Chapter 3

Dielectric Theory Of ECE Spacetime

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Abstract

The Einstein Cartan Evans (ECE) unified field theory is developed using the methods of dielectric spectroscopy to show that the effect of gravitation on electromagnetism is in general to create a spectrum. Therefore a light beam reaching a telescope after having passed through regions in which such interaction takes place will in general have spectral properties such as dispersion, refraction and absorption. An objective unified field theory is needed to realize this, and so these effects are not present in the standard model despite being routinely observable as anomalous shifts and quantized shifts.
Keywords: ECE unified field theory; interaction of gravitation and electromagnetism; spectral effects of ECE theory; dielectric spectroscopy and ECE field theory.

3.1 Introduction

The Einstein Cartan Evans (ECE) unified field theory is based directly on Riemann geometry as developed by Cartan and completes the well known work of Einstein and Cartan. In consequence it becomes possible for the first time to study the detailed spectral effects of gravitation on electromagnetism using both classical and quantum theory. A spectrum is created by ECE spacetime, which is a four-dimensional spacetime with curvature and torsion [1]- [30]. The spectrum is generated by the homogeneous and inhomogeneous currents of ECE field theory. In this paper the homogeneous field equation of ECE field theory is developed in section 3.2 as an equation in the electric displacement $\mathbf{D}^a$ and magnetic field strength $\mathbf{H}^a$ of ECE spacetime, and in Section 3.3 as an equation in magnetization $\mathbf{M}^a$ and polarization $\mathbf{P}^a$ of ECE spacetime. The latter is therefore a dielectric or ponderable medium analogous in nature to a gas, liquid, solid, liquid crystal and so on. A dielectric is characterized by a spectrum [31] so ECE spacetime is also characterized by a spectrum, one which originates in the effect of gravitation on electromagnetism such as a light beam from a cosmological object reaching a telescope. In general this spectrum consists of a frequency dependent power absorption coefficient [31] which is directly related to the dielectric loss, and a frequency dependent refractive index which is directly related to the dielectric dispersion. The spectra of ECE spacetime may be as varied as those of any dielectric, consisting in general of many peaks, or anomalous shifts or quantized shifts [32]- [33] such as those observed experimentally in cosmology. These are a mystery to the standard model because the latter is not a truly objective unified field theory of general relativity, i.e. cannot describe the effect of gravitation on electromagnetism.

3.2 Homogeneous ECE Field Equation in Dielectric Theory

The homogeneous field equation of ECE field theory [1]- [30] derives directly from the first Bianchi identity of Cartan geometry using the Evans Ansatz:

$$A^a = A^{(0)} q^a \tag{3.1}$$

where $A^{(0)}$ is a scalar valued, C negative, potential magnitude, where q^a is the tetrad form and A^a the potential form. The tetrad [1]- [30] is the fundamental field of the Palatini variation of general relativity. In ECE field theory it is the fundamental field for matter and all kinds of radiation. It is seen from Eq.3.1 that Cartan geometry becomes unified field theory in physics directly through the Evans Ansatz. Since Cartan geometry is the most general type of Riemann geometry the ECE field theory is directly grounded in well known and accepted and rigorously self-consistent mathematics [1]- [30]. The well known Einstein Hilbert theory (EH theory) of 1915 used the same Riemann geometry but assumed that the torsion tensor is absent. This is adequate for some situations in gravitational theory but not for unified field theory. Cartan elegantly developed Riemann geometry into his well known theory of differential forms and anticipated in the nineteen twenties that the electromagnetic field may be his torsion form within a C negative factor. Despite thirty years of effort neither Einstein nor Cartan successfully pursued this to its logical conclusion. The main reason for this is that they did not have available at that time the inverse Faraday effect [34] which is the magnetization of matter by electromagnetic radiation. This effect was not inferred until the mid fifties and was not confirmed experimentally until the mid sixties. It was not until 1992 [35] that the effect was first explained using what is now known to be the Evans spin field, which is the archetypical signature of general relativity in electromagnetism [1]- [30]. The Evans spin field cannot be described in the standard model, which incorrectly uses special relativity for the electromagnetic sector. The ECE field theory [1]- [30] has confirmed this prediction of Cartan's using the Evans Ansatz (1), which implies:

$$F^a = A^{(0)} T^a \tag{3.2}$$

where F^a is the electromagnetic field form and T^a the torsion form of Cartan.

Using Eq.3.2 the first Bianchi identity of Cartan geometry:

$$d \wedge T^a = R^a{}_b \wedge q^b - \omega^a{}_b \wedge T^b \tag{3.3}$$

translates directly into the homogeneous field equation of ECE theory:

$$d \wedge F^a = \mu_0 j^a = A^{(0)} \left(R^a{}_b \wedge q^b - \omega^a{}_b \wedge T^b \right). \tag{3.4}$$

The homogeneous current is also defined directly by the Cartan geometry:

$$j^a = \frac{A^{(0)}}{\mu_0} \left(R^a{}_b \wedge q^b - \omega^a{}_b \wedge T^b \right). \tag{3.5}$$

Here $R^a{}_b$ is the Riemann or curvature form, $\omega^a{}_b$ is the spin connection, $d\wedge$ denotes the Cartan exterior derivative and μ_0 is the vacuum permeability in S.I. units. Eq.3.4 splits into two equations in vector notation:

$$\nabla \cdot \mathbf{B}^a = \mu_0 \widetilde{j}^a \tag{3.6}$$

and

$$\nabla \times \mathbf{E}^a + \frac{\partial \mathbf{B}^a}{\partial t} = \mu_0 \widetilde{\mathbf{j}}^a \tag{3.7}$$

where the homogeneous current is the four vector:

$$\widetilde{j}^{a\nu} = \left(\widetilde{j}^a, \widetilde{\mathbf{j}}^a \right) \tag{3.8}$$

and where a is the polarization index [1]- [30].

The equivalents of Eqs.3.6 and 3.7 in the standard model are:

$$\nabla \cdot \mathbf{B} = 0 \tag{3.9}$$

and

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0} \tag{3.10}$$

in which the homogeneous current is incorrectly missing and where the polarization index is implied . The basic failure of the standard model is that it is not rigorously objective, being a theory of special relativity where general relativity is needed. Eq.3.9 is known as the Gauss law applied to magnetism and Eq.3.10 is known as the Faraday law of induction. These laws work only in particular experimental situations. They are not able to account for the effect of gravitation on electromagnetism, not even in a qualitative way. The correctly objective laws of general relativity [1]- [30] are given by Eqs.3.6 and 3.7, which are derived from exactly the same principles and same type of Riemann geometry as used in 1915 for gravitation by Einstein, and independently, Hilbert. As mentioned however, the Einstein Hilbert (EH) theory neglects the torsion form.

Therefore the logical choice is to accept ECE theory or reject general relativity.

It has been shown [24] that Eq.3.7 may be written as:

$$\nabla \times \mathbf{D}^a + \mu_0 \epsilon_0 \frac{\partial \mathbf{H}^a}{\partial t} = \mathbf{0} \tag{3.11}$$

if the homogeneous current is defined as:

$$\widetilde{\mathbf{j}}^a = \frac{\partial \mathbf{M}^a}{\partial t} - c^2 \nabla \times \mathbf{P}^a. \tag{3.12}$$

Here ϵ_0 is the vacuum permittivity, defined in S.I. units by the speed of light c:

$$\epsilon_0 \mu_0 = \frac{1}{c^2}. \tag{3.13}$$

Eq.3.11 translates the homogeneous current into the permittivity ϵ and permeability μ of ECE spacetime using the standard relations [36, 37] between the displacement and polarization and the magnetic field strength and magnetization:

$$\mathbf{D}^a = \epsilon_0 \mathbf{E}^a + \mathbf{P}^a = \epsilon \mathbf{E}^a \tag{3.14}$$

$$\mathbf{B}^a = \mu_0 \left(\mathbf{H}^a + \mathbf{M}^a \right) = \mu \mathbf{H}^a \tag{3.15}$$

Here

$$\epsilon_r = \epsilon / \epsilon_0 \tag{3.16}$$

$$\mu_r = \mu / \mu_0 \tag{3.17}$$

are the relative permittivity and permeability respectively.

If it is assumed for the sake of simplicity and illustration that:

$$\epsilon \sim constant, \tag{3.18}$$

$$\mu \sim constant, \tag{3.19}$$

then:

$$\frac{\partial \mathbf{B}^a}{\partial t} + \frac{\mu \epsilon}{\mu_0 \epsilon_0} \nabla \times \mathbf{E}^a = \mathbf{0}. \tag{3.20}$$

The refractive index is defined in standard dielectric theory [36, 37] as:

$$n^2 = \frac{\mu \epsilon}{\mu_0 \epsilon_0} \tag{3.21}$$

so in this particular approximation it is seen clearly that the homogeneous current is equivalent to a dielectric with refractive index 3.21. In consequence ECE spacetime is in general a dielectric and not a vacuum with permeability μ_0 and ϵ_0 permittivity.

One solution of Eq.3.20 consists of a plane wave with phase velocity v, and phase:

$$\phi = \omega t - n^2 \kappa Z \tag{3.22}$$

where ω is the angular frequency and where κ is the wavenumber. If this plane wave were traversing a vacuum its refractive index would be:

$$n^2 = 1 \tag{3.23}$$

and so the ECE spacetime SHIFTS the wavenumber κ to $n^a\kappa$. Recall that this is a special case defined by Eq.3.18 and 3.19, but this case is enough to show that ECE spacetime produces cosmological shifts due to the interaction of gravitation with electromagnetism. From Eq.3.22 the phase velocity is:

$$v = \frac{1}{n^2}c. \tag{3.24}$$

The electric susceptibility κ_E of ECE spacetime and its volume magnetic susceptibility κ_m are defined by the standard [36, 37] equations:

$$\epsilon_r = 1 + \kappa_E \tag{3.25}$$

$$\mu_r = 1 + \kappa_m. \tag{3.26}$$

ECE spacetimes for which $\kappa_m < 0$ are diamagnetic and ECE spacetimes for which $\kappa_m > 0$ are paramagnetic. In the presence of absorption both ϵ and μ are complex:

$$\epsilon = \epsilon' + i\epsilon'' \tag{3.27}$$

$$\mu = \mu' + i\mu'' \tag{3.28}$$

so the wavenumber shift and the phase velocity become spectral quantities dependent on the nature of ECE spacetime, i.e. dependent on Cartan geometry. In consequence many types of shifts are expected, as observed in anomalous shifts and quantized shifts [32,33]. As can be seen from Eq.3.5, the ECE spacetime is in general a complicated function of differential forms and of the spin connection and there is reason to expect a rich spectrum of shifts, again as observed experimentally [32, 33] in contemporary cosmology.

In the next section it is shown that Eq.3.11 is a limiting case of a more general equation, and so Section 3.3 makes the dielectric theory a little more exact, but this section illustrates the major conclusion - that ECE field theory explains cosmological shifts as being due to the spectral effects of gravitation on electromagnetism. This concept is missing entirely from the standard model and contemporary cosmology, yet is a logical outcome of the work of Einstein and Cartan.

3.3 Homogeneous Field Equation In Terms Of Magnetization And Polarization

The polarization and magnetization of ECE spacetime can be expressed in terms of the electric field strength $\mathbf{E}^a$ and the magnetic flux density $\mathbf{B}^a$ as:

$$\mathbf{P}^a = (\epsilon - \epsilon_0)\,\mathbf{E}^a \tag{3.29}$$

$$\mathbf{M}^a = \left(\frac{1}{\mu_0} - \frac{1}{\mu}\right)\mathbf{B}^a. \tag{3.30}$$

So the homogeneous field equation becomes:

$$\frac{\partial \mathbf{M}^a}{\partial t} + \left(\frac{1}{\mu_0} - \frac{1}{\mu}\right)\left(\frac{1}{\epsilon - \epsilon_0}\right)\nabla \times \mathbf{P}^a = \mu_0 \widetilde{\mathbf{j}}^a. \tag{3.31}$$

In the weak interaction limit defined by:

$$\epsilon \longrightarrow \epsilon_0, \tag{3.32}$$

$$\mu \longrightarrow \mu_0, \tag{3.33}$$

and

$$\widetilde{\mathbf{j}}^a \longrightarrow \mathbf{0} \tag{3.34}$$

Eq.3.31 reduces to:

$$\frac{\partial \mathbf{M}^a}{\partial t} + \left(\frac{1}{\mu_0} - \frac{1}{\mu}\right)\left(\frac{1}{\epsilon - \epsilon_0}\right)\nabla \times \mathbf{P}^a \sim \mathbf{0} \tag{3.35}$$

which is a soluble wave equation. When interaction between gravitation and electromagnetism (EMG coupling) is entirely absent:

$$\epsilon = \epsilon_0, \tag{3.36}$$

$$\mu = \mu_0, \tag{3.37}$$

$$\mathbf{P}^a = \mathbf{0}, \tag{3.38}$$

$$\mathbf{M}^a = \mathbf{0}, \tag{3.39}$$

and we recover:

$$\nabla \times \mathbf{E}^a + \frac{\partial \mathbf{B}^a}{\partial t} = \mathbf{0}. \tag{3.40}$$

This is the Faraday law of induction for each polarization index a. Eq.3.31 makes no assumptions about the current so this development is more general than that in Section 3.2. In the presence of absorption the refractive index is complex:

$$n(\omega) = n'(\omega) + in''(\omega) \tag{3.41}$$

and the power absorption coefficient [31] is:

$$\alpha(\omega) = \frac{\omega \epsilon''(\omega)}{n'(\omega) c}. \tag{3.42}$$

A spectrum is defined as a graph of α against wavenumber. This graph can be built up from geometry of ECE spacetime and in general is what is observed in a telescope as cosmological shifts. In the standard model these shifts are explained simplistically either with special relativity (Doppler red shift due to assumed universal expansion - Big Bang) or by the gravitational shifts of EH theory using a hybrid mix of photon mass and classical theory. Thus ECE theory is more self consistent and far richer in predictive power than the standard model. This is what is expected from a truly objective unified field theory in classical and quantum mechanics.

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