

Chapter 4

Spectral Effects Of Gravitation

by

F. Amador, P. Carpenter, G. J. Evans, M. W. Evans,
L. Felker, J. Guala-Valverde, D. Hamilton, J. B. Hart, J. Heidenreich,
A. Hill, G. P. Owen and J. Shelburne.

Alpha Foundation's Institute for Advance Study (A.I.A.S.).
(emyrone@aol.com, www.aias.us, www.atomicprecision.com)

and

Energy Secretariat of the Argentine Government,
Fundación Julio Palacios,
Alderete 285 (8300) Neuquen,
Argentina.

Abstract

It is argued that the various cosmological shifts observed routinely are due to the spectral effects of gravitation on electromagnetism. These effects originate in the homogeneous current of ECE field theory and the homogeneous field equation. In this paper the latter is re-expressed as a wave equation in the refractive index of the ECE spacetime considered as a ponderable medium. Gravitation can change the electric and magnetic field strengths of electromagnetic radiation traversing a region of ECE spacetime, which acts like a dielectric of complex permittivity and permeability. In consequence a spectrum is observable as the result of the homogeneous current. The frequency, wave-number and phase velocity of a monochromatic wave are changed by gravitation. If a polychromatic light beam is considered, a rich variety of effects is expected in general.

Keywords: Spectral effects of gravitation, cosmological consequences of ECE field theory.

4.1 Introduction

A straightforward field unification scheme has recently been developed [1]– [30] based on the philosophy of general relativity, that physics is an objective subject. This was originally proposed by Francis Bacon in the sixteenth century and developed into the theory of relativity at the turn of the twentieth century. Many contributed to relativity theory prior to Einstein’s well known special theory of 1905. The latter is routinely applied to dynamics and electrodynamics but does not apply to gravitation or rotational motion. This is self contradictory because electrodynamics is based on rotational motion, rotating electric and magnetic fields implying automatically rotational accelerations. Special relativity contains no accelerations yet is routinely applied to electrodynamics in the Maxwell Heaviside field theory. The incorporation of acceleration into dynamics (but not electrodynamics) was finally achieved within general relativity in 1915 by Einstein, and independently by Hilbert using a different lagrangian approach to the problem. Both obtained the same field equation:

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = kT_{\mu\nu} \quad (4.1)$$

where $R_{\mu\nu}$ 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 tensor. Index contraction of Eq.4.1 [31] produces a particularly clear correlation between geometry and physics:

$$R = -kT. \quad (4.2)$$

Eq.4.1 was derived by Einstein from the cyclic equation of Ricci:

$$R_{\sigma\mu\nu\rho} + R_{\sigma\nu\rho\mu} + R_{\sigma\rho\mu\nu} = 0 \quad (4.3)$$

where $R_{\sigma\mu\nu\rho}$ is the Riemann tensor with lowered indices. Hilbert derived the field equation 4.1 by constructing a lagrangian.

The Ricci cyclic equation is often known as a Bianchi identity, but it is neither an identity nor was it first derived by Bianchi. Eq.4.3 follows from the assumption:

$$\Gamma^{\kappa}_{\mu\nu} = \Gamma^{\kappa}_{\nu\mu} \quad (4.4)$$

for the Christoffel symbol [32], and if this assumption is not true Eq.4.3 is not true and the field equation 4.1 is not true. The torsion tensor [32] of Riemann geometry is defined as:

$$T^{\kappa}_{\mu\nu} = \Gamma^{\kappa}_{\mu\nu} - \Gamma^{\kappa}_{\nu\mu} \quad (4.5)$$

so the assumption 4.4 is equivalent to assuming that the torsion tensor is zero. This assumption severely restricts the validity of the famous theory of general relativity, even within the restricted gravitational context for which the 1915 theory was developed and first tested. A consideration of torsion is best achieved using Cartan geometry [32]. This geometry is fully equivalent to the most general type of Riemann geometry but is more elegant and easier to work with. Cartan geometry is essential for the development of a unified field theory and for the development of a truly objective physics. Cartan himself was the first to suggest that the electromagnetic field tensor is the Cartan torsion, more

accurately the torsion form. The Einstein Cartan Evans (ECE) field theory [1]–[30] develops this suggestion by Cartan into an objective unified field theory applicable to the whole of physics and chemistry and related subject areas of natural science.

In order to make the language of Cartan more understandable a few preliminary definitions are given first before summarizing each section of this paper, whose main aim is to develop a simple and easily understandable version of ECE theory based on dielectric theory. The dielectric version of ECE field theory is used to show that the well known cosmological shifts [33] are due to the effect of gravitation on light in general relativity. They cannot be Doppler shifts in special relativity because as just argued, special relativity cannot be applied to electromagnetism, and cannot therefore be applied to the objective unified field theory sorely needed to explain basic cosmological facts. This argument is simple, but unfortunately, the Maxwell Heaviside field theory is still widely used as the basis for an expanding universe through a Doppler type explanation of red shifts in special relativity. The basic assumption of an expanding universe theory has been refuted experimentally in many ways. For example it has been shown [34] that different red shifts occur for objects equidistant from the Earth, contradicting the simple Hubble Law. However the Big Bang theory (expanding universe) is still widely taught despite the facts.

Cartan geometry is based on differential forms [1]–[30, 32]. The torsion form is a two-form and its tensorial representation is a rank two antisymmetric tensor. In addition there is an index representing the tangent spacetime at a point P to the base manifold. Therefore the torsion form is known as a vector valued two-form and can be thought of as representing spin in a four dimensional spacetime. The torsion form is represented in Cartan geometry by:

$$T^a_{\mu\nu} = -T^a_{\nu\mu}. \quad (4.6)$$

The antisymmetric Greek indices represent the base manifold. Therefore this is the basic representation of electromagnetism as proposed by Cartan and in consequence a unified field theory cannot be obtained without considerations of torsion. The ECE field theory flows from this basic assumption [1]–[30].

In Section 4.2 the first structure equation of Cartan is used to derive the extended Faraday Law of induction in the ECE theory, in which the influence of gravitation on electromagnetism is accounted for objectively [1]–[30]. As shown in previous papers the extended law can be expressed as a simple wave equation in which appears the refractive index n . In general the latter is a complex quantity, and can be used to generate a spectrum consisting as usual of frequency dependent power absorption coefficients and frequency dependent refractive indices. In general therefore the effect of gravitation on a light beam reaching the Earth from a distant cosmological source is to create spectral effects of various kinds. These cannot be the velocity dependent red shifts of special relativity as asserted in the standard model because the latter is not objective physics as argued. In other words general relativity is needed for a self consistent description both of electromagnetism and gravitation. The fundamental field of ECE theory is an eigenfunction, the tetrad governed by the ECE wave equation [1]–[30, 32], and in consequence the refractive index n is quantized in general. The nature of cosmological shifts is therefore defined by the regions of ECE spacetime through which the light beam has traveled before reaching the

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Earthbound spectrometer. These are diverse because the universe is obviously richly structured.

Finally in Section 4.3 the effects of gravitation on the angular frequency, wavenumber and phase velocity of the light beam are defined.

4.2 Extension Of The Faraday Law Of Induction

In the standard model the Faraday law of induction is well known to be:

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0} \quad (4.7)$$

where \mathbf{E} is the electric field strength in *volt/m* and where \mathbf{B} is the magnetic flux density in tesla. In ECE theory [1]– [30] Eq.4.7 is extended to:

$$n \nabla \times \mathbf{E}^a + \frac{1}{n} \frac{\partial \mathbf{B}^a}{\partial t} = \mathbf{0} \quad (4.8)$$

where a is the polarization index and n is the refractive index of ECE spacetime considered as a dielectric or ponderable medium. The refractive index is defined [35, 36] as:

$$n^2 = \frac{\mu \epsilon}{\mu_0 \epsilon_0} \quad (4.9)$$

where μ is the permeability and where ϵ is the permittivity of ECE spacetime, and where μ_0 and ϵ_0 are their vacuum values. In general:

$$n = n' + i n'' \quad (4.10)$$

$$\mu = \mu' + i \mu'' \quad (4.11)$$

$$\epsilon = \epsilon' + i \epsilon'' \quad (4.12)$$

are complex quantities [35]– [37] whose real parts characterize dispersion and whose imaginary parts characterize absorption or dielectric loss. The power absorption coefficient is defined [37] by:

$$\alpha(\omega) = \frac{\omega \epsilon''(\omega)}{n'(\omega) c} \quad (4.13)$$

Therefore the effect of gravitation on electromagnetism is measured by these spectral quantities, for example by a graph of $\alpha(\omega)$.

It has been shown [1]– [30] that Eq4.8 is equivalent to:

$$\nabla \times \mathbf{E}^a + \frac{\partial \mathbf{B}^a}{\partial t} = \tilde{\mathbf{j}}^a \quad (4.14)$$

where $\tilde{\mathbf{j}}^a$ is the homogeneous current of ECE theory, a current defined by:

$$j^a = \frac{A^{(0)}}{\mu_0} (R^a{}_b \wedge q^b - \omega^a{}_b \wedge T^b) \quad (4.15)$$

in standard differential form notation [32]. In Eq4.15 $R^a{}_b$ is the Riemann or curvature form, q^b is the tetrad form, $\omega^a{}_b$ is the spin connection and T^b is the

torsion form. When there is no influence of gravitation on electromagnetism [1]–[30]:

$$R^a{}_b \wedge q^b = \omega^a{}_b \wedge T^b \quad (4.16)$$

and

$$n^2 = 1 \quad (4.17)$$

Eqs.4.16 and 4.17 define the validity of the Faraday law of induction of the standard model. The latter is further restricted by the subjective, nineteenth century, assumption that electromagnetism is an entity superimposed on a passive or static frame of reference, whereas in ECE theory and general relativity electromagnetism is described objectively by Cartan geometry. Loosely writing, electromagnetism in an objective physics is a spinning frame, gravitation in an objective physics is a curving frame.

Using the two Cartan structure equations [1]–[30, 32]:

$$T^a = d \wedge q^a + \omega^a{}_b \wedge q^b \quad (4.18)$$

and

$$R^a{}_b = d \wedge \omega^a{}_b + \omega^a{}_c \wedge \omega^c{}_b \quad (4.19)$$

it is seen that Eq.4.16 implies:

$$\omega^a{}_b = \kappa \epsilon^a{}_{bc} q^c, \quad (4.20)$$

$$R^a{}_b = \kappa \epsilon^a{}_{bc} T^c, \quad (4.21)$$

where κ has the units of inverse meters or wave-number. Eqs.4.20 and 4.21 show that $\omega^a{}_b$ is dual to q^c and that $R^a{}_b$ is dual to T^c , and these two equations define the validity of the Faraday law of induction of the standard model for each polarization index [1]–[30]:

$$a = (1), (2) \text{ and } (3). \quad (4.22)$$

Eqs.4.20 and 4.21 are equivalent to:

$$\tilde{\mathbf{j}}^a = \mathbf{0}, \quad (4.23)$$

$$n^2 = 1, \quad (4.24)$$

$$\mu = \mu_0, \quad (4.25)$$

$$\epsilon = \epsilon_0. \quad (4.26)$$

In Eqs.4.20 and 4.21 the spin connection $\omega^a{}_b$ and Riemann form $R^a{}_b$ are anti-symmetric in their a and b indices. The wave-number in Eqs.4.20 and 4.21 is defined as

$$\kappa = \frac{\omega}{c} \quad (4.27)$$

where ω is the angular frequency (radians / s) and where c is the vacuum speed of light (m / s).

The effect of gravitation is to produce:

$$\tilde{\mathbf{j}}^a \neq \mathbf{0}, \quad (4.28)$$

$$n^2 \neq 1, \quad (4.29)$$

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$$\mu \neq \mu_0, \quad (4.30)$$

$$\epsilon \neq \epsilon_0, \quad (4.31)$$

and from Eq.4.8:

$$\nabla \times (n\mathbf{E}^a) + \frac{\partial}{\partial t}(\mathbf{B}^a/n) = \mathbf{0}, \quad (4.32)$$

i.e. to produce the shifts:

$$\mathbf{E}^a \rightarrow n\mathbf{E}^a, \quad \mathbf{B}^a \rightarrow \frac{\mathbf{B}^a}{n}. \quad (4.33)$$

In form notation Eq.4.33 means that the field two-form F^a is changed by gravitation. The Evans Ansatz [1]– [30]:

$$F^a = A^{(0)}T^a \quad (4.34)$$

implies that:

$$F^a = d \wedge A^a + \omega^a_b \wedge A^b \quad (4.35)$$

where:

$$A^a = A^{(0)}q^a \quad (4.36)$$

is the potential one-form. The latter is defined by the ECE wave equation:

$$\square A^a = RA^a \quad (4.37)$$

in which R is defined by Eq.4.2, the fundamental and objective correlation between geometry and physics in relativity theory. Therefore gravitation shifts both the potential and the field from their values in the vacuum to their values in the presence of gravitation. The interaction of gravitation and electromagnetism changes the symmetry of the spin connection and Riemann form from anti-symmetric to asymmetric in a and b , so the duality conditions 4.20 and 4.21 no longer hold. The interaction affects R because the tetrad is affected, and so in consequence T is also affected. These geometrical changes manifest themselves in observable cosmological spectra currently referred to as shifts. These effects can be summarized [1]– [30] as a polarization (\mathbf{P}^a) and magnetization (\mathbf{M}^a) of ECE space-time through the homogeneous current:

$$\tilde{\mathbf{j}}^a = \frac{\partial \mathbf{M}^a}{\partial t} - \frac{1}{\mu_0 \epsilon_0} \nabla \times \mathbf{P}^a. \quad (4.38)$$

Therefore in general gravitation has several, hitherto unknown, effects on electromagnetism.

The problem of describing the various observable cosmological shifts is described objectively in ECE theory using Cartan geometry and the fundamental Ansatz 4.2 [1]– [30]. Rigorous objectivity is given by the structure of Cartan geometry. One way of approaching the problem is to define a model for T or R and to solve for A^a from the eigenequation 4.37. Conversely the eigenfunction A^0 may be modeled to give the set of eigenvalues R or T . Eq.4.37 is an equation of wave mechanics, i.e. of rigorously objective quantum electrodynamics influenced by gravitation. Its solutions are eigenvalues which translate into spectral lines or in contemporary parlance quantized cosmological shifts. The latter are now routinely observable and cannot be explained by the red shift to distance

correlation of the Hubble Law. It makes no sense to try to describe these spectra with a complete universe somehow expanding in sudden jumps, thus vividly exposing the fallacy in the Big Bang theory. The spectral patterns from the ECE wave equation are governed as in the Schrödinger equation (a well defined limit of the ECE wave equation) by the model chosen for T or the hamiltonian. This argument is analogous to the unequally spaced lines of atomic spectra, for example, where the Coulomb law is used in the model hamiltonian, or to the equally spaced lines given by a harmonic oscillator or Hooke's law model for the hamiltonian at the root of quantum electrodynamics and photon number theory. Recall that these models are being applied conceptually here to ECE space-time in order to model the effect of gravitation on electromagnetism. The rigorously complete problem is defined by Cartan geometry and probably requires numerical methods of solution. However some simple analytical examples of solution are possible, and have been given in this series of papers and books [1]– [30].

Without immediate recourse to supercomputers it is possible as in this paper to fit observable cosmological shifts of any kind with a model for the refractive index n of ECE spacetime. This makes a map of a region of spacetime in the universe in terms of n . The spectrum defined as a graph of power absorption coefficient against angular frequency is the Fourier transform [37] of the rotational velocity correlation function:

$$c(t) = \langle \dot{\mu}(t) \cdot \dot{\mu}(0) \rangle \quad (4.39)$$

where μ is the dipole moment. In the far infra red for example a statistical model such as Mori theory [37] can be used to build up the relevant correlation functions, which can also be obtained from molecular dynamics computer simulation [38]. Arguing by analogy, the same type of modelling can be used to build up the refractive index n in ECE theory. Yet another approach would be to build up the spin connection from perturbation theory and proceed from there.

4.3 The Effect Of Gravitation On The Wave Properties Of A Light Beam

Gravitation changes the fundamental wave equation of the light beam from:

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

to:

$$n \nabla \times \mathbf{E}^a + \frac{1}{n} \frac{\partial \mathbf{B}^a}{\partial t} = \mathbf{0}. \quad (4.41)$$

Therefore the phase of the light wave (or radio frequency wave) is changed from:

$$\phi = \omega t - \kappa Z \quad (4.42)$$

to

$$\phi = \frac{\omega}{n} t - n \kappa Z. \quad (4.43)$$

The fundamental S.I. equation:

$$E^{(0)} = cB^{(0)} \quad (4.44)$$

is changed to:

$$E^{(0)} = vB^{(0)} \quad (4.45)$$

where

$$v = \frac{c}{n^2}. \quad (4.46)$$

The angular frequency of the beam is changed as follows by gravitation:

$$\omega \longrightarrow \frac{\omega}{n} \quad (4.47)$$

and the wavenumber of the beam is changed by gravitation as follows:

$$\kappa \longrightarrow n\kappa. \quad (4.48)$$

Finally the phase velocity of the beam is changed by gravitation as follows:

$$c \longrightarrow \frac{c}{n^2}. \quad (4.49)$$

When there is no absorption the refractive index is a real quantity [35]– [37] and is well known to cause the phenomenon of refraction. Thus gravitation in ECE space-time causes refraction, in other words changes the path of the light beam as observed in the Eddington effect. Thus ECE theory gives the required classical explanation of this well known effect. In the contemporary standard model the explanation of the Eddington effect is still the semi-quantum model proposed by Einstein in terms of the gravitational effect of an object on the photon mass. ECE theory gives this explanation [1]– [30], because Einstein's theory of general relativity is a limit of ECE theory, but the latter also gives the much needed classical explanation in terms of refraction.

In any red shift ECE theory shows that the frequency is lowered according to Eq.4.47 by $n > 1$. Thus the no blue shift rule of cosmology is given immediately by ECE field theory through the fact that the refractive index is almost always greater than one in nature. Only under very special conditions can n appear to be less than unity in some manufactured composites, and even then this is not a fundamental property. So shifts are almost always red shifts. This well known observation of astronomy has nothing to do with an assumed expanding universe or Big Bang theory. The latter is a subjective construct made in the absence of an objective unified field theory. Some parts of ECE spacetime (the universe) may be locally expanding, but other parts may be locally contracting. It is vanishingly unlikely that such a big and complicated place such as the universe will all expand uniformly from an assumed single initial condition at an assumed single time and place, or event. Some parts of the universe may contract locally to a very dense condition, then re-expand to produce features such as galaxies, stars and planets. In a simple red shift without absorption the frequency appears to be lowered as in Eq.4.47. Thus a simple red shift is explained in ECE theory as diffraction, i.e. the Eddington effect. More generally, when there is absorption then the refractive index becomes complex valued [37]:

$$n = n' + in'' \quad (4.50)$$

so the effect of gravitation on a light beam in this case is as follows

$$\omega \longrightarrow \frac{(n' - in'')}{n'^2 + n''^2} \omega \quad (4.51)$$

The real and physical part of ω is thus shifted as follows:

$$Re(\omega) \longrightarrow \frac{n'\omega}{n'^2 + n''^2} \quad (4.52)$$

A red shift occurs because:

$$n'^2 + n''^2 > n' \quad (4.53)$$

but this red shift depends on the real and imaginary parts of the refractive index and is no longer a simple red shift.

The definitions of this section are for a monochromatic source - in a polychromatic source there will be different shifts for different frequencies, thus building up a SPECTRUM of shifts in an Earth-bound or Earth orbiting telescope.

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