THE COULOMB LAW IN GENERALLY COVARIANT UNIFIED FIELD THEORY.

by

Myron W. Evans,

Civil List Scientist.

(emyrone@aol.com, www.aias.us)

ABSTRACT

The Coulomb law is calculated exactly from Einstein Cartan Evans (ECE) unified field theory. The result shows that there are relativistic corrections of the same order as those responsible for the deflection of light by gravity and perihelion advance for example. In the special relativistic limit the Coulomb law of classical electrodynamics is recovered self consistently.

Keywords : Einstein Cartan Evans (ECE) unified field theory, exact calculation of the generally covariant Coulomb Law.

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1. INTRODUCTION

In classical electrodynamics the Coulomb law is well known to be a precise law of special relativity in Minkowski space-time {1}. However in a generally covariant unified field theory all the laws of classical electrodynamics become unified with those of gravitation and other fundamental fields {2-9}. In previous work {2-9} the Coulomb Law has been developed using the spin connection, revealing the presence of resonance phenomena that can lead to new sources of energy. A dielectric formulation of the laws of classical electrodynamics has also been given. This showed that light deflected by gravity also changes polarization, as observed for example in light deflected by white dwarf stars {10}. More generally, there are many optical and electro-dynamical changes predicted by Einstein Cartan Evans (ECE) unified field theory {2-9}. In Section Two one of these predictions is worked out exactly for the Coulomb Law, starting with the Bianchi identity of differential geometry. In Section Three a discussion is given of the generally covariant Coulomb law and suggestions made as to how to test the theory experimentally. Appendices give sufficient mathematical detail to follow the derivation step by step.

2. THE GENERALLY COVARIANT COULOMB LAW.

The starting point of the derivation is the Bianchi identity {11} of Cartan geometry:

$$d \wedge T^a + \omega^a{}_b \wedge T^b := R^a{}_b \wedge q^b \quad -(1)$$

where T^a is the torsion form, $\omega^a{}_b$ is the spin connection, d ^ denotes the wedge product of differential geometry, $R^a{}_b$ is the curvature form and q^b is the tetrad form. Using the fundamental hypothesis {2-9}:

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

$$F^a = A^{(0)} T^a, \qquad (3)$$

Eq. (1) becomes the ECE field equation:

$$d \wedge F^a = A^{(0)} \left(R^a{}_b \wedge q^b - \omega^a{}_b \wedge T^b \right) := \mu_0 j^a . \qquad (4)$$

Here A^a is the potential form, F^a is the field form, and $cA^{(0)}$ is a primordial scalar in volts. The hypothesis (2) has been tested experimentally in an extensive manner (www.aias.us). The field equation (4) is generally covariant because the Bianchi identity is generally covariant. Under the general coordinate transformation the field equation becomes:

$$\left(d \wedge F^a \right)' = \left(\mu_0 j^a \right)' \qquad (5)$$

which is:

$$\left(d \wedge T^a + \omega^a{}_b \wedge T^b \right)' := \left(R^a{}_b \wedge q^b \right)' . \qquad (6)$$

It retains its form under the coordinate transform because it consists of tensorial quantities. This is the essence of general relativity.

Applying the Hodge dual transform to both sides of Eq. (4) (Appendix (1)) the inhomogeneous ECE field equation is obtained:

$$d \wedge \tilde{F}^a = A^{(0)} \left(\tilde{R}^a{}_b \wedge q^b - \omega^a{}_b \wedge \tilde{T}^b \right) := \mu_0 J^a . \qquad (7)$$

Here the tilde denotes Hodge transformation {2-9, 11}. It is seen that the same Hodge transform is applied to two-forms on both sides of the equation. The generally covariant Coulomb law is part of the inhomogeneous field equation (7). As shown in Appendix (2), the homogeneous and inhomogeneous field equations are the tensor equations:

$$\partial_\mu \tilde{F}^{a\mu\nu} = \mu_0 \tilde{j}^{a\nu} \quad -(8)$$

and

$$\partial_\mu F^{a\mu\nu} = \mu_0 J^{a\nu} \quad -(9)$$

respectively. These tensor equations are generally covariant. They look like the Maxwell Heaviside field equations but contain more information. In the special case:

$$R^a{}_b \wedge q^b = \omega^a{}_b \wedge T^b \quad -(10)$$

the homogeneous field equation becomes:

$$\partial_\mu \tilde{F}^{a\mu\nu} = 0 \quad -(11)$$

and the inhomogeneous equation becomes:

$$\partial_\mu F^{a\mu\nu} = A^{(0)} \left(R^a{}_\mu{}^{\mu\nu} \right)_{grav} . \quad -(12)$$

It has been shown {2-9} that the special case (10) is pure rotation. A solution of Eq. (10) is:

$$R^a{}_b = -\frac{\kappa}{2} \epsilon^a{}_{bc} T^c , \quad \omega^a{}_b = -\frac{\kappa}{2} \epsilon^a{}_{bc} q^c \quad -(13)$$

in which case the curvature is this well defined dual of the torsion and the spin connection is the well defined dual of the tetrad. These results are developed in all detail elsewhere {2-9}. When the connection is the Christoffel connection, however, the gravitational torsion vanishes:

$$\left(T^{a}\right)_{grav} = 0, \quad -(14)$$

$$\left(T^{\kappa}_{\mu\nu}\right)_{grav} = \Gamma^{\kappa}_{\mu\nu} - \Gamma^{\kappa}_{\nu\mu} = 0, \quad -(15)$$

and the curvature form becomes the Riemann tensor:

$$R^{\rho}{}_{\sigma\mu\nu} = \partial_{\mu}\Gamma^{\rho}_{\nu\sigma} - \partial_{\nu}\Gamma^{\rho}_{\mu\sigma} + \Gamma^{\rho}_{\mu\lambda}\Gamma^{\lambda}_{\nu\sigma} - \Gamma^{\rho}_{\nu\lambda}\Gamma^{\lambda}_{\mu\sigma}. \quad -(16)$$

In this case the inhomogeneous equation becomes:

$$\partial_{\mu} F^{a\mu\nu} = A^{(0)} R^{a}{}_{\mu}{}^{\mu\nu} \quad -(17)$$

and as shown in Appendix (3) can be written as two vector equations:

$$\left(\underline{\nabla}\cdot\underline{E}\right)^{0} = -\phi^{(0)}\left(R^{0}{}_{1}{}^{10} + R^{0}{}_{2}{}^{20} + R^{0}{}_{3}{}^{30}\right) \quad -(18)$$

and

$$\underline{\nabla}\times\underline{B}^{a} = \frac{1}{c^{2}}\frac{\partial \underline{E}^{a}}{\partial t} + \mu_{0}\underline{J}^{a} \quad -(19)$$

where

$$J^{1}_{1} = -\frac{A^{(0)}}{\mu_{0}}\left(R^{1}{}_{0}{}^{10} + R^{1}{}_{2}{}^{12} + R^{1}{}_{3}{}^{13}\right), \quad -(20)$$

$$J^{2}_{2} = -\frac{A^{(0)}}{\mu_{0}}\left(R^{2}{}_{0}{}^{20} + R^{2}{}_{1}{}^{21} + R^{2}{}_{3}{}^{23}\right), \quad -(21)$$

$$J^{3}_{3} = -\frac{A^{(0)}}{\mu_{0}}\left(R^{3}{}_{0}{}^{30} + R^{3}{}_{1}{}^{31} + R^{3}{}_{2}{}^{32}\right). \quad -(22)$$

Eq. (18) is the generally covariant Coulomb Law, the subject of this paper. As shown in Appendix (4) the index a must be zero on both sides because it is the time-like index indicating scalar quantities on both sides.

The precise Coulomb law is finally worked out by evaluating the Riemann elements on the right hand side of Eq. (18). This exercise is gone through in all detail in Appendix (5). It consists of choosing a general, spherically symmetric, line element {11}, evaluating the Christoffel symbols and Riemann tensor elements, and finally raising indices with the metric. The final result is:

$$\underline{\nabla} \cdot \underline{E} := (\underline{\nabla} \cdot \underline{E})^{\circ} = -\frac{\phi}{r^2}\left(1 - \frac{2GM}{rc^2}\right)^{-1}\left(1 + \frac{GM}{rc^2}\left(1 + \sin^2\theta\right)\right). \quad -(23)$$

Here, the scalar potential ϕ has the units of volts, G is the Newton constant, r is the radial vector of the spherical polar coordinate system (r, θ, ϕ), and M is the mass defined by the gravitational potential:

$$\Phi = -\frac{MG}{r}. \quad -(24)$$

Eq. (23) is valid for the weak field limit when the gravitational torsion is zero. This limit applies in the solar system for example. When:

$$2GM \ll rc^2 \quad -(25)$$

it is seen that Eq. (23) reduces to:

$$\underline{\nabla} \cdot \underline{E} = -\frac{\phi}{r^2} \quad -(26)$$

which as discussed n Section 3 is the usual Coulomb law of special relativity, one of the most precise {1} laws of special relativity. Eq. (23) is its equivalent in general relativity, i.e. in a theory that unifies the laws of electromagnetism and gravitation.