THE ECE2 FIELD AND POTENTIAL EQUATIONS

by

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ABSTRACT

The complete set of ECE2 field and potential equations is derived from the Cartan and Cartan Evans identities with two fundamental hypotheses. The tangent indices of Cartan geometry are removed and the equations of electrodynamics derived exactly, together with the conservation laws of electrodynamics. New field potential equations are derived from the Maurer Cartan structure equations. ECE2 is much simpler than ECE and produces field equations familiar to every physicist and engineer from the first successful generally covariant unified field theory.

Keywords: ECE2 theory, field and potential equations and conservation equations.

UFT 317

1. INTRODUCTION

In recent papers of this series {1 - 10} new identities of geometry were inferred in UFT313 and developed in vector notation in UFT314 to UFT316 into ECE2 theory, a simpler and more powerful theory than ECE. In UFT311 the basic spin connection of ECE theory was proven experimentally using a circuit designed by Ide. In Section 2 the complete set of field and potential equations of ECE2 are summarized for ease of reference. As usual this paper should be read with its background notes, each UFT paper is a condensed summary of the extensive calculations in the background notes posted with each paper. In note 317(1) the complete background geometry is given for the inhomogeneous field equations, the geometry of the Cartan Evans identity in four dimensions. The antisymmetric torsion and curvature tensors are defined in terms of spin and orbital components. The geometry is transformed into electrodynamics using the two fundamental hypotheses introduced in immediately preceding papers. Note 317(2) derives the Coulomb law and discusses a simple example. Note 317(3) derives the Ampère Maxwell law and gives an extensive summary of S. I. units. In note 317(4) the ECE2 field equations are developed for magnetostatics and electrostatics. In general ECE2 allows for the presence of a magnetic monopole, and can also be used if the magnetic monopole is assumed to vanish. The latter case is discussed in Note 317(4) and the self consistency of the theory demonstrated. Note 317(5) develops the Ampère law in ECE2 using the quantum hypothesis, and again a self consistent result is found. Notes 317(6) and 317(7) are comprehensive checks of all calculations from UFT255 to UFT317 giving all necessary details and producing the final ECE2 field equations which are summarized in Notes 317(6) and 317(7). Section 2 is based on Note 317(7).

2. THE FIELD AND POTENTIAL EQUATIONS.

In general the field equations of ECE2 for electrodynamics are as follows:

$$\underline{\nabla} \cdot \underline{B} = \underline{\kappa} \cdot \underline{B} \quad -(1)$$

$$\underline{\nabla} \cdot \underline{E} = \underline{\kappa} \cdot \underline{E} \quad -(2)$$

$$\frac{\partial \underline{B}}{\partial t} + \underline{\nabla} \times \underline{E} = -\left(\kappa_0 c \underline{B} + \underline{\kappa} \times \underline{E} \right) \quad -(3)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} = \frac{\kappa_0}{c} \underline{E} + \underline{\kappa} \times \underline{B} \quad -(4)$$

where:

$$\kappa_0 = 2 \left(\frac{q_0}{r^{(0)}} - \omega_0 \right) \quad -(5)$$

$$\underline{\kappa} = 2 \left(\frac{\underline{q}}{r^{(0)}} - \underline{\omega} \right). \quad -(6)$$

Here $\underline{B}$ is the magnetic flux density, $\underline{E}$ the electric field strength, the tetrad four vector is

$$q_\mu = \left(q_0, -\underline{q} \right) \quad -(7)$$

and the spin connection four vector is:

$$\omega_\mu = \left(\omega_0, -\underline{\omega} \right). \quad -(8)$$

Here $\underline{\kappa}$ is a wave vector of spacetime, and $c\kappa_0$ has the units of frequency. The ECE2 Eqs. (1) to (4) have exactly the same structure as the Maxwell Heaviside (MH) field equations of special relativity but ECE2 is a generally covariant unified field theory which contains a spin connection and tetrad of Cartan geometry, whereas MH is special relativity as is well known, and as such does not contain a connection. Torsion and curvature are always both non zero in ECE2, whereas the concepts of torsion and curvature do not exist in MH. ECE2 is a powerful simplification of ECE theory, whose spin connection leads to many new effects and new explanations for well known effects {1 - 10}. In ECE2 the tetrad and spin connection are incorporated into the wave four vector of spacetime itself

$$\kappa^\mu = (\kappa^0, \underline{\kappa}) = (\kappa_0, -\underline{\kappa}) \quad -(9)$$

and the components of the wave four vector appear in the magnetic and electric four current densities.

In the assumed absence of a magnetic monopole:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(10)$$

$$\underline{\nabla} \cdot \underline{E} = \underline{\kappa} \cdot \underline{E} = \rho / \epsilon_0 \quad -(11)$$

$$\underline{\nabla} \times \underline{E} + \partial \underline{B} / \partial t = \underline{0} \quad -(12)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} = \mu_0 \underline{J} = \underline{\kappa} \times \underline{B} \quad -(13)$$

and this structure is precisely that of MH theory but of course written in a more general Cartan geometry in which both the torsion and the curvature are identically non-zero. In the absence of a magnetic monopole therefore:

$$\kappa_0 = 2\left(\frac{q_0}{r^{(0)}} - \omega_0 \right) = 0 \quad -(14)$$

and:

$$\underline{B} \perp \underline{\kappa}, \quad -(15)$$

$$\underline{E} \parallel \underline{\kappa}. \quad -(16)$$

It follows that

$$\underline{E} \perp \underline{B} \quad -(17)$$

which is self consistently derived form the Jacobi Cartan Evans (JCE) identity of UFT313 in UFT314 ff. In ECE2 the electric charge density is:

$$\rho = \epsilon_0 \underline{\kappa} \cdot \underline{E} \quad -(18)$$

and the electric current density is:

$$\underline{J} = \frac{1}{\mu_0} \underline{\kappa} \times \underline{B} \quad -(19)$$

where:

$$\epsilon_0 \mu_0 = \frac{1}{c^2}. \quad -(20)$$

$$-(21)$$

The electric charge current four density is therefore:

$$J^\mu = (c\rho, \underline{J}) = \frac{1}{\mu_0} \left(\frac{1}{c} \underline{\kappa} \cdot \underline{E}, \underline{\kappa} \times \underline{B} \right).$$

in the absence of a magnetic monopole.

The conservation of charge current density is a fundamental law of physics which is given immediately by ECE2 as follows. From Eq. (13):

$$\mu_0 \underline{\nabla} \cdot \underline{J} = \underline{\nabla} \cdot \underline{\nabla} \times \underline{B} - \frac{1}{c^2} \underline{\nabla} \cdot \frac{\partial \underline{E}}{\partial t} = -\frac{1}{c^2} \frac{\partial}{\partial t} (\underline{\nabla} \cdot \underline{E}) = -\mu_0 \frac{\partial \rho}{\partial t} \quad -(22)$$

using Eq. (11). So:

$$\frac{\partial \rho}{\partial t} + \underline{\nabla} \cdot \underline{J} = 0 \quad -(23)$$

i.e.

$$\partial_\mu J^\mu = 0. \quad -(24)$$

This means that:

$$\frac{\partial}{\partial t} (\underline{\kappa} \cdot \underline{E}) + c^2 \underline{\nabla} \cdot (\underline{\kappa} \times \underline{B}) = 0 \quad -(25)$$

in the absence of magnetic monopoles. Therefore if $\underline{E}$ and $\underline{B}$ are known, $\underline{\kappa}$ can be found from Eq. (25). The free space equations are defined by Eq. (14) together with:

$$\underline{v} = r^{(0)} \underline{\omega} \quad -(26)$$

and so in free space:

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

$$\underline{\nabla} \cdot \underline{E} = 0 \quad -(28)$$

$$\underline{\nabla} \times \underline{E} + \partial \underline{B} / \partial t = \underline{0} \quad -(29)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \partial \underline{E} / \partial t = \underline{0} \quad -(30)$$

So everything about electrodynamics can be derived form the Cartan and Cartan Evans equations of geometry together with the following hypotheses:

$$\underline{B}^a = A^{(0)} \underline{T}^a (\text{spin}) \quad -(31)$$

$$\underline{E}^a = c A^{(0)} \underline{T}^a (\text{orb}) \quad -(32)$$

$$\underline{B}^a{}_b = W^{(0)} \underline{R}^a{}_b (\text{spin}) \quad -(33)$$

$$\underline{E}^a{}_b = c W^{(0)} \underline{R}^a{}_b (\text{orb}) \quad -(34)$$

discussed in the immediately preceding UFT papers. In addition ECE2 gives all the new information in ECE in a much simpler format easily understandable by physicists, chemists and engineers. The key difference between ECE2 and MH resides in the relation between fields and potentials. Define the four potential:

$$A^\mu = (\phi, c\underline{A}) \quad -(35)$$

where ϕ is the scalar potential and $\underline{A}$ the vector potential. Then in MH:

$$\underline{B} = \underline{\nabla} \times \underline{A} \quad -(36)$$

and in ECE2:

$$\underline{B} = \underline{\nabla} \times \underline{A} + 2\underline{\omega} \times \underline{A} \quad -(37)$$

where the spin connection four vector is defined by:

$$\omega_\mu = (\omega_0, -\underline{\omega}). \quad -(38)$$

Similarly in MH:

$$\underline{E} = -\underline{\nabla}\phi - \frac{\partial A}{\partial t} \quad -(39)$$

and in ECE2:

$$\underline{E} = -\underline{\nabla}\phi - \frac{\partial \underline{A}}{\partial t} + 2(c\omega_0 \underline{A} - \phi\underline{\omega}). \quad -(40)$$

The existence of the spin connection was proven recently in UFT311.

In ECE2 there are new relations between the fields and spin connections based on the vector format of the second Maurer Cartan structure equation:

$$\underline{R}^a{}_b(\text{spin}) = \underline{\nabla} \times \underline{\omega}^a{}_b - \underline{\omega}^a{}_c \times \underline{\omega}^c{}_b \quad -(41)$$

and

$$\underline{R}^a{}_b(\text{orb}) = -\underline{\nabla}\omega^a{}_{0b} - \frac{1}{c}\frac{\partial \underline{\omega}^a{}_b}{\partial t} - \omega^a{}_{0c}\underline{\omega}^c{}_b + \omega^c{}_{0b}\underline{\omega}^a{}_c. \quad -(42)$$

Tangent indices are removed using:

$$\underline{R}(\text{spin}) = e^b e_a \underline{R}^a{}_b(\text{spin}) \quad -(43)$$

and

$$\underline{R}(orb) = e^b e_a \underline{R}^a{}_b(orb). \quad -(44)$$

Therefore:

$$\underline{R}(spin) = \underline{\nabla} \times \underline{\omega} - \underline{\omega}_c \times \underline{\omega}^c = \underline{\nabla} \times \underline{\omega} \quad -(45)$$

and

$$\underline{R}(orb) = -\underline{\nabla}\omega_0 - \frac{1}{c}\frac{\partial \underline{\omega}}{\partial t} - \omega_{0c}\underline{\omega}^c + \omega^c{}_0\underline{\omega}_c = -\underline{\nabla}\omega_0 - \frac{1}{c}\frac{\partial \underline{\omega}}{\partial t} \quad -(46)$$

The geometry is converted into electrodynamics using:

$$\underline{B} = W^{(0)}\underline{R}(spin) \quad -(47)$$

$$\underline{E} = cW^{(0)}\underline{R}(orb) \quad -(48)$$

and:

$$W^\mu = W^{(0)}\omega^\mu \quad -(49)$$

and the new potential four vector:

$$W^\mu = (\phi_W, c\underline{W}) \quad -(50)$$

which has the same units as A^μ, i.e. tesla metre. Here $W^{(0)}$ has the units of magnetic flux or weber (tesla metre squared).

Therefore:

$$\underline{B} = \underline{\nabla} \times \underline{W} \quad -(51)$$

and

$$\underline{E} = -c\underline{\nabla}W_0 - \frac{\partial \underline{W}}{\partial t} = -\underline{\nabla}\phi_W - \frac{\partial \underline{W}}{\partial t} \quad -(52)$$

where:

$$\phi_W = c W_0 . \quad -(53)$$

The overall result is:

$$\underline{B} = \underline{\nabla} \times \underline{W} = \underline{\nabla} \times \underline{A} + 2 \underline{\omega} \times \underline{A} \quad -(54)$$

and:

$$\underline{E} = -\underline{\nabla} \phi_W - \frac{\partial \underline{W}}{\partial t} = -\underline{\nabla} \phi - \frac{\partial \underline{A}}{\partial t} + 2 \left(c\omega_0 \underline{A} - \phi \underline{\omega} \right) . \quad -(55)$$

A vast amount of development is possible with ECE2 in all the areas covered by ECE but in a much simpler and more powerful way.

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