ECE GENERALIZATION OF THE D'ALEMBERT, PROCA AND SUPERCONDUCTIVITY WAVE EQUATIONS: ELECTRIC POWER FROM ECE SPACE-TIME.

by

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ABSTRACT

The well known d'Alembert, Proca and superconductivity wave equations are shown to be special cases of the wave equations which can be constructed from the homogeneous and inhomogeneous field equations of Einstein Cartan Evans (ECE) unified field theory. One of the important practical consequences is that a material can become a superconductor by absorption of the inhomogeneous and homogeneous currents of ECE spacetime. This means that in a well designed circuit or material, the output voltage or power can exceed by orders of magnitude the input power needed to run the circuit. This phenomenon has been observed experimentally and is reproducible and repeatable. An array of such circuits would in principle produce a new type of electric power for general use on a sufficiently large scale to be significant.

Keywords: Einstein Cartan Evans (ECE) unified field theory; electric power from ECE space-time; generally covariant d'Alembert, Proca and superconductivity equations.

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1. INTRODUCTION

Rigorous objectivity in science requires general relativity to be applied to all the main equations of physics, chemistry and the natural sciences. The equations must all retain their form under the general coordinate transformation, and the philosophy of relativity requires that every event have a cause, science must be causal as well as objective. A plausible theoretical structure for causal and objective natural science has recently been suggested using standard Riemann geometry in its most general form {1-34}. This type of geometry was developed by Cartan into well known differential geometry, a concise and elegant formulation of the general Riemann geometry of the early nineteenth century. In well known letters to Einstein, Cartan suggested in the early twenties of the twentieth century that the electromagnetic field be the torsion form of Cartan geometry. From 2003 onwards this suggestion led to ECE unified field theory {1-33}. The gravitational field is represented by the Riemann or curvature form of Cartan geometry. The torsion form represents the spinning of four-dimensional space-time (the electromagnetic, weak and strong fields, fermion and boson fields), and the curvature form the curving of four-dimensional space-time (the gravitational field, gravitons and gravitinos). This was a notable advance upon the Einstein Hilbert field theory of 1915, which was the first theory to successfully apply general relativity to gravitation. In so doing however general Riemann geometry was specialized into Riemann geometry without torsion. Only the curvature of space-time was considered, the spinning of space-time was neglected by use of the symmetric or Christoffel connection {34}, sometimes also known as the Riemann or Levi-Civita connection. In general Riemann geometry the connection is asymmetric in its lower two indices. For a given upper index the connection is therefore a matrix which is the sum of a symmetric and anti-symmetric component. In Cartan's well known formulation of general Riemann geometry, the torsion and curvature forms are in general non zero, and defined respectively by the Cartan structure equations, known in contemporary, standard, differential geometry as the master equations.

A differential two-form translates into an anti-symmetric tensor, both the torsion and Riemann tensors are anti-symmetric in their last two indices. The Riemann form is a tensor valued two-form, the torsion form is a vector valued two-form {34}. As inferred by Cartan, the latter becomes the electromagnetic field, for example, through the Evans Ansatz {1-33}:

$$F^a = A^{(0)} T^a \qquad -(1)$$

where $A^{(0)}$ is a vector potential magnitude. The electromagnetic potential is the fundamental field, the tetrad, or fundamental field of ECE theory:

$$A^a = A^{(0)} q^a. \qquad -(2)$$

In Cartan geometry the torsion form is the covariant exterior derivative of the tetrad:

$$T^a = d \wedge q^a + \omega^a{}_b \wedge q^b \qquad -(3)$$

and the curvature form is defined by the spin connection as follows:

$$R^a{}_b = d \wedge \omega^a{}_b + \omega^a{}_c \wedge \omega^c{}_b. \qquad -(4)$$

The torsion and curvature forms are inter-related by the first Bianchi identity:

$$d \wedge T^a + \omega^a{}_b \wedge T^b := R^a{}_b \wedge q^b \qquad -(5)$$

and the curvature form always obeys the second Bianchi identity:

$$D \wedge R^a{}_b := 0. \qquad -(6)$$

Using the Evans Ansatz (1) or (2) links the electromagnetic field to the electromagnetic potential as follows:

$$F^a = d \wedge A^a + \omega^a{}_b \wedge A^b \qquad (7)$$

using Eq. (3). The first Bianchi identity (5) produces with the Ansatz the homogeneous field equation of ECE theory {1-33}:

$$d \wedge F^a = \mu_0 j^a \qquad (8)$$

where the homogeneous current of ECE field theory is defined by:

$$j^a = \frac{A^{(0)}}{\mu_0} \left(R^a{}_b \wedge q^b - \omega^a{}_b \wedge T^b \right). \qquad (9)$$

Hodge duality transformation fo Eq. (9) {1-333} produces the inhomogeneous field equation of ECE field theory:

$$d \wedge \tilde{F}^a = \mu_0 J^a \qquad (10)$$

where the inhomogeneous current is defined by:

$$J^a = \frac{A^{(0)}}{\mu_0} \left(\tilde{R}^a{}_b \wedge q^b - \omega^a{}_b \wedge \tilde{T}^b \right). \qquad (11)$$

In Section 2 Eqs. (7) and (10) are translated into tensor notation and the ECE generalization obtained of the d'Alembert, Proca and superconductivity wave equations {35, 36}. This means (Section 3), that superconductivity can be understood in terms of general relativity, a conclusion which indicates the possibility of designing a material or circuit that becomes a superconductor from absorbing j^a and J^a from ECE space-time. The generally covariant London equation and Meissner effect follow from the ECE superconductivity equation. This conclusion of ECE field theory has been verified experimentally in reproducible and repeatable experiments { 37 }.

2. DERIVATION OF THE WAVE EQUATION.

The d'Alembert wave equation in the standard model {35, 36} is derived using tensor notation. This exercise is given here in preparation for deriving the equivalent wave equation in ECE theory. The electromagnetic field tensor in the standard model is defined by:

$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu \qquad -(12)$$

and the inhomogeneous wave equation of the standard model is given by:

$$\partial_\mu F^{\mu\nu} = \mu_0 J^\nu . \qquad -(13)$$

A wave equation may be constructed by substituting Eq. (12) into Eq. (13) to give:

$$\partial_\mu \left(\partial^\mu A^\nu - \partial^\nu A^\mu \right) = \mu_0 J^\nu \qquad -(14)$$

i.e.

$$\Box A^\nu = \partial^\nu \left(\partial_\mu A^\mu \right) + \mu_0 J^\nu . \qquad -(15)$$

The standard model uses the Lorentz condition { 35 }:

$$\partial_\mu A^\mu = 0 \qquad -(16)$$

to give the d'Alembert wave equation:

$$\Box A^\nu = \mu_0 J^\nu \qquad -(17)$$

whose solutions are the Liennard-Wiechert potentials. The Proca equation of the standard model is { 1-33 }:

$$\left(\Box + \left(\frac{m_P c}{\hbar} \right)^2 \right) A^\nu = 0 \qquad -(18)$$

where m_p is the mass of the photon, c the speed of light and $\hbar$ the reduced Planck constant. Eqs. (17) and (18) imply that photon mass may be understood as a charge current density {1-33 }:

$$J^\mu = -\frac{1}{\mu_0}\left(\frac{m_p c}{\hbar}\right)^2 . \quad -(19)$$

For all practical purposes in the laboratory:

$$m_p \rightarrow 0 \quad -(20)$$

giving the free space d'Alembert equation:

$$\square A^\mu = 0. \quad -(21)$$

In the standard model the space-time used for electrodynamics is Minkowski space-time, or "flat" space-time. In consequence electrodynamics in the standard model cannot be unified with gravitational theory { 35 } because the equations of electrodynamics are not generally covariant, they are Lorentz covariant. In ECE theory the equations of electrodynamics (Section 1) are generally covariant ans unified with the equations of all other fields, including gravitation. In both the standard model and ECE field theory indices are raised and lowered with the metric tensor { 34 }. Thus for example:

$$\left.\begin{aligned} J^\mu &= g^{\mu\rho} J_\rho , \quad A_\nu = g_{\nu\rho} A^\rho , \\ \partial_\mu A_\nu &= g_{\mu\rho}\, g_{\nu\sigma}\, \partial^\rho A^\sigma , \\ F_{\mu\nu} &= g_{\mu\rho}\, g_{\nu\sigma}\, F^{\rho\sigma} , \end{aligned}\right\} -(22)$$

and

$$\left.\begin{aligned} F_{\mu\nu} &= \partial_\mu A_\nu - \partial_\nu A_\mu , \\ F^{\mu\nu} &= \partial^\mu A^\nu - \partial^\nu A^\mu . \end{aligned}\right\} -(23)$$

From the ECE Lemma {1-33} the correct and complete structure of the wave equation of electrodynamics is:

$$\square A^a_\mu = R A^a_\mu \quad -(24)$$

where R is a well defined scalar curvature. The latter is missing completely from the standard model but is a hitherto unconsidered source of electric power from space-time. The generalization of the d'Alembert equation in ECE field theory is obtained from the tensor notation of equations (7) and (10):

$$F^{a\mu\nu} = \partial^\mu A^{a\nu} - \partial^\nu A^{a\mu} + \omega^{\mu a}{}_b A^{\nu b} - \omega^{\nu a}{}_b A^{\mu b} \quad -(25)$$

and

$$\partial_\mu F^{a\mu\nu} = \mu_0 \tilde{J}^{a\nu}. \quad -(26)$$

The indices of the spin connection have been raised with the appropriate metric, that of ECE space-time with torsion and curvature:

$$\omega^{\mu a}{}_b = g^{\mu\sigma} \omega_\sigma{}^a{}_b . \quad -(27)$$

So we obtain from Eqs. (25) and (26):

$$\square A^{a\nu} = R A^{a\nu} = \mu_0 \tilde{J}^{a\nu} + \partial_\mu \left(\partial^\nu A^{a\mu} - \omega^{\mu a}{}_b A^{\nu b} + \omega^{\nu a}{}_b A^{\mu b} \right). \quad -(28)$$

The current is therefore defined by:

$$\tilde{J}^{a\nu} = \frac{1}{\mu_0} \left(R A^{a\nu} - \partial_\mu \left(\partial^\nu A^{a\mu} - \omega^{\mu a}{}_b A^{\nu b} + \omega^{\nu a}{}_b A^{\mu b} \right) \right) \quad -(29)$$

and the scalar curvature by {1-33}:

$$R = q^{\lambda}_{a}\,\partial^{\mu}\left(\Gamma^{\nu}_{\mu\lambda} q^{a}_{\nu} - \omega^{a}_{\mu b} q^{b}_{\lambda}\right). \quad -(30)$$

Using the Ansatz in the form:

$$A^{a\nu} = A^{(0)} q^{a\nu} \quad -(31)$$

it is seen that $\tilde{J}^{a\nu}$ is derived completely from geometry. In tensor notation:

$$\tilde{J}^{a\nu} = \frac{A^{(0)}}{\mu_0}\left(R q^{a\nu} - \partial_{\mu}\left(\partial^{\nu} q^{a\mu} - \omega^{\mu a}{}_{b} q^{\nu b} + \omega^{\nu a}{}_{b} q^{\mu b}\right)\right). \quad -(32)$$

This result can be compared with the current from Eq. (11) in form notation. These sources of current are not present in special relativity and so are absent from the standard model. They are, however, the currents responsible for the generation of electricity from space-time as observed experimentally { 37 }. In these equations the tetrad with raised index is defined as usual through the metric.

Similarly, a wave equation can be built up from Eqs. (7) and (8) to show that j^{a} can also be built up from space-time in a manner analogous to Eq. (32). These equations give new insights into the process of absorption - which takes electromagnetic energy from space-time, stores it in a material such as an atom, and changes it into other forms of energy within the material. Such a change of energy can take place within a superconductor or semiconductor, or a well designed circuit. The end process is an output voltage - the production of electricity from ECE space-time. The structure of the wave equation (28) is:

$$\square A^{\mu} = -k^{2} A^{\mu} = \mu_0 J^{\mu} \quad -(33)$$

which is also the structure of the wave equation of superconductivity { 35 }. The space part of Eq. (33) is the London equation { 35 }:

$$\underline{J} = -k^2 \underline{A}. \quad -(34)$$

If $\underline{A}$ is time-independent then:

$$\underline{E} = -\partial \underline{A} / \partial t = \underline{0}. \quad -(35)$$

Ohm's law is

$$\underline{E} = R\underline{J} \quad -(36)$$

so $\underline{E} = \underline{0}$, $\underline{J} \neq \underline{0}$, meaning that R = 0. The resistance to a finite current $\underline{J}$ from ECE space-time is zero under these circumstances and so the material thus defined is a superconductor. This theory is similar to Cooper pair theory { 35 } and also gives the Meissner effect (exclusion of magnetic flux). The extra insight given by ECE theory is that A^μ, k^2 and J^μ are identified as space-time properties. Therefore under well defined circumstances it is conceivable that the absorption of ECE space-time produces a superconductor.

3. DISCUSSION

The photon in ECE theory is a space-time property defined by Eq. (24), which is obtained from the ECE Lemma:

$$\square q^a_\mu = R q^a_\mu \quad -(37)$$

with the fundamental ansatz (2). Here q^a_μ is the fundamental tetrad field and R is defined by the Einstein ansatz { 38 }:

$$R = -kT \quad -(38)$$

where k is the Einstein constant and where T is a well defined { 38 } canonical energy-momentum magnitude formed by index contraction. In the linear limit where the photon does not interact with the gravitational field of for example an electron:

$$kT \rightarrow \left(\frac{m_p c}{\hbar}\right)^2 \quad -(39)$$

where m_p is the mass of the photon. The photon is therefore defined entirely by $A^{(0)}$, k and Cartan geometry in an appropriate representation space - that of the boson. Wave equations such as (24) or (28) in ECE field theory can be solved simultaneously with the field equations (8) and (10), and indeed equations such as Eq. (28) are a re-statement of the field equations as deduced in Section 2. For the free electromagnetic field {1-33}:

$$\omega^a{}_b = \epsilon^a{}_{bc} q^c, \quad -(40)$$

$$R^a{}_b = \epsilon^a{}_{bc} T^c. \quad -(41)$$

In contrast the photon in the standard model is defined by the Proca equation (or the free space d'Alembert equation if the photon mass is neglected) and by the field equations of the standard model:

$$d \wedge F = 0 \quad -(42)$$

$$d \wedge \tilde{F} = \mu_0 J \quad -(43)$$

in which the field is related to the potential by:

$$F = d \wedge A. \quad -(44)$$

In the standard model there are therefore several fundamental problems, for example the inability to describe the interaction of electromagnetism with gravitation, the conflict between spin accelerations and special relativity (where there are no accelerations); the conflict between photon mass theory and gauge theory; the absence of the Evans spin field { 1-33 } because of the absence of general relativity.

The electron in ECE theory is described by

$$(\square + kT)\, q^a_\mu = 0 \qquad -(45)$$

where q^a_μ is the wave function of the electron. The latter is a fermion in an SU(2) representation space that defines the tetrad as:

$$q^a_\mu = \begin{bmatrix} q^R_1 & q^R_2 \\ q^L_1 & q^L_2 \end{bmatrix} . \qquad -(46)$$

The Dirac spinor is obtained straightforwardly from the tetrad. Eq. (45) describes the trajectory of an electron in a gravitational field. The superscripts R and L denote left and right fermion spin and the subscripts 1 and 2 denote components of the two dimensional complex SU(2) representation space. The free electron is defined when the gravitational field is vanishingly weak. In this limit:

$$kT \rightarrow \left(\frac{m_e c}{\hbar}\right)^2 \qquad -(47)$$

where m_e is the mass of the electron. In this limit Eq. (45) becomes the Dirac equation

$$\left(\square + \left(\frac{m_e c}{\hbar}\right)^2\right)\psi = 0 \qquad -(48)$$

where:

$$\psi = \begin{bmatrix} \phi^R \\ \phi^L \end{bmatrix} \qquad -(49)$$

is the Dirac spinor, and where ϕ^R and ϕ^L are the Pauli spinors.

The interaction between an electron and photon is described by solving Eqs. (24) and (45) simultaneously - the fermion boson interaction problem in general relativity. The wave-function of the fermion is a tetrad in SU(2) representation space and the wave-function of the boson is a tetrad in O(3) representation space. In the standard model this problem is approached in the semi-classical limit or by using quantum electrodynamics with artificial renormalization of unphysical infinities which do not occur in general relativity. The process of renormalization introduces adjustable parameters and therefore quantum electrodynamics is an incomplete theory of special relativity, and not general relativity as required. In ECE theory the interaction of a photon and electron {1-33} is defined by solving two simultaneous equations:

$$\square q^a_{\mu e} = R_e q^a_{\mu e}, \quad -(50)$$

$$\square A^a_\mu = R_p A^a_\mu . \quad -(51)$$

Within a factor $A^{(0)}$ Eq. (51) is

$$\square q^a_{\mu p} = R_p q^a_{\mu p} . \quad -(52)$$

Here R_e is the scalar curvature of the electron and R_p is the scalar curvature of the photon. The tetrad in Eq. (52) denotes the wave function of the photon, and the tetrad in Eq. (50) denotes the wave function of the electron. The effect of the electron on the photon is described by Eqs. (50) and (52), which are derived from Cartan geometry. The influence of the electron wave function on the photon wave function is to set up the currents j^a and J^a. The wave function of the free photon will be changed by the electron and vice versa. Therefore the basic problem is one of interaction of curvatures, total curvature being conserved. Before interaction:

$$R = R_{ei} + R_{pi} . \quad -(53)$$

After interaction:

$$R = R_{ef} + R_{pf} \quad -(54)$$

and:

$$R_{ei} + R_{pi} = R_{ef} + R_{pf}. \quad -(55)$$

Therefore the wave function of the electron after interaction is:

$$R_{ef} = R_{ei} + (R_{pi} - R_{pf}) \quad -(56)$$

and:

$$R_{ef} - R_{ei} = R_{pi} - R_{pf}. \quad -(57)$$

In conventional language this means that the electron has absorbed energy and momentum from the photon, but ECE theory shows also that the photon originates in Cartan geometry, and in curvature and torsion. Therefore in absorbing a photon, the electron has absorbed energy from space-time itself. Depending on material and circuit design a large amount of energy may be absorbed by the electron, producing a large j^a and $\bar{J}^a$, and providing electric power from space-time as observed experimentally { 37 }. The simplest possible type of theory may be developed for atoms and molecules, absorption and emission theory, the theory of conduction, semi-conductors and superconductors. Gravitational theory may be incorporated into quantum electrodynamics, the theory of radio activity, and quantum chromo-dynamics, and conversely electromagnetic theory may be incorporated into graviton, gravitino and supersymmetry theory.