scalar field.

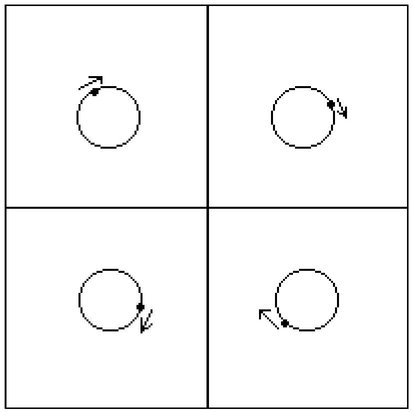
Electrodynamical free energy devices that show overunity

A device operates in overunity mode if the output power of the device exceeds the input power. This means that the device is an open system that can assimilate extra energy from the environment that has no price tag. The device can convert this energy into electricity. For example, a solar cell is an overunity device according to this definition. A solar cell absorbs sun light (TEM waves) and converts this energy into electricity. Now that longitudinal electro-scalar (LES) wave radiation has been defined, it is necessary to research the literature for possible devices that can input extra energy in the form of LES waves.

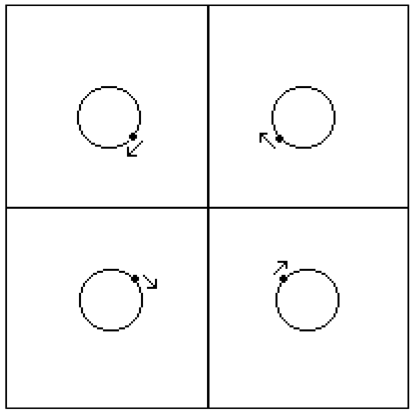
Electro-scalar polarization in magnets or electro-magnet cores, and resonance absorption of Tesla waves

A magnet is a source of a magnetic field. Theoretically a magnet can also be a source of electro-scalar fields. Electrons in the magnet, or in the core of an electromagnet, are magnetically polarized, which means that the electrons follow a circular path. With respect to the North-South axis of the magnet, each electron in circular motion has a particular phase, which defines the distance between the electron and the north-south axis. If one can order the relatively random phases of all magnetically polarized electrons, such that they all have the closest distance at the same time, and the longest distance at the same time, then this is equivalent to a dynamical electric polarization of the magnet, thus equivalent to a dynamical electric potential between the axis of the magnet and the surface of the magnet. I call this a radially ordered phase of the charge in circular motion. This also means there is a diverging and converging electron flow, such that $S = -\varepsilon_0\mu_0 \partial_t\Phi - \nabla\cdot\mathbf{A}$ is not zero (the scalar factor $\nabla\cdot\mathbf{A}$ is induced by diverging/converging currents). The frequency of this dynamical electro-scalar polarization is exactly the orbital frequency of the magnetically polarized charges. In theory a magnet/electromagnet-core with an ordered phase pattern can be a transmitter/receiver of longitudinal electro-scalar waves. During a MEG (motionless energy generator) congress in Biebelried-Germany engineer Achleitner presented a remarkable result: at certain input frequencies a portion of the input power simply disappeared from his MEG device. He has checked for the presence of TEM wave radiation, but he was not able to measure such waves. Therefore it is logical to assume that his MEG was radiating LES waves, and that the particular resonance frequency caused an ordering of the phase of the circular currents.

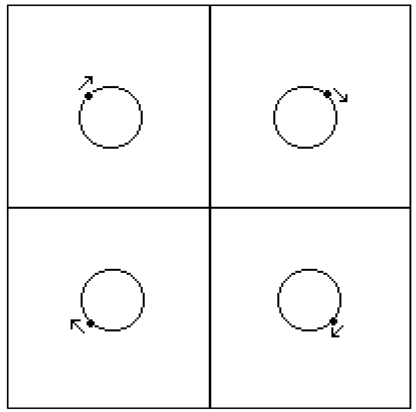
Tom Bearden explains the OU operation of the MEG device by assuming that the MEG assimilates a non-Herzian type of radiation with an energy flow that is not the Poynting vector. Bearden describes that the magnetic potential in non-rotational form plays an important role. The simplest form of non-rotational magnetic potential is a diverging magnetic potential, which is one of the two terms of the scalar field. The absorbed radiation might be of the longitudinal electro-scalar type. The input signal should resonate with the natural frequency of the MEG, and that is the orbital frequency of the charge in circular motion in the MEG core. Resonance means that the frequency of the input signal must be equal to the natural frequency divided or multiplied by a natural number. Such a "chaos corrective" input signal probably orders the phase of magnetically polarized electrons, and the resulting effect can be called *electro-scalar resonance absorption of Tesla waves.*.



Random phase



Ordered phase:
all orbital electrons have smallest distance to the centre at a particular time



Ordered phase:
all orbitting electrons have greatest distance to the center at a particular time

There is another ingenious way to achieve an electro-scalar polarization in permanent magnets: the *conditioning* of an extra motional E-field. This has been described in Floyd Sweet's paper 'Nothing is Something'. The motional E-field is $\mathbf{E} = \mathbf{v} \times \mathbf{B}$. If $\mathbf{v}$ is the velocity of a circular motion, the motional E field is radial. A radial electric field can be induced via the Faraday disc effect, therefore the conditioning of this E field is done by rotating the $BaFe_{12}O_{19}$ material during its conditioning; the rotation axis should be parallel to the external magnetic field that conditions the magnet.

This is a practical interpretation of Sweet's theory, and I assume that Sweet conditioned his magnets this way. A dynamic Bloch wall was not mentioned by Sweet. The conditioned motional E-field has the consequence of an extra electric polarization, and since the divergence of the polarization current is not zero, I also expect the induction of scalar fields and therefore the possibility of the absorption of LES wave energy. This could explains the overunity of the VTA device. Sweet mentioned the reduction of molecular bonds during conditioning, such that $BaFe_{12}O_{19}$ can be electrically polarized more easily during the usage of the VTA device. Electrical polarization of molecules require a shift of the position of molecules in the lattice, therefore too many inter-molecular bonds prevent an electric polarizability. There is definitely a mechanical stress in the Barium Ferrite during VTA usage (drawing too much power from the VTA fractures the magnets). This is another indication that the VTA functions as a special ferroelectric device. Even the spectacular story of gravity reduction might be true, since a boundary condition for the alternating motional E-field, the scalar field, and the electric polarization, is a polarization of the Dirac sea. This is equivalent to a gravity field. This has been described also by Sweet in 'Nothing is Something'.

Energy transport in cooled wires via "cold current" charge density waves

Cold current in an electrical conductor simply means the reduction of heat activity of the conduction electrons and the atom nuclei of the conductor. This is done by reducing the freedom of movement of the electrons. In other words, one has to create order in the chaos that we call temperature. This can be done by organising the conduction electrons in the form of a charge density wave (CDW). The thermic energy of a CDW is reduced, because the conduction electrons move in a much less chaotic way (say, vibrate from left to right only), and this explains the cooling effect. A charge density wave in a metal wire must have a very high frequency, and considering the fact that the conductance electrons almost have the speed of light, then 1 to 100 Giga Hz waves have wavelength of at most 3cm to 0,3 mm. In each point in the wire there is a constant diverging/converging current. Therefore $S = -\varepsilon_0\mu_0\,\partial_t\Phi - \nabla\cdot\mathbf{A}$ is very high in a wire where the chaotic thermic activity of the electrons is ordered into a charge density wave. Suppose that the scalar field S is very high compared with the electric and magnetic field. Then we can set $\mathbf{E} = \mathbf{0}$ and $\mathbf{B} = \mathbf{0}$ in the equations(6-9). From the resulting field equations it follows that the charge density is a wave solution. This charge-density wave is driven by longitudinal forces (see equation (22)) as a consequence of the scalar field presence. I don't expect the electric field to be totally zero, because the electric field is the gradient of the electric potential, therefore there is a longitudinal electric wave in the direction of the wire. The energy flow vector in this situation is equal to the Tesla vector $\mathbf{E}S$ and is not equal to the Poynting vector $\mathbf{E}\times\mathbf{B}$. In other words: there is a longitudinal electro-scalar wave energy flow, guided by the charge density wave in a cooled wire.

A magnet with ordered phase magnetically polarized electrons can induce a charge density wave in a (bifilar) coil close to the magnet. The reason for this is the very high orbital frequency of the magnetically polarized electrons. It is said that Sweet's conditioned BaFe magnets showed spin waves, and these waves have frequencies in the giga Hertz range. But as far as I know I am the first to describe an extra electro-scalar polarization via phase ordering, which is a ferro-electro-scalar effect. Such a polarization is the best explanation for the cold current phenomenon and the unusual high energy flow guided by wires that do not get hot and that are cooled.

Superluminal waves

By introducing a new constant σ via the following additional field equation:

$$\nabla S = \sigma\varepsilon_0\mu_0\,\partial_t\mathbf{E} \tag{33}$$

and combining this equation with the source free Maxwell/Heaviside equations (6-9), it is possible to derive the following wave equations:

$$\sigma\varepsilon_0\mu_0\,\partial_t^2 S - \nabla\cdot\nabla S = 0 \tag{34}$$
$$\sigma\varepsilon_0\mu_0\,\partial_t^2\mathbf{E} - \nabla\nabla\cdot\mathbf{E} = \mathbf{0} \tag{35}$$
$$(1-\sigma)\varepsilon_0\mu_0\,\partial_t^2\mathbf{B} + \nabla\times\nabla\times\mathbf{B} = \mathbf{0} \tag{36}$$
$$(1-\sigma)\varepsilon_0\mu_0\,\partial_t^2\mathbf{E} + \nabla\times\nabla\times\mathbf{E} = \mathbf{0} \tag{37}$$

Only when $\sigma \in [0,1]$ do we have 4 wave equations. For $\sigma \in [0,1>$ the LES wave is superluminal and for $\sigma = 1$ the LES wave is luminal. For $\sigma \in <0,1]$ the TEM wave is superluminal and for $\sigma = 0$ the TEM wave is luminal. However, only the superluminal waves with (near) infinite speed are correct, which means that σ can only have the values 0 or 1. This is proven as follows.

Equation (33) can also be used to eliminate the electric field term from Ampère's law:

$$(\sigma-1)\nabla S = \sigma\nabla\times\mathbf{B} \tag{38}$$

According to standard vector identities, the next equations are true:

$$(\sigma-1)\nabla\cdot\nabla S = \sigma\nabla\cdot\nabla\times\mathbf{B} = 0 \tag{39}$$
$$(\sigma-1)\nabla\times\nabla S = \sigma\nabla\times\nabla\times\mathbf{B} = \mathbf{0} \tag{40}$$

Actually this means that there are no TEM waves and LES waves for $\sigma \in <0,1>$ and the reader can verify that only the values 0 and 1 remain valid. In the published paper of van Vlaenderen and Waser the values between 0 and 1 have been taken also as valid, but this is a mistake made by me. As far as I know, only via an extra equation like (33) is it possible to introduce an extra constant in the generalised Maxwell/Heaviside equations. This results into the prediction of superluminal waves with (near) infinite speed. Thus, both TEM waves and LES can be luminal or can be of infinite speed, after making the assumption of equation 33.

Conclusions

After a simple adaptation of the Maxwell/Heavside equations by adding scalar terms to the Gauss law and the Ampère law, a much richer electrodynamics can be derived. It has been said often that Tesla's non-Herzian waves are longitudinal scalar waves. However, a scalar field wave cannot be longitudinal nor transversal, since it does not have a direction like a vector field. This riddle has been solved by the longitudinal electro-scalar wave, where the electrical component is longitudinal. This is exactly how Tesla described the vacuum wave, as a longitudinal electric wave. The definition of the scalar field is such that it can explain unusual phenomena in pulsed power systems with strong fluctuations of the electric potential and with diverging/converging currents, such as an unusual wired or wireless power flow in the form of longitudinal electro-scalar waves, longitudinal forces that can give rise to charge density waves, applied electrostatic power, scalar field energy, and new magneto-scalar stress terms. At least three types diverging/converging current effects have been identified: the phase ordering of magnetically polarized charge, the Faraday disc effect, and radial discharges. In all three cases also radial electric fields are present. A device that induces a dynamic scalar field and a dynamic radial electric field might be a sender/receiver of LES waves (Tesla waves), and that might explain the COP>1 of for instance the Moray/Gray/Chernetski/Correa/Pereault power tubes, the dePalma/Tewari N-machine, or Sweet's specially conditioned $BaO(Fe_2O_3)_6$ magnets.

The theory can be cast into biquaternion form, then only a few definitions and biquaternion equations are sufficient for describing the theory.

Discussion

Overunity systems with technical COP > 1 always assimilate ambient energy in some form, such that the technical input energy + the extra assimilated ambient energy equals the output energy. Nuclear reactors and fuel based technology are not considered to be overunity systems, because the technical input energy fully accounts for the technical output energy in these cases. Overunity systems can act as power generators, and can be classified in several ways:

By scale of organisation of the assimilated ambient energy
- entropic systems that absorb/convert ambient energy that already has a large scale ordered form, for example wind energy or a particular spectrum of radiation energy from the sun.
- negentropic systems that absorb/convert ambient energy in small scale chaotic form, for example the kinetic energy of the molecules of an ambient gas or atmosphere, the chaotic vacuum activity or ZPE.

By type of ambient energy and conversion process
- assimilation of TEM wave radiation
- assimilation of LES wave radiation
- assimilation of kinetic energy of ambient gas or atmosphere

LES wave radiation is a new type of far field energy, and it might be produced in great quantities by the sun and stars. It is not known if this form of energy is also part of the "quantum" vacuum activity, for example in the form of "virtual Goldstone boson" generation and annihilation. There is very little literature about the Goldstone boson and its macroscopic effects in systems. Some assumed without proper proof that the Goldstone boson and the resulting longitudinal polarisations of the magnetic vector potential are "unphysical". The generalisation of the Maxwell/Heaviside with an extra scalar field shows a theory that predicts macroscopic effects based on gauge symmetry breaking of electrodynamics, see equations (1) to (22) on this web page. The publications of Podkletnov and Modanese about a new kind of far field wave, which is not a gravity wave nor a TEM wave, clearly proves the incompleteness of classical field theory, since the observed effects are macroscopic. An explanation of the Podkletnov force field can be based on a real massless spin 0 scalar field that interacts with the electric field. This does not have to be the Goldstone-Nambu scalar boson, and secondly this effect simply requires a generalisation of the classical Maxwell/Heaviside theory of electrodynamics because of its macroscopic nature. The Podkletnov force is not shieldable, which is like the Aharonov Bohm experiment. A logical candidate for this new macroscopic field, that transfers energy and momentum, is the scalar field defined by (3).

Diverging/converging currents and very high frequencies in electric potential are the design principles for overunity systems that assimilate LES waves. This principle is *absent* in magnetic flux switching devices and brushless DC motors.

Bearden's theoretical outlines with respect to the MEG is confusing, because he describes far too many outlines, and some are not relevant at all, or even worse, some are wrong. Bearden cannot know if his MEG device assimilates energy from the active vacuum (MEG = negentropic?). At the moment it is not at all certain that Bearden's MEG shows COP>1, it is not mentioned in the patent, and the MEG patent isn't even original. Dr. Bearden is correct about a non-rotational form of A-potential and associated energetic effects which I have proven mathematically on this web page via scalar field S, and this means that Bearden is looking for a better theory than the simple flux switching concept. He is totally incorrect about a "magneto static scalar potential" and its "Whittaker decomposition". Only the electric potential is static and might have a Whittaker decomposition. The reference to Whittaker's superpotentials, that are even more difficult to understand with respect to physical effects than potentials, cannot show interference effects, or Bearden should present generalised force/power theorems based on super potentials. Such a generalisation does not exist. Heaviside already disliked potentials for a good reason, and one can imagine the opinion he should have had about the non-retarded instantaneous super potentials. For this reason I introduced an extra scalar field that is not a potential nor a superpotential, but is on the same footage as the electromagnetic fields. Bearden assumes that any permanent magnet is also a source of non-rotational magnetic potential (in other words, the scalar field). This is wrong, a non-rotational vector potential is induced only via a phase ordering of the magnetically polarized charges, and this can be called also a 'gyro electro-scalar resonance' in a magnet. Bearden's "time-backward" phase conjugated signals via phase conjugating mirrors does not explain anything, and certainly not Sweet's VTA device. Such time-backward signals do not exist. The scientific literature on Phase Conjugated Mirrors mentions a "time-reversed" PC signal, but one actually means a phase conjugated signal. If the PC signal was really time backwards, then this signal would annihilate its original signal, and in that case an undistorted PC mirror image would not be observed as a TEM wave. Bearden describes the annihilation as follows: the vector field (electric and magnetic) components of the original signal and PC signal cancel each other, and only a "standing scalar wave" is the end result. Bearden's twist of PC mirror theory is wrong again: the undistorted mirrored PC signals can be observed as TEM waves in the optic frequency domain, and that is why these signals and PC mirrors are useful in the first place.

Recently I made a brushless DC motor, it had a very cold switching FET and stator coil, but always the measured current through the battery lead wires was positive, so there is no negative current effect what so ever. The FET is cold because most of the electric energy is converted efficiently into mechanical energy, without heating the electric circuit. It is only an efficient motor design. My theory cannot explain at all a brushless DC motor overunity effect, and it is the question if a permanent magnet rotor is key to overunity. I think it is not.