A SUMMARY OF ECE UNIFIED FIELD THEORY IN VECTOR NOTATION.

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ABSTRACT

A summary is given of the ECE unified field theory in vector notation, complete details of all derivations are appended in notes accompanying this paper, UFT255, on www.aias.us. The ECE theory is an intricate construction when written out completely in vector notation, but it can be simplified by reasonable assumptions and approximations, and the vector notation is the one used almost exclusively by engineers. These are equations of the post Einsteinian era in physics, equations which correctly incorporate spacetime torsion as well as curvature.

Keywords: ECE theory, vector notation, electrodynamics, gravitation.

UFT 255

1 INTRODUCTION

In this series of two hundred and fifty five papers to date {1-10} a unified field theory has been developed and applied systematically in the physical sciences and engineering. It is known as Einstein Cartan Evans (ECE) unified field theory to distinguish it from the earlier Einstein Cartan theory. The original concepts of Cartan {11} have been extended and the Evans identity inferred from the Cartan identity. The theory and precursor B(3) theory is mainstream post Einsteinian natural philosophy and have attracted an estimated thirty six million readings in eleven years from detailed and accurate scientometrics. It is important therefore to express ECE theory in vector notation, because this is the one used by engineers, and because ECE theory is the only unified field theory that accounts for energy from spacetime, and devices constructed from that idea (www.upitec.org, www.et3m.net). ECE theory has also been applied to low energy nuclear reactors (LENR). Both energy from spacetime and LENR are now used routinely in industry but the standard model of physics has no explanation for them and is therefore entirely obsolete.

In Section 2 the Cartan Maurer structure equations and the Cartan and Evans identities are expressed in vector notation and written out for convenience of reference. For complete details the notes accompanying this paper, UFT255, should be consulted on www.aias.us. These notes give the information needed to translate from differential form notation to tensor notation to vector notation. The results of Section 2 form the basis for an extended ECE engineering model.

2. THE VECTOR EQUATIONS OF ECE THEORY.

The ECE theory is based entirely on well known {11} Cartan geometry, which consists of two structure equations and the Cartan identity. The structure equations have been defined many times in this series of papers in all detail. They define the torsion and the curvature of any space of any dimension. The Cartan identity is an identity between torsion and curvature. The Evans identity is an example of the Cartan identity in four dimensions. In ECE theory the structure equations define the field in terms of the potential, and the Cartan and Evans identities give the field equations. All the wave equations of physics are given by the tetrad postulate. In differential form notation the equations of ECE theory are simple, but the form notation is too abstract for immediate practical implementation by engineers. The form notation must be translated into tensor notation and then in to vector notation. The latter is used almost exclusively by engineers and chemists, and also by most physicists. In so doing the structure of the antisymmetric field tensors must be defined, and the field tensors translated into field vectors. This process requires a considerable amount of skill and experience, so for the purposes of engineering it is essential to give the entire theory in vector format. The latter is summarized in this section. Those interested in the complete details are referred to the accompanying notes for UFT255 on www.aias.us. The vector equations look very different from the form and tensor equations, but express the same thing in different format. It is essential to realize that the underlying mathematical space is the general space described by the general metric.

The first Cartan structure equation defines the Cartan torsion in terms of the spin connection and tetrad using the wedge derivative and wedge product. A convenient summary of details is given in Note 255(6). In vector notation there are two types of torsion vector, the spin torsion and the orbital torsion. In ECE theory the spin torsion gives rise to the magnetic flux density in electromagnetism and the gravitomagnetic field in gravitational theory. The orbital torsion vector gives rise to the electric field strength in electromagnetism and the gravitational field in gravitational theory. The orbital torsion vector is:

$$\underset{\sim}{T}(\text{orb}) = T^1(\text{orb})\,\underline{i} + T^2(\text{orb})\,\underline{j} + T^3(\text{orb})\,\underline{k} \quad -(1)$$

The tetrad four vector and spin connection four vector are:

$$\underline{q}^b = q^b_1\,\underline{i} + q^b_2\,\underline{j} + q^b_3\,\underline{k} \quad -(2)$$

$$\underline{\omega}^a{}_b = \omega^a{}_{1b}\,\underline{i} + \omega^a{}_{2b}\,\underline{j} + \omega^a{}_{3b}\,\underline{k} \quad -(3)$$

The spin torsion is defined by:

$$\underline{T}(\text{spin}) = T^1(\text{spin})\,\underline{i} + T^2(\text{spin})\,\underline{j} + T^3(\text{spin})\,\underline{k} \quad -(4)$$

In these equations the indices a and b refer to states of polarization.

The second Cartan structure equation defines the Cartan curvature in terms of the spin connection, the wedge derivative and the wedge product. There is orbital curvature and spin curvature in vector notation. The orbital curvature vector is:

$$\underline{R}^a{}_b(\text{orb}) = R^a{}_b{}^1(\text{orb})\,\underline{i} + R^a{}_b{}^2(\text{orb})\,\underline{j} + R^a{}_b{}^3(\text{orb})\,\underline{k} \quad -(5)$$

and the spin curvature vector is:

$$\underline{R}^a{}_b(\text{spin}) = R^a{}_b{}^1(\text{spin})\,\underline{i} + R^a{}_b{}^2(\text{spin})\,\underline{j} + R^a{}_b{}^3(\text{spin})\,\underline{k} \quad -(6)$$

Therefore there are four structure equations in vector notation. In electromagnetism for example the ECE hypothesis is:

$$\underline{E}^a = cA^{(0)}\,\underline{T}^a(\text{orb}) \quad -(7)$$

$$\underline{B}^a = A^{(0)}\,\underset{\sim}{\underline{T}}^a(\text{spin}) \quad -(8)$$

and translates the geometrical structure equations into equations between electric field strength, magnetic flux density and the vector and scalar potentials for different states of polarization. The electromagnetic four potential is defined as:

$$A^a_\mu = \left(\frac{\phi^a}{c}, -\underline{A}^a\right) \quad -(9)$$

so the electric field strength is:

$$\underline{E}^a = -c\underline{\nabla} A^a_0 - \frac{\partial \underline{A}^a}{\partial t} - c\omega^a_{0b}\underline{A}^b + cA^b_0\,\underline{\omega}^a_b \quad -(10)$$

and the magnetic flux density is:

$$\underline{B}^a = \underline{\nabla} \times \underline{A}^a - \underline{\omega}^a_b \times \underline{A}^b \quad -(11)$$

The relation between fields and potentials contains the scalar and vector spin connections. These are missing in the standard model of physics.

The field equations of electromagnetism and gravitation are given by the identities of Cartan geometry. In tensor notation the Cartan identity is:

$$D_\mu T^a_{\nu\rho} + D_\rho T^a_{\mu\nu} + D_\nu T^a_{\rho\mu} := R^a_{\mu\nu\rho} + R^a_{\rho\mu\nu} + R^a_{\nu\rho\mu} \quad -(12)$$

where $T^a_{\mu\nu}$ is an antisymmetric tensor for each a, and where $R^a_{b\mu\nu}$ is an antisymmetric tensor for each a and b. In differential geometry they are respectively vector and tensor valued two-forms. In UFT254 it was shown that Eq. (12) in vector notation is the vector identity:

$$\underline{\nabla} \cdot \underline{\omega}^b_c \times \underline{q}^c = \underline{\omega}^a_b \cdot \underline{\nabla} \times \underline{q}^b - \underline{q}^b \cdot \underline{\nabla} \times \underline{\omega}^a_b \quad -(13)$$

This was derived using three space indices only:

$$D_1 T^a_{23} + D_2 T^a_{31} + D_3 T^a_{12} := R^a_{123} + R^a_{231} + R^a_{312}. \quad -(14)$$

The vector identity (13) is much easier to implement than the abstract Eq. (12). In four dimensions there are also identities with timelike index 0 as follows:

$$D_0 T^a_{23} + D_2 T^a_{30} + D_3 T^a_{02} := R^a_{023} + R^a_{230} + R^a_{302} \quad -(15)$$

$$D_0 T^a_{31} + D_1 T^a_{03} + D_3 T^a_{10} := R^a_{031} + R^a_{103} + R^a_{310} \quad -(16)$$

$$D_0 T^a_{12} + D_1 T^a_{20} + D_2 T^a_{01} := R^a_{012} + R^a_{120} + R^a_{201} \quad -(17)$$

It is shown in complete detail in Note 255(5) that Eqs. (15) - (17) are equivalent to:

$$\frac{1}{c}\frac{\partial T^{a0}}{\partial t} + \omega^{a}{}_{0b} T^{b0} = R^{a}{}_{0}{}^{0}. \quad -(18)$$

It is shown in Section 3 that this has a resonant like solution. So the Cartan identity in vector notation gives two simple equations (13) and (18) which are much more transparent and understandable than the antisymmetric tensorial sum (12).

The Hodge dual representation of Eq. (12) is:

$$D_{\mu} \tilde{T}^{\mu\nu} := \tilde{R}_{\mu}{}^{a\mu\nu} \quad -(19)$$

where the tilde denotes the well known {1 - 11} Hodge dual:

$$\tilde{T}^{\mu\nu} = \frac{1}{2} \epsilon^{\mu\nu\rho\sigma} T_{\rho\sigma} \quad -(20)$$

The homogenous field equation in ECE theory is:

$$\partial_{\mu} \tilde{T}^{\mu\nu} = \tilde{R}_{\mu}{}^{a\mu\nu} - \omega^{a}{}_{\mu b} \tilde{T}^{b\mu\nu} = 0 \quad -(21)$$

In electromagnetism this translates into:

$$\partial_{\mu} \tilde{F}^{\mu\nu} = 0. \quad -(22)$$

Experimentation has resulted in a controversy about the existence of the magnetic charge current density. Assuming that this is zero, then:

$$\tilde{R}_{\mu}{}^{a\mu\nu} = \omega^{a}{}_{\mu b} \tilde{T}^{b\mu\nu} \quad -(23)$$

and the geometrical structure reduces to:

$$\partial_{\mu} \tilde{T}^{\mu\nu} = 0. \quad -(24)$$

In note 255(6) it is shown that this is:

$$\underline{\nabla} \cdot \underline{T}^{a}(\text{spin}) = 0 \quad -(25)$$

$$\frac{1}{c}\frac{\partial \underset{\sim}{T}^{a}(\text{spin})}{\partial t} + \underline{\nabla} \times \underset{\sim}{T}^{a}(\text{orb}) = \underline{0} \quad -(26)$$

which in electromagnetic theory becomes:

$$\underline{\nabla} \cdot \underline{B}^{a} = 0 \quad -(27)$$

$$\frac{\partial \underline{B}^{a}}{\partial t} + \underline{\nabla} \times \underline{E}^{a} = \underline{0} \quad -(28)$$

in any four dimensional spacetime and for any metric. Eqs. (27) and (28) generalize the Gauss law of magnetism and the Faraday law of induction.

The torsion tensor and its Hodge dual are defined for a given state of polarization a by:

$$T_{\rho\sigma} = \begin{bmatrix} 0 & T_1(\text{orb}) & T_2(\text{orb}) & T_3(\text{orb}) \\ -T_1(\text{orb}) & 0 & -T_3(\text{spin}) & T_2(\text{spin}) \\ -T_2(\text{orb}) & T_3(\text{spin}) & 0 & -T_1(\text{spin}) \\ -T_3(\text{orb}) & -T_2(\text{spin}) & T_1(\text{spin}) & 0 \end{bmatrix} \quad -(29)$$

and:

$$\tilde{T}^{\mu\nu} = \begin{bmatrix} 0 & -T^1(\text{spin}) & -T^2(\text{spin}) & -T^3(\text{spin}) \\ T^1(\text{spin}) & 0 & T^3(\text{orb}) & -T^2(\text{orb}) \\ T^2(\text{spin}) & -T^3(\text{orb}) & 0 & T^1(\text{orb}) \\ T^3(\text{spin}) & T^2(\text{orb}) & -T^1(\text{orb}) & 0 \end{bmatrix} \quad -(30)$$

The torsion tensor with raised indices is defined by the metric:

$$\tilde{T}^{\mu\nu} = g^{\mu\alpha} g^{\nu\beta} \tilde{T}_{\alpha\beta}. \quad -(31)$$

The spin and orbital torsion vectors are defined by:

$$\underline{T}(spin) = T^1(spin)\,\underline{i} + T^2(spin)\,\underline{j} + T^3(spin)\,\underline{k} \quad -(32)$$

and:

$$\underline{T}(orb) = T^1(orb)\,\underline{i} + T^2(orb)\,\underline{j} + T^3(orb)\,\underline{k} \quad -(33)$$

in which the components in contravariant notation are defined by:

$$\left.\begin{array}{l} T^1(spin) = \tilde{T}^{10} = -\tilde{T}^{01} \\ T^2(spin) = \tilde{T}^{20} = -\tilde{T}^{02} \\ T^3(spin) = \tilde{T}^{30} = -\tilde{T}^{03} \end{array}\right] \quad -(34)$$

$$\left.\begin{array}{l} T^1(orb) = \tilde{T}^{23} = -\tilde{T}^{32} \\ T^2(orb) = \tilde{T}^{31} = -\tilde{T}^{13} \\ T^3(orb) = \tilde{T}^{12} = -\tilde{T}^{21} \end{array}\right] \quad -(34a)$$

Similarly the spin and orbital curvature vectors are defined by:

$$\underline{R}(spin) = R^1(spin)\,\underline{i} + R^2(spin)\,\underline{j} + R^3(spin)\,\underline{k} \quad -(35)$$

and:

$$\underline{R}(orb) = R^1(orb)\,\underline{i} + R^2(orb)\,\underline{j} + R^3(orb)\,\underline{k} \quad -(36)$$

in contravariant notation. Here:

$$R^1(spin) = \tilde{R}^{10} = -\tilde{R}^{01} \quad -(37)$$
$$R^1(orb) = \tilde{R}^{23} = -\tilde{R}^{32}$$

and so forth as in Eqs. (34) and (34a) for torsion.

The assumption (23) that there is no magnetic charge current density produces two more vector equations:

$$\underline{\omega}^a{}_b \cdot \underline{T}^b(spin) = \underline{q}^b \cdot \underline{R}^a{}_b(spin) \quad -(38)$$

and

$$\omega^a{}_{0b}\,\underline{T}^b(spin) + \underline{\omega}^a{}_b \times \underline{T}^b(orb) = q^b{}_0\,\underline{R}^a{}_b(spin) + \underline{q}^b \times \underline{R}^a{}_b(orb)$$
$$-(39)$$

as in Note 255(6). In Eqs. (38) and (39) the spin connection four-vector is defined in covariant notation as:

$$\omega^a{}_{\mu b} = \left(\omega^a{}_{0b}, \, -\underline{\omega}^a{}_b \right) \quad - (40)$$

so the spin connection vector is:

$$\underline{\omega}^a{}_b = \omega^a{}_{1b}\,\underline{i} + \omega^a{}_{2b}\,\underline{j} + \omega^a{}_{3b}\,\underline{k}. \quad - (41)$$

Similarly the tetrad four-vector is defined as as:

$$q^b{}_\mu = \left(q^b{}_0, \, -\underline{q}^b \right) \quad - (42)$$

so the tetrad vector is:

$$\underline{q}^b = q^b{}_1\,\underline{i} + q^b{}_2\,\underline{j} + q^b{}_3\,\underline{k} \quad - (43)$$

As shown in UFT254 the constraint (23) reduces the vector identity (13) to the simple result:

$$\underline{\nabla} \cdot \underline{\omega}^b{}_c \times \underline{q}^c = 0. \quad - (44)$$

In electromagnetic theory Eq. (38) becomes:

$$\underline{\omega}^a{}_b \cdot \underline{B}^b = \underline{A}^b \cdot \underline{R}^a{}_b(\text{spin}) \quad - (45)$$

and Eq. (39) becomes:

$$\omega^a{}_{0b}\,\underline{B}^b + \frac{1}{c}\,\underline{\omega}^a{}_b \times \underline{E}^b = A^b{}_0\,\underline{R}^a{}_b(\text{spin}) + \underline{A}^b \times \underline{R}^a{}_b(\text{orb}) \quad - (46)$$

producing additional relations between fields and potentials. We denote Eqs. (45) and (46) as additional equations of the extended engineering model.

The geometry of the inhomogeneous field equations of ECE theory is given by the Evans identity {1 - 11}:

$$D_\mu \tilde{T}^a_{\nu\rho} + D_\rho \tilde{T}^a_{\mu\nu} + D_\nu \tilde{T}^a_{\rho\mu} := \tilde{R}^a_{\mu\nu\rho} + \tilde{R}^a_{\rho\mu\nu} + \tilde{R}^a_{\nu\rho\mu} \quad -(47)$$

which can be written as:

$$D_\mu T^{a\mu\nu} := R^{a\ \mu\nu}_{\ \mu} \quad -(48)$$

The inhomogeneous field equation is defined to be:

$$\partial_\mu T^{a\mu\nu} = j^{a\nu} \quad -(49)$$

where the four current is:

$$j^{a\nu} = R^{a\ \mu\nu}_{\ \mu} - \omega^a_{\ \mu b} T^{b\mu\nu} \neq 0. \quad -(50)$$

Experiments show that the four current is not zero. In defining the Hodge dual equation (48) the metric cancels out on both sides so the torsion tensor with raised indices is:

$$T^{\mu\nu} = \begin{bmatrix} 0 & -T^1(orb) & -T^2(orb) & -T^3(orb) \\ T^1(orb) & 0 & -T^3(spin) & T^2(spin) \\ T^2(orb) & T^3(spin) & 0 & -T^1(spin) \\ T^3(orb) & -T^2(spin) & T^1(spin) & 0 \end{bmatrix} \quad -(51)$$

Therefore in vector notation Eq. (49) is:

$$\underline{\nabla} \cdot \underset{\sim}{T}^a(orb) = j^{a0} \quad -(52)$$

and

$$\underline{\nabla} \times \underline{T}^a(\text{spin}) - \frac{1}{c}\frac{\partial \underline{T}^a}{\partial t}(\text{orb}) = \underline{j}^a . \quad -(53)$$

In electromagnetism they become generalizations of the Coulomb law:

$$\underline{\nabla} \cdot \underline{E}^a = \frac{\rho^a}{\epsilon_0} \quad -(54)$$

and the Ampere Maxwell law:

$$\underline{\nabla} \times \underline{B}^a - \frac{1}{c^2}\frac{\partial \underline{E}^a}{\partial t} = \mu_0 \underline{J}^a . \quad -(55)$$

These are generalizations that are written in any four dimensional space and include the spin connection. Full details are given in note 255(7).

In note 255(8) full details are given of the derivation of the geometrical structure of charge density and current density in ECE theory. Using Cartesian notation:

$$\underline{q}^b = q^b_x \underline{i} + q^b_y \underline{j} + q^b_z \underline{k} \quad -(56)$$

$$\underline{\omega}^a{}_b = \omega^a{}_{xb} \underline{i} + \omega^a{}_{yb} \underline{j} + \omega^a{}_{zb} \underline{k} \quad -(57)$$

the charge density is:

$$j^{a0} = \underline{\omega}^a{}_b \cdot \underline{T}^b(\text{orb}) - \underline{q}^b \cdot \underline{R}^a{}_b(\text{orb}) \quad -(58)$$

and the current density is:

$$\underline{j}^a = \omega^a{}_{0b} \underline{T}^b(\text{orb}) + \underline{\omega}^a{}_b \times \underline{T}^b(\text{spin}) - \left(q^b_0 \underline{R}^a{}_b(\text{orb}) + \underline{q}^b \times \underline{R}^a{}_b(\text{spin})\right) \quad -(59)$$

The individual components of the torsion and curvature vectors are defined by:

$$T^a_{\ x}(orb) = T^{a1}(orb) = T^{a10} - T^{a01} \quad -(60)$$

etc.

$$R^a_{\ bx}(orb) = R^a_{\ b}{}^1(orb) = R^a_{\ b}{}^{10} - R^a_{\ b}{}^{01}$$

etc. $\quad -(61)$

To translate into electric charge density ($C m^{-3}$) use:

$$\underline{E}^a = cA^{(0)}\underset{\sim}{T}^a(orb) \quad -(62)$$

where $\underline{E}^a$ is the electric field strength in units of $V m^{-1}$ or $J C^{-1} m^{-1}$. The units of $A^{(0)}$ are $J s C^{-1} m^{-1}$ so it follows that:

$$\underline{\nabla} \cdot \underline{E}^a = cA^{(0)} j^{a0} = \rho^a / \epsilon_0 \quad -(63)$$

where ϵ_0 is the vacuum permittivity in units of $J^{-1} C^2 m^{-1}$. In S. I. Units:

$$\epsilon_0 \mu_0 = \frac{1}{c^2} \quad -(64)$$

where μ_0 is the vacuum permeability in units of $J s^2 C^{-2} m^{-1}$. Therefore the electric charge density can be expressed as:

$$\rho^a = \epsilon_0 c A^{(0)}\left(\underline{\omega}^a_{\ b} \cdot \underset{\sim}{T}^b(orb) - \underline{q}^b \cdot \underline{R}^a_{\ b}(orb)\right) \quad -(65)$$

so:

$$\rho^a = \epsilon_0\left(\underline{\omega}^a_{\ b} \cdot \underline{E}^b - c\underline{A}^b \cdot \underline{R}^a_{\ b}(orb)\right). \quad -(66)$$

For the free field:

$$\rho^a = 0 \quad -(67)$$

so:

$$\underline{\omega}^a{}_b \cdot \underline{E}^b = c\underline{A}^b \cdot \underline{R}^a{}_b(\text{orb}). \quad -(68)$$

Experimentally the electric field strength between two charges is observed with great precision to be:

$$\underline{E} = E_r \underline{e}_r = -\frac{e}{4\pi\epsilon_0 r^2}\underline{e}_r. \quad -(69)$$

If the vector potential is assumed to be absent in electrostatics then Eq. (63) reduces to:

$$\underline{\nabla} \cdot \underline{E}^a = \underline{\omega}^a{}_b \cdot \underline{E}^b \quad -(70)$$

and of there is only one sense of radially directed polarization then:

$$\frac{\partial E_r}{\partial r} = \omega E_r = \frac{e}{2\pi\epsilon_0 r^3} = -\frac{\omega e}{4\pi\epsilon_0 r^2} \quad -(71)$$

so the spin connection is:

$$\omega = -\frac{2}{r}. \quad -(72)$$

As shown in all detail in note 255(8) the geometrical structure of the current density vector is:

$$\underline{j}^a = \omega^a{}_b \underline{T}^b(\text{orb}) + \underline{\omega}^a{}_b \times \underline{T}^b(\text{spin}) - \left(\omega_0{}^b \underline{R}^a{}_b(\text{orb}) + \underline{\omega}^b \times \underline{R}^a{}_b(\text{spin})\right) \quad -(73)$$

in which the spin torsion and spin curvature vectors are:

$$\underline{T}^a(\text{spin}) = T^a_x(\text{spin})\underline{i} + T^a_y(\text{spin})\underline{j} + T^a_z(\text{spin})\underline{k} \quad -(74)$$

and

$$\underline{R}^a{}_b(\text{spin}) = R^a{}_{bx}(\text{spin})\underline{i} + R^a{}_{by}(\text{spin})\underline{j} + R^a{}_{bz}(\text{spin})\underline{k} \quad -(75)$$

with individual components:

$$T^a_x(\text{spin}) = T^{a1}(\text{spin}) = T^{a32} = -T^{a23}$$
$$T^a_y(\text{spin}) = T^{a2}(\text{spin}) = T^{a13} = -T^{a31}$$
$$T^a_z(\text{spin}) = T^{a3}(\text{spin}) = T^{a21} = -T^{a12} \quad -(76)$$
$$R^a{}_{bx}(\text{spin}) = R^a{}_b{}^1(\text{spin}) = R^a{}_b{}^{32} = -R^a{}_b{}^{23}$$
$$R^a{}_{by}(\text{spin}) = R^a{}_b{}^2(\text{spin}) = R^a{}_b{}^{13} = -R^a{}_b{}^{31}$$
$$R^a{}_{bz}(\text{spin}) = R^a{}_b{}^3(\text{spin}) = R^a{}_b{}^{21} = -R^a{}_b{}^{12}$$

The basic geometrical structure of the field equation is:

$$\underline{\nabla} \times \underline{T}^a(\text{spin}) - \frac{1}{c}\frac{\partial \underline{T}^a(\text{orb})}{\partial t} = \underline{j}^a \quad -(77)$$

Multiplying Eq. (77) by $A^{(0)}$ gives the ECE generalization of the Ampère Maxwell law:

$$\underline{\nabla} \times \underline{B}^a - \frac{1}{c^2}\frac{\partial \underline{E}^a}{\partial t} = \mu_0 \underline{J}^a = A^{(0)} \underline{j}^a \quad -(78)$$

in which the electromagnetic current density in units of $C s^{-1} m^{-2}$ is:

$$\underline{J}^a = \frac{A^{(0)}}{\mu_0} \underline{j}^a. \quad -(79)$$

The electromagnetic four current is therefore:

$$J^{\mu a} = (c\rho^a, \underline{J}^a). \quad -(80)$$

The current density can be expressed in terms of the electric field strength and scalar and vector potentials as follows:

$$\underline{J}^a = \epsilon_0 c \Big(\omega^a{}_{0b} \underline{E}^b - c A^b_0 \underline{R}^a{}_b(\text{orb}) + \underline{\omega}^a{}_b \times \underline{E}^b - c \underline{A}^b \times \underline{R}^a{}_b(\text{spin}) \Big) \quad -(81)$$

In note 255(9) a simple example is given of the application of these equations to energy from spacetime using the concept of vacuum charge density and current density:

$$\underline{\nabla} \cdot \underline{E}^a = \rho^a(\text{vacuum}) / \epsilon_0 \quad - (82)$$

$$\underline{\nabla} \times \underline{B}^a - \frac{1}{c^2} \frac{\partial \underline{E}^a}{\partial t} = \mu_0 \underline{J}^a(\text{vacuum}) \quad - (83)$$

If the Coulomb law (82) is considered in the absence of a vector potential using one sense of polarization the electric field strength simplifies to:

$$\underline{E} = -\underline{\nabla} \phi + \underline{\omega} \phi . \quad - (84)$$

If it is assumed that the spin connection is negative valued:

$$\underline{\omega} = -\left(\omega_X \underline{i} + \omega_Y \underline{j} + \omega_Z \underline{k} \right). \quad - (85)$$

For simplicity consider a Z axis alignment. The Coulomb law (82) gives:

$$\frac{\partial^2 \phi}{\partial Z^2} + \left(\frac{\partial \omega_Z}{\partial Z} \right) \phi + \omega_Z \frac{\partial \phi}{\partial Z} = -\frac{\rho(\text{vac})}{\epsilon_0} . \quad - (86)$$

From the radiative corrections it is known that the vacuum contains fluctuating potentials which give rise to the radiative corrections (e.g. UFT85). Assume that these take the simple form:

$$\rho(\text{vac}) = \rho_0 \cos(\kappa_0 Z + \pi) = -\rho_0 \cos(\kappa_0 Z) \quad - (87)$$

and a damped Euler Bernoulli equation is obtained:

$$\frac{\partial^2 \phi}{\partial Z^2} + \omega_Z \frac{\partial \phi}{\partial Z} + \left(\frac{\partial \omega_Z}{\partial Z} \right) \phi = \frac{\rho_0}{\epsilon_0} \cos(\kappa_0 Z) \quad - (88)$$

which can be written as:

$$\frac{\partial^2 \phi}{\partial Z^2} + \beta \frac{\partial \phi}{\partial Z} + \kappa^2 \phi = A \cos(\kappa_0 Z) \quad - (89)$$

where:

$$\kappa^2 := \frac{\partial \omega_Z}{\partial Z}, \quad \beta := \omega_Z; \quad A := \rho_0(vac) / \epsilon_0 \quad -(90)$$

By antisymmetry {1 - 10}:

$$\underline{\nabla} \phi = \underline{\omega} \phi \quad -(91)$$

so in the Z direction:

$$\frac{\partial \phi}{\partial Z} = -\omega_Z \phi \quad -(92)$$

and Eq. (89) becomes:

$$\frac{\partial^2 \phi}{\partial Z^2} + (\kappa^2 + \omega_Z^2)\phi = A\cos(\kappa_0 Z) \quad -(93)$$

This is an undamped Euler Bernoulli equation of the type:

$$\frac{\partial^2 \phi}{\partial Z^2} + \kappa_1^2 \phi = A\cos(\kappa_0 Z) \quad -(94)$$

with:

$$\kappa_1^2 = \kappa^2 + \omega_Z^2 \quad -(95)$$

whose solution is:

$$\phi = \frac{A\cos(\kappa_0 Z)}{\kappa_1^2 - \kappa_0^2} \quad -(96)$$

Therefore when:

$$\kappa_1^2 = \kappa_0^2 \quad -(97)$$

the scalar potential and electric field strength become infinite:

$$\phi \rightarrow \infty . \quad -(98)$$

This is spin connection resonance as observed by the Alex Hill group (www.et3m.net), a mechanism which is probably also responsible for LENR. An infinitesimal vacuum charge current density produces infinite electric field strength in the measuring apparatus. In the Rossi E Cat reactor {12} for example the spin connection resonance vapourizes steel.

Note 255(3) develops the vectorial format of the Cartan identity given in Eq. (12):

$$\underline{\nabla} \cdot \underline{T}^a + \underline{\omega}^a{}_b \cdot \underline{T}^b := \underline{q}^b \cdot \underline{R}^a{}_b \quad -(99)$$

This equation shows clearly that if torsion is neglected the curvature also vanishes unless:

$$\underline{q}^b \cdot \underline{R}^a{}_b = 0, \quad \underline{R}^a{}_b \neq \underline{0} . \quad -(100)$$

In tensor notation this is the first Bianchi identity:

$$R^a{}_{\mu\nu\rho} + R^a{}_{\rho\mu\nu} + R^a{}_{\nu\rho\mu} = 0. \quad -(101)$$

Note 255(3) demonstrates that the first Bianchi identity (101) implies:

$$\underline{\nabla} \cdot \underline{\omega}^a{}_b \times \underline{q}^b = 0 \quad -(102)$$

which in ECE theory means that there is no magnetic monopole. The correct version of the first Bianchi identity must always be the Cartan identity:

$$D_\mu T^a{}_{\nu\rho} + D_\rho T^a{}_{\mu\nu} + D_\nu T^a{}_{\rho\mu} := R^a{}_{\mu\nu\rho} + R^a{}_{\rho\mu\nu} + R^a{}_{\nu\rho\mu} \quad -(103)$$

In note 255(4) the derivation is given of the second Bianchi identity:

$$D_\mu R^\kappa{}_{\lambda\nu\rho} + D_\rho R^\kappa{}_{\lambda\mu\nu} + D_\nu R^\kappa{}_{\lambda\rho\mu} = 0 \quad -(104)$$

of the standard physics from the first Bianchi identity, and it is shown that the correct version of the second Bianchi identity is:

$$D_\mu D_\lambda T^\kappa{}_{\nu\rho} + D_\rho D_\lambda T^\kappa{}_{\mu\nu} + D_\nu D_\lambda T^\kappa{}_{\rho\mu} \quad -(105)$$
$$:= D_\mu R^\kappa{}_{\lambda\nu\rho} + D_\rho R^\kappa{}_{\lambda\mu\nu} + D_\nu R^\kappa{}_{\lambda\rho\mu} .$$

This is a trivial extension of the Cartan identity:

$$D_\lambda T^\kappa{}_{\nu\rho} + D_\rho T^\kappa{}_{\lambda\nu} + D_\nu T^\kappa{}_{\rho\lambda} := R^\kappa{}_{\lambda\nu\rho} + R^\kappa{}_{\rho\lambda\nu} + R^\kappa{}_{\nu\rho\lambda} \quad -(106)$$

which is derived simply bv differentiating both sides of Eq. (106) by D_μ. Therefore the second Bianchi identity (104) is obsolete and incorrect due to neglect of torsion.

The commutator of covariant derivatives acting on a vector (or more generally any tensor) in any space of any dimension produces the result:

$$[D_\mu, D_\nu] V^\rho = -(\Gamma^\lambda_{\mu\nu} - \Gamma^\lambda_{\nu\mu}) D_\lambda V^\rho + R^\rho{}_{\mu\nu\sigma} V^\sigma \quad -(107)$$

in which there is a one to one correspondence between the commutator and the gamma connection (see UFT139):

$$[D_\mu, D_\nu] V^\rho = -\Gamma^\lambda_{\mu\nu} D_\lambda V^\rho + \ldots \quad -(108)$$

The commutator is defined to be antisymmetric:

$$[D_\mu, D_\nu] V^\rho = -[D_\nu, D_\mu] V^\rho \quad -(109)$$

so the gamma connection is also antisymmetric. If torsion is assumed to vanish, or is neglected, then the curvature also vanishes. The reason is that a zero torsion means:

$$\Gamma^{\lambda}_{\mu\nu} = \Gamma^{\lambda}_{\nu\mu} \quad -(110)$$

in which case the commutator is symmetric and zero by definition. So the curvature also vanishes, Q. E. D. This is the fatal flaw in Einsteinian physics. It is clearly demonstrated in the vectorial Eq. (99).

Finally notes 255(1) and 255(2) deal with the two classes of Hodge duality present in for example electrodynamics. The basic Hodge duals from magnetic to electric field components are:

$$\tilde{F}^{03} = \epsilon^{0312} F_{12} \quad -(111)$$

$$\tilde{F}^{01} = \epsilon^{0123} F_{23}$$

$$\tilde{F}^{02} = \epsilon^{0231} F_{31},$$

$$\epsilon^{0123} = 1 = -\epsilon^{0213} = \epsilon^{0231} = -\epsilon^{0321} = \epsilon^{0312}.$$

If the Minkowski spacetime and standard Maxwell Heaviside (MH) theory is used for the sake of illustration only then:

$$(\partial_1 A_2 - \partial_2 A_1)_{HD} = \partial^0 A^3 - \partial^3 A^0 \quad -(112)$$

$$(\partial_2 A_3 - \partial_3 A_2)_{HD} = \partial^0 A^1 - \partial^1 A^0$$

$$(\partial_3 A_1 - \partial_1 A_3)_{HD} = \partial^0 A^2 - \partial^2 A^0$$

In the MH theory the metric is:

$$g^{\mu\nu} = g_{\mu\nu} = \mathrm{diag}(1, -1, -1, -1). \quad -(113)$$

In the general space the metric determinant enters into the Hodge dual. As shown in note 255(1) this type of Hodge duality (which is named "class one Hodge duality") gives equations such as:

$$\underline{E} = -\underline{\nabla}\phi - \frac{\partial \underline{A}}{\partial t} = c(\underline{\nabla} \times \underline{A})_{HD} \quad -(114)$$

where the subscript HD denotes "Hodge dual". Therefore the electric field strength is the class one Hodge dual of the magnetic flux density:

$$\underline{E} = c\,\underline{B}_{HD} \qquad -(115)$$

It is well known that the free electromagnetic field is invariant under the duality transformation:

$$\underline{E} = ic\,\underline{B} \qquad -(116)$$

so for the free field:

$$\underline{E} = ic\,\underline{\nabla} \times \underline{A} = c\,\underline{\nabla} \times (i\underline{A}) = c\left(\underline{\nabla} \times \underline{A}\right)_{HD} \qquad -(117)$$

It follows that for the free field:

$$A^{\mu}_{HD} = i A^{\mu}. \qquad -(118)$$

The basic class one Hodge dual transform from electric to magnetic field is:

$$\begin{aligned} \partial^1 A^2 - \partial^2 A^1 &= \epsilon^{1203}\left(\partial_0 A_3 - \partial_3 A_0\right) \\ \partial^3 A^1 - \partial^1 A^3 &= \epsilon^{3102}\left(\partial_0 A_2 - \partial_2 A_0\right) \\ \partial^2 A^3 - \partial^3 A^2 &= \epsilon^{2301}\left(\partial_0 A_1 - \partial_1 A_0\right) \end{aligned} \qquad -(119)$$

where:

$$\begin{aligned} \epsilon^{0123} &= -\epsilon^{1023} = \epsilon^{1203} = \epsilon^{0312} = -\epsilon^{3012} \\ &= \epsilon^{3102} = \epsilon^{0231} = -\epsilon^{2031} = \epsilon^{2301} = 1 \end{aligned} \qquad -(120)$$

Therefore:

$$\begin{aligned} \left(\partial_0 A_3 - \partial_3 A_0\right)_{HD} &= \partial^1 A^2 - \partial^2 A^1 \\ \left(\partial_0 A_2 - \partial_2 A_0\right)_{HD} &= \partial^3 A^1 - \partial^1 A^3 \\ \left(\partial_0 A_1 - \partial_1 A_0\right)_{HD} &= \partial^2 A^3 - \partial^3 A^2 \end{aligned} \qquad -(121)$$

i.e.

$$\underline{E}_{HD} = -c\underline{B} \quad - (122)$$

The complete class one Hodge dual transform is:

$$\underline{B}_{HD} = \underline{E}/c \quad - (123)$$
$$\underline{E}_{HD} = -c\underline{B}$$

and for free fields:

$$\underline{B}_{HD} = i\underline{B} \quad - (124)$$
$$\underline{E}_{HD} = i\underline{E}$$

The class two Hodge dual transform is the familiar one defined by:

$$\tilde{F}^{\mu\nu} = \frac{1}{2}\epsilon^{\mu\nu\rho\sigma}F_{\rho\sigma} \quad - (125)$$

i.e. is the Hodge transform of fields rather than potentials. The relevant MH field tensors are:

$$\tilde{F}^{\mu\nu} = \begin{bmatrix} 0 & -cB_X & -cB_Y & -cB_Z \\ cB_X & 0 & E_Z & -E_Y \\ cB_Y & -E_Z & 0 & E_X \\ cB_Z & E_Y & -E_X & 0 \end{bmatrix}, \quad F_{\rho\sigma} = \begin{bmatrix} 0 & E_X & E_Y & E_Z \\ -E_X & 0 & -cB_Z & cB_Y \\ -E_Y & cB_Z & 0 & -cB_X \\ -E_Z & -cB_Y & cB_X & 0 \end{bmatrix} \quad - (126)$$

so the class two Hodge duality rearranges matrix elements as follows:

$$\begin{aligned}
\tilde{F}^{01} &= \epsilon^{0123}F_{23}, & -cB_X &= -cB_X \\
\tilde{F}^{02} &= \epsilon^{0231}F_{31}, & -cB_Y &= -cB_Y \\
\tilde{F}^{03} &= \epsilon^{0312}F_{12}, & -cB_Z &= -cB_Z \\
\tilde{F}^{12} &= \epsilon^{1230}F_{30}, & E_Z &= E_Z \\
\tilde{F}^{13} &= \epsilon^{1302}F_{02}, & -E_Y &= -E_Y \\
\tilde{F}^{23} &= \epsilon^{2301}F_{01}, & E_X &= E_X .
\end{aligned} \quad - (127)$$

Finally Note 255(2) demonstrates how the B(3) field is defined in ECE theory in terms of spin connection elements, the B(3) field being the key to unification of

A summary of ECE unifed field theory in vector notation

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3 Illustration of a resonant type solution of Eq.(18)

In order to find solutions of Equation (18) which has been derived from the Cartan identity, we assume only one direction of polarization as in the simplified engineering model. Then all Latin indices disappear, and Eq.(18) simply reads

$$\frac{1}{c}\frac{\partial}{\partial t}\,\mathrm{T}\,(t)+\omega_0\,\mathrm{T}\,(t)=\mathrm{R}\,(t) \tag{128}$$

for a scalar torsion T and curvature R. In the engineering model we prefer a scalar spin connection in untis of reciprocal time, therefore we multiply by c and replace $c\,\omega_0$ by ω_0:

$$\frac{\partial}{\partial t}\,\mathrm{T}\,(t)+\omega_0\,\mathrm{T}\,(t)=c\;\mathrm{R}\,(t)\,. \tag{129}$$

The general solution of this differential equation is

$$\mathrm{T}\,(t)=c\,e^{-\omega_0\,t}\left(\int e^{\omega_0\,t}\,\mathrm{R}\,(t)\,dt+C\right) \tag{130}$$

with an integration constant C. If ω_0 is positive, the integrand will diverge if $R(t)$ remains finite. It is therefore reasonable to assume that ω_0 is negative. Setting

$$\omega_1=-\omega_0 \tag{131}$$

we obtain the solution

$$\mathrm{T}\,(t)=c\,e^{\omega_1\,t}\left(\int e^{-\omega_1\,t}\,\mathrm{R}\,(t)\,dt+C\right) \tag{132}$$

which is an exponentially growing function for $\omega_1>0$, indicating a resonance.

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electromagnetism and gravitation.

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