The mutual interaction of gravitation and electromagnetism.

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Abstract

By factorizing the metric of electromagnetism into its tetrad components, a complete theory of the effect of gravitation on electromagnetism emerges straightforwardly. This theory describes self consistently the deflection of light due to gravitation, and also the changes of amplitude and polarization that occur during this process. A tetrad based theory such as ECE theory includes the electromagnetic phase of for example a plane wave as part of the geometry. The phase appears only in the tetrad, but not in the metric. The latter still has the appearance of a Minkowski metric, but the underlying spacetime characteristics are determined by the tetrad, notably torsion and curvature, missing entirely from the standard model. In consequence the latter cannot produce a unified field theory, whereas ECE is able to do so scientifically, using Baconian principles.

Keywords: ECE theory, interaction of gravitation and electromagnetism.

1. Introduction

In a series of 154 papers to date [1–10] the Einstein Cartan Evans (ECE) unified field theory has been applied systematically to natural philosophy and engineering, and all the major equations of physics deduced from Cartan´s well known differential geometry [11]. The latter has been tested in many ways and in comprehensive detail and found to be correct and self consistent. All these calculations and proofs have been posted on www.aias.us in over a thousand notes, 154 source papers and other articles and books by the colleagues. The www.aias.us site is part of the archives of the National Library of Wales and the British national archives for outstanding websites (www.webarchive.org.uk). The most interesting part of a unified field theory is its ability to describe the effect of one fundamental field on another. An example is the mutual interaction of electromagnetism and gravitation. In UFT 150 on www.aias.us it was shown recently that Einstein´s calculation of light deflection is wildly incorrect, and his calculation was corrected using the concept of photon mass, giving a plausible result for photon mass from the accurate satellite based experiments now available of light deflection by gravitation. This is one example of how gravitation affects electromagnetism, but in this example the latter is represented by a particle, the photon with mass. Its wave properties are not considered but the calculation is based on a metric [11].

In Section 2, the curving of spacetime as represented in a suitable gravitational metric is incorporated in the ECE theory of electromagnetism [1–10]. This theory is based on the Cartan tetrad, which is defined as incorporating the electromagnetic phase. In ECE theory, the metric of electromagnetism is built up from this phase dependent tetrad, from which spacetime torsion and curvature are obtained using the well known Cartan structure equations [1–11]. Therefore the metric is a metric of spacetime with these fundamental properties defined. This is why ECE is able to produce a unified field theory from geometry. The standard model will not be able to do this unless it abandons the U(1) sector and non Baconian ideas such as string theory. By non Baconian is meant ideas that cannot be tested experimentally, there being far too many adjustable parameters, and things that are defined to be unobservable, a hopelessly unscientific attitude of the twentieth century. In consequence the standard model attempts to describe the effects of gravitation on electromagnetism are either wildy incorrect (such as the much vaunted but deeply incorrect Einstein theory (UFT 139 and UFT 150) on www.aias.us) or untestable and unscientific. In consequence the standard model has recently been discarded in favour of ECE theory. It is known that there has been a comprehensive international rejection of the standard model as recorded in great detail [12] over the past six years and more. In Section 2 it is shown that the effect of gravitation on the potential plane wave of electromagnetism is to change its amplitude by a well defined amount that can be tested experimentally, and also to change its polarization. Therefore the undulatory or wavelike properties of electromagnetism are changed as well as its particulate trajectory (UFT 150).

2. Gravitational metric and electromagnetic tetrad.

For the sake of argument consider the gravitational line element [1–11]:

$$ds^2 = c^2 dt^2\left(1 - \frac{r_0}{r}\right) - dr^2\left(1 - \frac{r_0}{r}\right)^{-1} - r^2 d\varphi^2 - dZ^2 \tag{1}$$

where

$$r_0 = \frac{2MG}{c^2} \quad . \tag{2}$$

Here G is Newton´s constant, c the vacuum speed of light, r the distance between an attracting object of mass M and attracted object. The infinitesimal line element (1) is written in cylindrical polar coordinates. In Cartan geometry (see accompanying notes to UFT 154 on www.aias.us), the metric corresponding to Eq. (1) is:

$$g_{\mu\nu} = \begin{pmatrix} 1-\frac{r_0}{r} & 0 & 0 & 0 \\ 0 & -(1-\frac{r_0}{r})^{-1} & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \quad . \tag{3}$$

Consider now the effect of this metric on the electromagnetic four potential:

$$A^\mu = (\varphi \, , \, c\boldsymbol{A}) \tag{4}$$

where φ is the scalar potential, and $\boldsymbol{A}$ is the vector potential. In ECE theory [1-10] the four potential is by hypothesis proportional to the Cartan tetrad through the scalar valued magnitude A. In the complex circular basis [1-10 and accompanying notes to UFT 154 on www.aias.us] the spacelike part of the tetrad is defined by:

$$\boldsymbol{q}^{(1)} = \boldsymbol{e}^{(1)} \exp(i\phi) \tag{5}$$

where the electromagnetic phase is:

$$\phi = \omega t - \mathrm{k} \, \mathrm{Z} \quad . \tag{6}$$

Here ω is the angular frequency at instant t, and k the wavenumber at a point Z. In ECE theory and precursor theories the phase has an internal non-Abelian structure. All the phases of physics have been derived from geometry in ECE theory, and inter-related in comprehensive detail. In Eq. (5), $\boldsymbol{e}^{(1)}$ is the unit vector of the complex circular basis:

$$\boldsymbol{e}^{(1)} = \frac{1}{\sqrt{2}} (\mathbf{i} - i\mathbf{j}) \quad . \tag{7}$$

The electromagnetic plane wave is therefore:

$$\boldsymbol{A}^{(1)} = A \, \boldsymbol{q}^{(1)} \quad . \tag{8}$$

The metric of electromagnetism is defined as [1-10 and accompanying notes to UFT 145]:

$$g_{\mu\nu} = q_{\mu}^{(a)}\, q_{\nu}^{(b)*}\, \eta_{(a)(b)} \tag{9}$$

where $\eta_{(a)(b)}$ is the Minkowski metric:

$$\eta_{(a)(b)} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} . \tag{10}$$

Here * denotes complex conjugate so as shown in the accompanying notes to UFT 145 on www.aias.us:

$$\boldsymbol{q}^{(2)} = \boldsymbol{q}^{(1)*} = \boldsymbol{e}^{(2)}\, \boldsymbol{e}^{-i\Phi} \tag{11}$$

and the metric of electromagnetism is:

$$g_{\mu\nu} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \tag{12}$$

in a spacetime with well defined torsion and curvature. Note carefully that Eq. (12) is not the Minkowski metric, because the latter refers to a spacetime without torsion and without curvature. These advances are key to a unified field theory. It has been shown in many ways [1–10] that a unified field theory cannot be based on a U(1) sector symmetry for electromagnetism, so a large part of the theory behind CERN for example collapses. The use of antisymmetry for example shows immediately that a U(1) sector symmetry is unsustainable. The search for the Higgs boson is meaningless, because the Higgs boson is based on a U(1) sector symmetry for electromagnetism, as is electroweak theory.

The effect of gravitation as represented in Eq. (1) on the electromagnetic plane wave is to change the metric (12) to the metric (1) in the same underlying spacetime. In the standard model this method is impossible to use, because the spacetime of the U(1) sector is the Minkowski spacetime, with no torsion and no curvature. Therefore it is not possible to build a simple unified field theory with a U(1) sector symmetry.

The vector potential must be written in the same coordinate system as that of the gravitational metric of Eq. (1), this is the cylindrical polar system, defined in comprehensive detail in the accompanying notes on www.aias.us to this paper, UFT 145, and other UFT papers. Thus:

$$\boldsymbol{A}^{(1)} = (A_r^{(1)} \boldsymbol{e}_r + A_\varphi^{(1)} \boldsymbol{e}_\varphi) \exp (i\phi) \tag{13}$$

where $\boldsymbol{e}_r$ and $\boldsymbol{e}_\varphi$ are the two transverse unit vectors of the cylindrical polar system. We omit consideration of the longitudinal component for simplicity only. In general the longitudinal and time-like components of $\boldsymbol{A}^\mu$ exist, not just the transverse components. The components of $\boldsymbol{A}^{(1)}$ in the cylindrical polar system are $A_r^{(1)}$and $A_\varphi^{(1)}$. The same vector potential in Cartesian coordinates is:

$$\boldsymbol{A}^{(1)} = (A_X^{(1)} \mathbf{i} + A_Y^{(1)} \mathbf{j}) \exp (i\phi) \tag{14}$$

and the same vector potential in complex circular coordinates is:

$$\boldsymbol{A}^{(1)} = A \ \boldsymbol{e}^{(1)} \exp (i\phi) \tag{15}$$

(see accompanying notes to UFT 145).

Therefore:

$$\begin{aligned} A^2 = \boldsymbol{A}^{(1)} \cdot \boldsymbol{A}^{(2)} &= A_X^{(1)} A_X^{(2)} + A_Y^{(1)} A_Y^{(2)} \\ &= A_r^{(1)} A_r^{(2)} + A_\varphi^{(1)} A_\varphi^{(2)} \quad . \end{aligned} \tag{16}$$

Now use:

$$\begin{bmatrix} A_r \\ A_\varphi \\ A_Z \end{bmatrix} = \begin{bmatrix} \cos\varphi & \sin\varphi & 0 \\ -\sin\varphi & \cos\varphi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} A_X \\ A_Y \\ A_Z \end{bmatrix} \tag{17}$$

as developed in the accompanying notes, and use the definitions:

$$\left. \begin{aligned} A_X^{(1)} &= A/\sqrt{2} \quad , \quad A_Y^{(1)} = -i\, A/\sqrt{2} \quad , \\ A_X^{(2)} &= A/\sqrt{2} \quad , \quad A_Y^{(2)} = \ i\, A/\sqrt{2} \quad , \end{aligned} \right\} \tag{18}$$

to obtain:

$$\left. \begin{aligned} A_r^{(1)} &= \frac{A}{\sqrt{2}} (\cos\varphi - i \sin\varphi) \quad , \\ A_\varphi^{(1)} &= \frac{A}{\sqrt{2}} (- i \sin\varphi - i \cos\varphi) \quad . \end{aligned} \right\} \tag{19}$$

In Cartan geometry (as defined precisely in the accompanying notes to UFT 154 and UFT 153) the effect of gravitation on the radial component of the metric is:

$$g_{rr} = \boldsymbol{e}_r \cdot \boldsymbol{e}_r \longrightarrow \left(1 - \frac{r_0}{r}\right)^{-1} g_{rr} \tag{20}$$

so

$$A_r^{(1)} A_r^{(2)} = \frac{A^2}{2} \longrightarrow \frac{A^2}{2}\left(1 - \frac{r_0}{r}\right)^{-1} . \tag{21}$$

Therefore from Eq. (16):

$$A^2 \longrightarrow \frac{A^2}{2}\left(\left(1 - \frac{r_0}{r}\right)^{-1} + 1\right) \tag{22}$$

and

$$A_r^{(1)} \longrightarrow A_r^{(1)}\left(1 - \frac{r_0}{r}\right)^{-1/2} . \tag{23}$$

The effect of gravitation on the vector potential plane wave is therefore as follows:

$$\begin{aligned} \boldsymbol{A}^{(1)} &= \frac{A}{2}\left(1 + \left(1 - \frac{r_0}{r}\right)^{-1}\right)^{-1/2} (\mathbf{i} - i\mathbf{j})\, \boldsymbol{e}^{-i\varphi} \\ &= \left(A_r^{(1)}\left(1 - \frac{r_0}{r}\right)^{-1/2} \boldsymbol{e}_r + A_\varphi^{(1)} \boldsymbol{e}_\varphi\right) \boldsymbol{e}^{-i\varphi} \end{aligned} \tag{24}$$

This result shows that gravitation affects the amplitude, as in the Cartesian representation, and also affects the polarization as in the cylindrical polar representation. These results confirm those of UFT 48 on www.aias.us, in which experimental evidence for gravity induced polarization changes was referenced. The metric (1) was used correctly in UFT 150 to produce the first correct calculation of light deflection by gravitation. Therefore this metric has been used to produce a theory of all aspects of the interaction of electromagnetism and gravitation.

Having derived the gravity affected electromagnetic potential (24, 25) the electric and magnetic fields are found as usual in ECE theory using the antisymmetry laws of ECE and the spin connection. The effect of gravitation on the scalar potential follows as:

$$\varphi^{(1)} \longrightarrow \left(1 - \frac{r_0}{r}\right)^{1/2} \varphi^{(1)} \tag{26}$$

The converse effect of electromagnetism upon gravitation is found by inverting Eq. (9):

$$\eta_{(a)(b)} = q^{\mu}_{(a)}\ q^{\nu}_{(b)}\ g_{\mu\nu} \tag{27}$$

where $q^{\mu}_{(a)}$ is the inverse of the tetrad matrix. As explained in full detail in the accompanying notes, the tetrad $q_\mu^{(a)}$ is defined as an n by n invertible matrix, and $q^\mu_{(a)}$ denotes the inverse matrix. Therefore, in three dimensions for example:

$$q_\mu^{(a)}\ q^\mu_{(a)} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{28}$$

by definition [11]. In n dimensions the unit diagonal matrix has n entries.

For example, there are tetrad elements such as:

$$A_X^{(1)} = \frac{A}{2}\,(\,1\ +\ (\,1 - \frac{r_0}{r}\,)^{-1}\,)^{1/2}\,\boldsymbol{e}^{-i\varphi} = i\,A_Y^{(1)} \tag{29}$$

and so in principle, gravitational interaction between m and M can be changed by changing electromagnetic properties. This is of great potential importance in counter gravitation (see also UFT 153). These elements form part of an invertible tetrad matrix, and the effect of gravitation on electromagnetism is defined by tetrad elements such as (24) and (29). The inverse effect of electromagnetism on gravitation is defined by the inverse tetrad matrix.

Acknowledgments.

The British Government is thanked for recognition of ECE theory and my Omnia Opera by the high honour of appointment to the Civil List on Feb. 28th., 2005, Armiger rank in July 2008 and the Queen´s invitation of July 20th 2010. Alex Hill and colleagues are thanked for translations and fast and accurate typesetting and David Burleigh for posting on www.aias.us.

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