ECE THEORY OF GRAVITY INDUCED POLARIZATION CHANGES.

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ABSTRACT

Gravity induced polarization effects recently observed from a white dwarf are explained straightforwardly in terms of the Einstein Cartan Evans (ECE) unified field theory. The homogeneous current of ECE theory is shown to change circular to elliptical polarization when electromagnetism is affected by gravitation on the classical level. In the Einstein Hilbert (EH) field theory of gravitation, such an effect does not exist. Therefore ECE is preferred to EH using these experimental data, and is preferred to other contemporary theories by Ockham's Razor.

Keywords: Einstein Cartan Evans (ECE) field theory, gravity induced polarization changes in light, interaction of gravitation and electromagnetism.

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1. INTRODUCTION

Einstein Cartan Evans (ECE) field theory is essentially a straightforward extension of Riemann to Cartan geometry {1-21} using the well known Cartan torsion. The latter is the electromagnetic field within a scalar factor $A^{(0)}$, where $cA^{(0)}$ has the units of volts and where c is the vacuum speed of light. ECE theory is a standard theory of general relativity and unifies the gravitational and electromagnetic fields using the well known Cartan structure equations and Bianchi identities. It therefore uses a universally constant speed of light c, and conforms with the Noether Theorem and the Einstein Equivalence Principle. In order to unify gravitation and electromagnetism on the classical level, there is no need for any fundamental hypothesis of general relativity not already proposed by Einstein. ECE transforms the Cartan torsion directly into the electromagnetic field, resulting in field equations capable of describing both the kinematic and electrodynamic aspects of gravitational lensing. The original Einstein Hilbert (EH) theory of this effect is a semi-classical theory based on the gravitation between a quantized photon and an object such as the sun. As is well known, the EH theory produces a light deflection angle which is twice that given by the Newtonian theory. The photon mass does not enter into the final expression for the light deflection, because it cancels out in the calculation. Therefore the deflection of light by gravitation in the EH theory is independent of frequency and polarization, and does not produce changes in refractive index, and related effects such as reflection, refraction, diffraction and so on.

In ECE theory it is shown in Section (2) that the polarization of the deflected light is changed in general from circular to elliptical. This effect is due to the homogeneous current of ECE theory {1-20}, the current that measures the extent to which gravitation affects electromagnetism on the classical level. The concepts and results of EH theory are obtained in a well defined limit of ECE theory, so the latter describes both the kinematic and electrodynamic aspects of gravitational lensing, on classical, semi-classical and fully

quantized levels. The EH theory describes only the semi-classical angle of deflection as already argued. As might be expected by the term "lensing", ECE theory produces polarization, refractive index, reflection, refraction and diffraction effects in general. In Section 2, attention is confined to the change of polarization from circular to elliptical, a change caused by the homogeneous current. In Section 3, a discussion is given of a recent paper {22} by Preuss et al. in which gravity induced polarization changes are measured from a white dwarf. A comparison is made of ECE theory with the Poincare' gauge theory used by Preuss et al. {22}, showing that ECE is a far simpler description of the data, and is therefore preferred by Ockham's Razor.

2. POLARIZATION CHANGE DUE TO THE HOMOGENEOUS CURRENT

This change originates in the homogeneous ECE field equations {1-20}:

$$\underline{\nabla} \cdot \underline{B}^{(a)} = \mu_0 \tilde{j}^{(a)}, \quad -(1)$$

$$\underline{\nabla} \times \underline{E}^{(a)} + \frac{\partial \underline{B}^{(a)}}{\partial t} = \mu_0 \underline{\tilde{j}}^{(a)} \quad -(2)$$

Here $\underline{B}^{(a)}$ is the magnetic flux density in tesla, $\underline{E}^{(a)}$ is the electric field strength in volt m^{-1}, μ_0 is the vacuum permeability in S.I. units, and $\underline{\tilde{j}}^{(a)}$ is the homogeneous current. The latter is defined in the notation of Cartan geometry {1-21} by:

$$j^{(a)} = \frac{A^{(0)}}{\mu_0} \left(R^{(a)}{}_{(b)} \wedge q^{(b)} - \omega^{(a)}{}_{(b)} \wedge T^{(b)} \right) \quad -(3)$$

where $R^{(a)}{}_{(b)}$ is the Riemann form, $q^{(b)}$ is the tetrad form, $\omega^{(a)}{}_{(b)}$ is the spin connection form, and $T^{(b)}$ is the torsion form. Equation (1) is the generally covariant Gauss law of magnetism, and Eq, (2) is the generally covariant Faraday law of induction. Interaction of

gravitation and electromagnetism occurs when j^a and $\underline{j}^a$ are non-zero. The interaction is therefore described by the following condition of Cartan geometry:

$$R^a{}_b \wedge q^b \neq \omega^a{}_b \wedge T^b . \quad -(4)$$

This condition has been developed in great detail {1-20} elsewhere. For the purposes of this section it is sufficient to note that the current $\underset{\sim}{j}^a$ is non zero when electromagnetism is affected by gravitation on the classical level.

It has been shown {1-20} that Eq (2) may be written as:

$$\underline{\nabla} \times (n \underline{E}^a) + \frac{\partial}{\partial t}\left(\frac{\underline{B}^a}{n}\right) = \underline{0} \quad -(5)$$

where the refractive index n is defined by:

$$n^2 = \frac{c}{v} \quad -(6)$$

and where v is the phase velocity. The plane wave solution of Eq. (5) is:

$$\underline{E}_1 = \frac{E^{(0)}}{\sqrt{2}}(\underline{i} - i\underline{j}) \exp(i\phi_1), \quad -(7)$$

$$\underline{B}_1 = \frac{B^{(0)}}{\sqrt{2}}(i\underline{i} + \underline{j}) \exp(i\phi_1), \quad -(8)$$

where:

$$\phi_1 = \frac{\omega}{n} t - n\kappa Z. \quad -(9)$$

The effect of gravity is to change the original $\underline{E}$ and $\underline{B}$ of circular polarization as follows:

$$\underline{E}_1 = n\underline{E}, \quad -(10)$$

$$\underline{B}_1 = \frac{1}{n}\underline{B}. \quad -(11)$$

It has been shown {1-20} that this mechanism produces the well known red-shift.

The real and physical part of Eq. (7) is:

$$\underline{E}_1 = \frac{E^{(0)}}{\sqrt{2}}\left(\underline{i}\cos\phi_1 + \underline{j}\sin\phi_1\right) \quad -(12)$$

and the real and physical part of the circularly polarized $\underline{E}$ is:

$$\underline{E} = \frac{E^{(0)}}{\sqrt{2}}\left(\underline{i}\cos\phi + \underline{j}\sin\phi\right). \quad -(13)$$

It is seen that if:

$$\cos\phi_1 = a\cos\phi, \quad -(14)$$

$$\sin\phi_1 = b\sin\phi \quad -(15)$$

then:

$$\underline{E}_1 = \frac{E^{(0)}}{\sqrt{2}}\left(a\underline{i}\cos\phi + b\underline{j}\sin\phi\right), \quad -(16)$$

for example, if $\phi = 45^\circ$, and $\phi_1 = 60^\circ$, then a = 1.414, b = 0.816. This means that gravity changes the original circular polarization of $\underline{E}$ to elliptical polarization, in which a is not the same as b. This effect is not present in EH theory, but has been observed by Preuss et al. {22}, whose work is discussed in the next section and compared with ECE theory.