

# Line Element for a Radiating Electron in a Generally Covariant Unified Field Theory

by

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## Abstract

A method is given to determine the four-dimensional line element for a radiating electron in a generally covariant unified field theory. The radiating electron is described classically as an object of finite volume and mass, carrying the electron charge  $-e$ . Starting from the most general line element in four dimensions and curvilinear coordinates, the Einstein Hilbert field equation is solved with a canonical energy momentum density tensor modeled in various ways, one example being a rotating electron. It is shown that the charge current density is in general directly proportional to the Ricci tensor in Einstein Cartan Evans (ECE) unified field theory, so disappears in Ricci flat space-times. However light bending due to gravity and changes of its polarization, occur in Ricci flat space-times. The complete system of equations is given for the line element of a radiating electron in ECE theory.

**Keywords:** ECE theory, radiating electron, line element, light bending and changes of polarization due to gravity.

## 4.1 Introduction

Recently a generally covariant unified field theory has been developed which expresses the equations of classical gravitation and electromagnetism in terms of geometry, as required by the philosophy of general relativity [1]. Standard Cartan geometry [2] is used for this purpose, and a unified view of classical

and quantum physics physics has emerged through Einstein Cartan Evans (ECE) unified field theory [3–12]. It has been shown that the equations of classical electrodynamics in a generally covariant unified field theory have the same vector form as in the Maxwell Heaviside (MH) field theory, but they are expressed in a space-time with curvature and torsion rather than in the flat Minkowski space-time without curvature or torsion. In ECE theory furthermore the electric and magnetic fields are related to the scalar and vector potentials with the scalar and vector parts of the spin connection of Cartan geometry, the object that indicates that space-time is curving and spinning. The charge-current density in ECE theory is built up from elements of the Ricci tensor, so in Ricci flat space-times the charge-current density vanishes. This result proves the conceptual self-consistency of ECE theory, because the charge-current density vanishes in a Ricci flat vacuum.

In Section 4.2, the dielectric formulation of ECE theory [3–12] is used to show that light grazing a massive object is deflected and also changes its polarization. This is a straightforward result of the ECE Ampère Maxwell law with finite current density in general. When the current density is zero the deflection is due to a change in phase velocity from  $c$  to  $v$ , as in the theory of refraction. This results in a phase change and change of polarization from circular to elliptical. Such a process is shown to occur in a Ricci flat space-time where the light travels along a null geodesic.

In Section 4.3 the general equations due to Crothers [13–15] are given for line elements in the class of Ricci flat space-times and it is emphasized that in general the geodesic proper radius is not the same as the radius of curvature. This is the basic flaw at the root of theories that give a singularity at initial event, such as Big Bang or black hole.

Finally in Section 4.4 a method is developed for defining the line element by starting from the most general type of metric in curvilinear coordinates in four dimensions and using models for the canonical energy momentum density in the Einstein Hilbert (EH) field equation.

## 4.2 Change of Polarization of Light Due to Gravitation

The basis of this calculation is the ECE Ampère Maxwell law [3–12]:

$$\nabla \times \mathbf{B} - \frac{1}{c^2} \frac{\partial E}{\partial t} = \mu_0 \mathbf{J}_{\text{grav}} \quad (4.1)$$

where the current density  $\mathbf{J}_{\text{grav}}$  is calculated from the space-time around a mass  $M$ . In order to generate  $\mathbf{J}_{\text{grav}}$  there must be present a primordial voltage  $cA^{(0)}$  and electric charge  $-e$ . There is no satisfactory metric currently in existence for the gravitational field external to a point mass, as argued rigorously by Crothers [13–15] the available metrics [16] confuse the radius of curvature of a line element with its geodesic proper radius. There are also

other serious errors in the standard model literature [13–15] so in this paper a method is suggested of deducing the line element of a radiating electron that is an exact solution of EH and which also obeys the fundamental rules [13–15] of differential geometry. In this section the dielectric theory of ECE [3–12] is used to illustrate how it is possible to proceed without knowledge of the precise line element.

In this theory the space-time around  $M$  is considered to be a dielectric:

$$\mathbf{E} = \frac{1}{\epsilon_0}(\mathbf{D} - \mathbf{P}), \mathbf{B} = \mu_0(\mathbf{H} + \mathbf{M}) \quad (4.2)$$

where  $\mathbf{P}$  is the polarization,  $\mathbf{M}$  is the magnetization,  $\mathbf{D}$  is the electric displacement,  $\mathbf{H}$  is the magnetic field strength,  $\mathbf{B}$  is the magnetic flux density,  $\mathbf{E}$  is the electric field strength and  $\epsilon_0$  and  $\mu_0$  are the permittivity and permeability in vacuo respectively. The vacuum is defined as flat or Minkowski space-time with no matter present, so the connection vanishes and the Christoffel symbols and Riemann tensor elements are all zero. From Eq. (4.2) in Eq. (4.1)

$$\nabla \times \mathbf{H} - \frac{\partial \mathbf{D}}{\partial t} = \mathbf{J} - \left( \nabla \times \mathbf{M} + \frac{\partial \mathbf{P}}{\partial t} \right). \quad (4.3)$$

The current density is defined in terms of  $\mathbf{M}$  and  $\mathbf{P}$  as follows:

$$\mathbf{J} := \nabla \times \mathbf{M} + \frac{\partial \mathbf{P}}{\partial t} \quad (4.4)$$

so Eq. (4.1) becomes:

$$\nabla \times \mathbf{H} - \frac{\partial \mathbf{D}}{\partial t} = \mathbf{0} \quad (4.5)$$

where

$$\mathbf{H} = \frac{1}{\mu} \mathbf{B}, \quad \mathbf{D} = \epsilon \mathbf{E}. \quad (4.6)$$

Here  $\mu$  and  $\epsilon$  are the permeability and permittivity respectively of the space-time around the mass  $M$ . The solution of Eq. (4.5) is

$$\mathbf{H} = \frac{H^{(0)}}{\sqrt{2}}(i\mathbf{i} + \mathbf{j}) \exp(i(\omega t - \kappa Z)) \quad (4.7)$$

$$\mathbf{D} = \frac{D^{(0)}}{\sqrt{2}}(i - i\mathbf{j}) \exp(i(\omega t - \kappa Z)) \quad (4.8)$$

provided that:

$$\kappa H^{(0)} = \omega D^{(0)} \quad (4.9)$$

i.e. provided that

$$\frac{B^{(0)}}{\mu} = \frac{\omega}{\kappa} \epsilon E^{(0)}. \quad (4.10)$$

If:

$$\epsilon\mu = \epsilon_0\mu_0 = \frac{1}{c^2} \quad (4.11)$$

then Eq. (4.10) becomes

$$E^{(0)} = cB^{(0)} \quad (4.12)$$

which is the vacuum result of Minkowski spacetime, i.e. the vacuum result in MH theory. Eq. (4.5) is:

$$\nabla \times \left( \frac{\mathbf{B}}{\mu} \right) - \frac{\partial}{\partial t} (\epsilon \mathbf{E}) = \mathbf{0}. \quad (4.13)$$

In the first approximation it is assumed that  $\epsilon$  and  $\mu$  are  $\mathbf{r}$  and  $t$  independent so:

$$\nabla \times \mathbf{B} - \epsilon\mu \frac{\partial \mathbf{E}}{\partial t} = \mathbf{0} \quad (4.14)$$

where the phase velocity of the wave is defined by:

$$\epsilon\mu = \frac{1}{v^2}. \quad (4.15)$$

The solution of eq. (4.14) is the plane wave:

$$\mathbf{B} = \frac{B^{(0)}}{\sqrt{2}} (i\mathbf{i} + \mathbf{j}) e^{i\phi'} \quad (4.16)$$

$$\mathbf{E} = \frac{E^{(0)}}{\sqrt{2}} (i - i\mathbf{j}) e^{i\phi'} \quad (4.17)$$

where

$$v = \frac{\omega}{\kappa} \quad (4.18)$$

and

$$\phi' = \omega t - \kappa Z. \quad (4.19)$$

The vacuum plane wave has the properties:

$$c = \frac{\omega}{\kappa}, \quad (4.20)$$

$$\phi = \omega t - \kappa Z. \quad (4.21)$$

So the effect of the current density  $\mathbf{J}_{\text{grav}}$  is to slow the phase velocity of the plane wave from  $c$  to  $v$ . This is a refractive index effect similar to light at an interface [16]. It is known from the EH theory that light in a null geodesic is bent by gravitation. This result is usually obtained from a purely kinematic consideration - the photon of mass  $m$  interacting with the gravitating mass  $M$ . The light goes into orbit and so its phase velocity is slowed from  $c$  to  $v$ .

The real part of Eq. (4.17) is obtained from the de Moivre theorem:

$$e^{i\phi'} = \cos \phi' + i \sin \phi' \quad (4.22)$$

giving:

$$\text{Re}(\mathbf{E}) = \frac{E^{(0)}}{\sqrt{2}} (\mathbf{i} \cos \phi' + \mathbf{j} \sin \phi'). \quad (4.23)$$

The equivalent vacuum result is:

$$\text{Re}(\mathbf{E}) = \frac{E^{(0)}}{\sqrt{2}} (\mathbf{i} \cos \phi + \mathbf{j} \sin \phi). \quad (4.24)$$

Using:

$$\cos \phi' = a \cos \phi \quad (4.25)$$

$$\sin \phi' = b \sin \phi \quad (4.26)$$

Eq. (4.23) becomes:

$$\text{Re}(\mathbf{E}) = \frac{E^{(0)}}{\sqrt{2}} (a\mathbf{i} \cos \phi + b\mathbf{j} \sin \phi) \quad (4.27)$$

so the circularly polarized plane wave of Eq. (4.24) is changed to the elliptically polarized plane wave (4.27).

In a Ricci flat space-time the charge/current density vanishes, so:

$$R_{\mu\nu} = 0, R = 0, \rho = 0, \mathbf{J} = \mathbf{0}. \quad (4.28)$$

The line element that is usually used to produce the kinematic theory of light bending due to gravity is:

$$ds^2 = \left(1 - \frac{2mG}{rc^2}\right) c^2 dt^2 - \left(1 - \frac{2mG}{rc^2}\right)^{-1} dr^2 - r^2 (d\theta^2 + \sin^2 \theta d\phi^2) \quad (4.29)$$

which has serious flaws in it [13–15] and is wrongly attributed to Schwarzschild. The line element (4.29) is Ricci flat by construction [2] but its Christoffel symbols and Riemann tensor elements may be non-zero. In the kinematic theory of light bending by gravitation a null geodesic is constructed from (4.29), but the Ricci tensor elements are all zero. The phase velocity of the plane wave in this case is given by Eq. (4.18) with:

$$\mathbf{J}_{\text{grav}} = 0 \quad (4.30)$$

and this results in a change of polarization. So whenever light is bent by gravity, its polarization also changes in ECE theory. This is as observed experimentally [3–12].

### 4.3 Light Bending in Ricci Flat Space-Times

Crothers has shown [13–15] that Ricci flat space-times have the form:

$$ds^2 = \left(1 - \frac{\alpha}{C^{1/2}}\right) c^2 dt^2 - \left(1 - \frac{\alpha}{C^{1/2}}\right)^{-1} d(C^{1/2}) - C(r)(d\theta^2 + \sin^2 \theta d\phi^2) \quad (4.31)$$

where the radius of curvature is defined as:

$$R_c = C^{1/2} = (|r - r_0|^n + \alpha^n)^{1/n}. \quad (4.32)$$

The important points in the analysis by Crothers [13–15] are as follows.

1.  $C$  is not determined by the EH field equation.
2. Any  $C$  can be used in Eq. (4.31) without changing the spherical symmetry or violating the field equation.
3.  $C$  must be asymptotically Minkowskian.

4. There is a difference between the radius of curvature and the geodesic proper radius  $R_p$

The latter is defined for the Crothers line element [13–15]:

$$ds^2 = AC^{1/2}c^2 dt^2 - BC^{1/2}d(C^{1/2}) - C(r)(d\theta^2 + \sin^2 \theta d\phi^2) \quad (4.33)$$

by:

$$\begin{aligned} R_p &= \int_0^{R_p} dR_p = \int_{R_c(r_0)}^{R_c(r)} \left( B(R_c(r))^{1/2} dR_c(r) \right) \\ &= \int_{r_0}^r (B(R_c(r)))^{1/2} \left( \frac{dR_c(r)}{dr} \right) dr. \end{aligned} \quad (4.34)$$

5. It is not possible to assume that

$$0 \leq R_c(r) < \infty \quad (4.35)$$

if

$$0 \leq r < \infty. \quad (4.36)$$

6. The Ricci flat space-times include the following classes: Schwarzschild, Kerr-Newman, Kerr, charged Kerr, and the exterior of an incompressible spherical fluid [13–15]. All these describe the gravitational field in terms of a center of mass, a pure mathematical construct. In physics a center of mass is contained within an identically non-zero volume, and the line elements inside and outside the volume are in general different [13–15].

Light bending occurs in a Ricci flat space-time because the Christoffel symbols and Riemann tensor elements may be non-zero while by construction [2, 13–15]:

$$R_{\mu\nu} = 0, R = 0. \quad (4.37)$$

The usual line element used to describe light bending is Eq. (4.29), which is wrongly attributed to Schwarzschild and which is a special case of Eq. (4.31) [13–15]. In the kinematic theory of light bending a photon of mass  $m$  is attracted by the mass  $M$  along a null geodesic [3–12] constructed from Eq. (4.29). The line elements (4.29) and (4.31) both give in ECE theory:

$$\rho = 0, \mathbf{J} = \mathbf{0} \quad (4.38)$$

so the ECE laws for light bending in a Ricci flat space-time are the four equations:

$$\nabla \cdot \mathbf{B} = 0 \quad (4.39)$$

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0} \quad (4.40)$$

$$\nabla \cdot \mathbf{E} = 0 \quad (4.41)$$

$$\nabla \times \mathbf{B} - \frac{1}{v^2} \frac{\partial \mathbf{E}}{\partial t} = \mathbf{0} \quad (4.42)$$

where the phase velocity of the plane wave is defined by Eq. (4.18) of Section 4.2. These considerations are also true for the Ricci flat line element outside a sphere of incompressible fluid [13–15]:

$$ds^2 = \left(1 - \frac{\alpha}{R_c}\right) c^2 dt^2 - \left(1 - \frac{\alpha}{R_c}\right)^{-1} dR_c^2 - R_c^2 (d\theta^2 + \sin^2 \theta d\phi^2). \quad (4.43)$$

Outside the sphere:

$$\rho = 0, \quad \mathbf{J} = \mathbf{0} \quad (4.44)$$

but inside the sphere:

$$\rho \neq 0, \quad \mathbf{J} \neq \mathbf{0}. \quad (4.45)$$

The irretrievable problems with line element (4.29) are well known and discussed in Chapter 23 of [www.aiaa.us](http://www.aiaa.us). In addition, the standard model does not correctly distinguish between the passive mass:

$$M = \rho_0 V \quad (4.46)$$

and the active mass:

$$m = \frac{\alpha}{2}. \quad (4.47)$$

In Eq. (4.43), in the Crothers notation of Chapter 23:

$$R_c = (|r - r_0|^n + \epsilon^n)^{1/3}, \quad (4.48)$$

$$\alpha = \left(\frac{3}{\kappa \rho_0}\right)^{1/2} \sin^3 |\chi_a - \chi_0|, \quad (4.49)$$



$$\epsilon = \left( \frac{3}{\kappa \rho_0} \right)^{1/2} \left( \frac{3}{2} \sin^3 |\chi_a - \chi_0| - \frac{9}{4} \cos |\chi_a - \chi_0| \cdot \left( |\chi_a - \chi_0| - \frac{1}{2} \sin^2 |\chi_a - \chi_0| \right) \right)^{1/3}. \quad (4.50)$$

The original Schwarzschild result of 1916 is obtained for:

$$n = 3, r_0 = 0, \chi_0 = 0, r > 0, \chi_a > 0. \quad (4.51)$$

The geodesic proper radius is determined by the line element of the interior of the sphere and in general:

$$\alpha \neq M. \quad (4.52)$$

These fundamental properties of geometry irretrievably invalidate the theory of Big Bang and of black holes and dark matter. None exist in natural philosophy.

#### 4.4 General Method for Determining The Line Element of a Radiating Electron

The most general line element in four dimensions and in curvilinear coordinates is

$$ds^2 = A(dx_0)^2 - B(dx_1)^2 - C(dx_2)^2 - D(dx_3)^2. \quad (4.53)$$

where  $A$ ,  $B$ ,  $C$  and  $D$  are a priori unknown. Computer algebra was used to evaluate all the Christoffel symbols, Riemann tensor elements, Ricci tensor elements, scalar curvature and Einstein tensor elements of the line element (4.53). It was checked that it obeys the usually named “first Bianchi identity”, which in differential form notation is:

$$R \wedge q = 0 \quad (4.54)$$

and in tensor notation is:

$$R_{\sigma\mu\nu\rho} + R_{\sigma\rho\mu\nu} + R_{\sigma\nu\rho\mu} = 0. \quad (4.55)$$

Therefore the left hand side of the Einstein Hilbert equation:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = k T_{\mu\nu} \quad (4.56)$$

can be evaluated in terms of  $A$ ,  $B$ ,  $C$ , and  $D$ . The complexity of the algebra is no longer a factor because computational packages such as Maxima can be used, in this case code written by Dr. Horst Eckardt. In Eq. (4.56),  $R_{\mu\nu}$  is the Ricci tensor,  $R$  is the scalar curvature,  $g_{\mu\nu}$  is the symmetric metric,  $k$  is the Einstein constant and  $T_{\mu\nu}$  is the canonical energy momentum density tensor of Noether. Thus  $T_{\mu\nu}$  can be expressed in terms of  $A$ ,  $B$ ,  $C$  and  $D$  in the curvilinear coordinate system  $(x_0, x_1, x_2, x_3)$  or any other coordinate system. To determine  $A$ ,  $B$ ,  $C$ , and  $D$  a system of simultaneous equations is solved numerically for given initial and boundary conditions.

Particular models are then introduced for  $T_{\mu\nu}$  in order to simplify the problem and to find what  $A$ ,  $B$ ,  $C$ , and  $D$  are needed for the model. The tensor  $T_{\mu\nu}$  determines the curvature of space-time in Eq. (4.56) and its properties are described for example by Ryder [17]. The angular momentum density for example is a rank three tensor defined by:

$$M^{0\mu\nu} = T^{0\mu}x^\nu - T^{0\nu}x^\mu \quad (4.57)$$

and the angular momentum tensor is:

$$M^{\mu\nu} = \int M^{0\mu\nu} dx^3. \quad (4.58)$$

The Noether Theorem gives the conservation of energy momentum density as follows:

$$D_\mu T^{\mu\nu} = 0. \quad (4.59)$$

The three components [17] of the spin angular momentum are  $M^{12}$ ,  $M^{23}$ , and  $M^{31}$  and the three components of the orbital angular momentum are  $M^{01}$ ,  $M^{02}$  and  $M^{03}$ . The conservation of angular momentum is given from the Noether Theorem as:

$$D_0 M^{\mu\nu} = 0 \quad (4.60)$$

and in curved space-time:

$$D_\rho M^{\rho\mu\nu} = 0 \quad (4.61)$$

where:

$$M^{\rho\mu\nu} = T^{\rho\mu}x^\nu - T^{\rho\nu}x^\mu. \quad (4.62)$$

Thus:

$$(D_\rho T^{\rho\mu})x^\nu + T^{\rho\mu}D_\rho x^\nu - (D_\rho T^{\rho\nu})x^\mu - T^{\rho\nu}D_\rho x^\mu = 0. \quad (4.63)$$

Using Eq. (4.59):

$$T^{\rho\mu}D_\rho x^\nu = T^{\rho\nu}D_\rho x^\mu. \quad (4.64)$$

The left hand side is true when

$$\rho = \nu \quad (4.65)$$

and the right hand side is true when:

$$\rho = \mu. \quad (4.66)$$

Thus, self consistently:

$$T^{\nu\mu} = T^{\mu\nu}. \quad (4.67)$$

The orbital angular momentum in classical dynamics is:

$$\mathbf{J} = \mathbf{p} \times \mathbf{r} \quad (4.68)$$

where  $p$  is linear momentum and  $r$  is distance, so it is seen by comparison of Eqs. (4.68) and (4.57) that:

$$M^{012} = T^{01}x^2 - T^{02}x^1, M^{12} = \int M^{012}d^3x \quad (4.69)$$

and so on are tensor representations of Eq. (4.68). By definition:

$$\begin{aligned} x^\mu &= (ct, X, Y, Z) \\ &= (x^0, x^1, x^2, x^3), \end{aligned} \quad (4.70)$$

$$\begin{aligned} p^\mu &= \left( \frac{En}{c}, p_X, p_Y, p_Z \right) \\ &= (p^0, p^1, p^2, p^3), \end{aligned} \quad (4.71)$$

Therefore

$$T^{00} = p^0/V = E_n/(cV) \quad (4.72)$$

$$T^{01} = p^1/V = p_X/(V) \quad (4.73)$$

$$T^{02} = p^2/V = p_Y/(V) \quad (4.74)$$

$$T^{03} = p^3/V = p_Z/(V). \quad (4.75)$$

These considerations can now be applied to the radiating electron, which in ECE theory [3–12] is described by the vector equations:

$$\nabla \cdot \mathbf{B} = 0 \quad (4.76)$$

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = 0 \quad (4.77)$$

$$\nabla \cdot \mathbf{E} = \rho/\epsilon_0 \quad (4.78)$$

$$\nabla \times \mathbf{B} - \frac{1}{c^2} \frac{\partial \mathbf{E}}{\partial t} = \mu_0 \mathbf{J}. \quad (4.79)$$

The charge density and current density are found from the components of the Ricci tensor of Eq. (4.56). The electron is considered as possessing an orbital angular momentum, a finite volume  $V$ , and a charge  $-e$ . So the system of equations (4.56) reduces to:

$$R_{00} - \frac{1}{2} R g_{00} = k p_0(\mathbf{r}, t)/V \quad (4.80)$$

$$R_{01} - \frac{1}{2} R g_{01} = k p_1(\mathbf{r}, t)/V \quad (4.81)$$

$$R_{02} - \frac{1}{2} R g_{02} = k p_2(\mathbf{r}, t)/V \quad (4.82)$$

$$R_{03} - \frac{1}{2} R g_{03} = k p_3(\mathbf{r}, t)/V \quad (4.83)$$

with:

$$T_{00}(\mathbf{r}, t) = p_0(\mathbf{r}, t)/V \quad (4.84)$$

$$T_{01}(\mathbf{r}, t) = p_1(\mathbf{r}, t)/V \quad (4.85)$$

$$T_{02}(\mathbf{r}, t) = p_2(\mathbf{r}, t)/V \quad (4.86)$$

$$T_{03}(\mathbf{r}, t) = p_3(\mathbf{r}, t)/V. \quad (4.87)$$

Therefore Eqs. (4.80) to (4.83) defined  $A$ ,  $B$ ,  $C$ , and  $D$  in Eq. (4.52) in a particular coordinate system in terms of

$$p_0(\mathbf{r}, t), p_1(\mathbf{r}, t), p_2(\mathbf{r}, t), \text{ and } p_3(\mathbf{r}, t). \quad (4.88)$$

Using the minimal prescription:

$$p_\mu = eA_\mu \quad (4.89)$$

we have defined  $A$ ,  $B$ ,  $C$ , and  $D$  in terms of the four potential  $A_\mu$  of ECE theory, and thus in terms of the electric and magnetic fields of a radiating electron and the spin connection [3–12]:

$$\mathbf{B} = \nabla \times \mathbf{A} - \boldsymbol{\omega} \times \mathbf{A} \quad (4.90)$$

$$\mathbf{E} = -\nabla\phi - \frac{\partial \mathbf{A}}{\partial t} - c\omega^0 \mathbf{A} + c\boldsymbol{\omega}, \quad (4.91)$$

where

$$A^\mu = (A^0, \mathbf{A}) = (\phi, \mathbf{A}) \quad (4.92)$$

The system of equations (4.80) to (4.83) thus becomes:

$$R_{00} - \frac{1}{2}Rg_{00} = ekA_0(\mathbf{r}, t)/V \quad (4.93)$$

$$R_{01} - \frac{1}{2}Rg_{01} = ekA_1(\mathbf{r}, t)/V \quad (4.94)$$

$$R_{02} - \frac{1}{2}Rg_{02} = ekA_2(\mathbf{r}, t)/V \quad (4.95)$$

$$R_{03} - \frac{1}{2}Rg_{03} = ekA_3(\mathbf{r}, t)/V \quad (4.96)$$

where:

$$A_\mu = (A_0, -\mathbf{A}) \quad (4.97)$$

and where  $A^\mu$  must obey Eqs. (4.76)–(4.79), (4.90) and (4.91). Using computer algebra Eqs. (4.76)–(4.79) can be expressed in terms of  $A^\mu$  and  $\omega^\mu$ , where:

$$\omega^\mu = (\omega^0, \boldsymbol{\omega}). \quad (4.98)$$

The charge current density can be expressed [3–12] as

$$J^{\kappa\nu} = -A^{(0)}R^{\kappa\nu} = -A^{(0)}R^{\kappa}_{\mu\mu\nu}. \quad (4.99)$$

Therefore this system of equations defines a radiating electron in ECE theory. They must be solved self-consistently using computer algebra and packages for any given method.

The Ricci flat solution is:

$$R_{00} - \frac{1}{2}Rg_{00} = 0 \quad (4.100)$$

$$R_{01} - \frac{1}{2}Rg_{01} = 0 \quad (4.101)$$

$$R_{02} - \frac{1}{2}Rg_{02} = 0 \quad (4.102)$$

$$R_{03} - \frac{1}{2}Rg_{03} = 0 \quad (4.103)$$

and in this case  $A$ ,  $B$ ,  $C$ , and  $D$  of Eq. (4.52) are constrained by Eqs. (4.100) to (4.103). It is seen that this system of equations goes further than the standard model by considering the following contradiction of the standard model. In the latter it is possible to have a plane wave such as:

$$\mathbf{A} = \frac{A^{(0)}}{\sqrt{2}}(\mathbf{i} - i\mathbf{j}) \exp(i(\omega t - \kappa Z)) \quad (4.104)$$

propagating in free space without a source:

$$\rho = 0, \mathbf{J} = \mathbf{0}. \quad (4.105)$$

This is a well known philosophical contradiction of the standard model, one of many, because the field of force exists without a source for the field. In ECE the equations of this type of plane wave are:

$$R^{\kappa\nu} = 0 \quad (4.106)$$

and

$$R_{01} - \frac{1}{2}Rg_{01} = ek \frac{A^{(0)}}{\sqrt{2}} e^{i(\omega t - \kappa Z)} \quad (4.107)$$

$$R_{02} - \frac{1}{2}Rg_{02} = -iek \frac{A^{(0)}}{\sqrt{2}} e^{i(\omega t - \kappa Z)} \quad (4.108)$$

$$R_{03} - \frac{1}{2}Rg_{03} = 0. \quad (4.109)$$

Eq. (4.106) contradicts Eqs. (4.107) and (4.108) because the Ricci tensor is zero in Eq. (4.106) and non-zero in Eqs. (4.107) and (4.108). If the scalar potential is considered to be:

$$A^0 = \phi = \frac{\phi^{(0)}}{\sqrt{2}} \exp(i(\omega t - \kappa Z)) \quad (4.110)$$

there is another contradiction:

$$R_{00} - \frac{1}{2}Rg_{00} = ekc\frac{\phi^{(0)}}{\sqrt{2}}e^{i(\omega t - \kappa Z)}, \quad (4.111)$$

so it is seen that ECE is both rigorously self consistent and also a generally covariant unified field theory which describes the radiating electron with the equations of classical gravitation and classical electrodynamics in one self consistent geometrical framework.

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