Notes for Paper 49 (101st Publication)

In this paper a space dependent permittivity and permeability of ECE spacetime is considered:

$$\epsilon = \epsilon(X, Y, Z) \quad -(1)$$

$$\mu = \mu(X, Y, Z). \quad -(2)$$

Therefore the refractive index is also space dependent, i.e. a function of X, Y, and Z:

$$n^2 = \epsilon(X, Y, Z)\mu(X, Y, Z) / \mu_0 \epsilon_0. \quad -(3)$$

The orbit of a light beam is therefore described by a function of X, Y, and Z, more rigorously:

$$n = (ct, X, Y, Z). \quad -(4)$$

In a strong enough gravitational field the light beam orbits a gravitating object. The sun is able only to deflect a light beam by a few seconds of arc. A very intense gravitational object would cause the light beam to fall into the mass.

In papers 46 - 48 it was shown that the homogeneous field equation of ECE theory:

$$\underline{\nabla} \times \underline{E}^a + \frac{\partial \underline{B}^a}{\partial t} = \mu_0 \underline{\tilde{j}}^a \quad -(5)$$

can be written as:

$$\underline{\nabla} \times \underline{D}^a + \mu_0 \epsilon_0 \frac{\partial \underline{H}^a}{\partial t} = \underline{0}. \quad -(6)$$

2)

Here:

$$\underline{D}^a = \epsilon_0 \underline{E}^a + \underline{P}^a = \epsilon \underline{E}^a \quad -(7)$$

$$\underline{H}^a = \frac{1}{\mu_0}\underline{B}^a - \underline{M}^a = \frac{1}{\mu}\underline{B}^a \quad -(8)$$

and

$$\epsilon_0 \mu_0 = \frac{1}{c^2} . \quad -(9)$$

The quantities are all defined in pages 46 - 48, and this procedure defines the homogeneous current as:

$$\underline{\tilde{j}}^a = \frac{\partial \underline{M}^a}{\partial t} - c^2 \underline{\nabla} \times \underline{P}^a . \quad -(10)$$

thus identifying the effect of gravitation on light as a process of magnetization and polarization of ECE spacetime.

Using eqns (7) and (8), eqn (6) can be written as:

$$\boxed{\underline{\nabla} \times (\epsilon_r \underline{E}^a) + \frac{\partial}{\partial t}(\underline{B}^a / \mu_r) = \underline{0}} \quad -(11)$$

where

$$\epsilon_r = \epsilon / \epsilon_0 \quad -(12)$$

is the relative permittivity of ECE spacetime and where

$$\mu_r = \mu / \mu_0 \quad -(13)$$

is the relative permeability of ECE spacetime.

Therefore the effect of gravitation on a light beam is summarized by:

$$\boxed{\begin{aligned} \underline{E}^a &\rightarrow \epsilon_r \underline{E}^a && -(14) \\ \underline{B}^a &\rightarrow \frac{1}{\mu_r} \underline{B}^a. && -(15) \end{aligned}}$$

In general:

$$\epsilon_r = \epsilon_r(ct, X, Y, Z) \quad -(16)$$

$$\mu_r = \mu_r(ct, X, Y, Z), \quad -(17)$$

and the refractive index is:

$$n^2 = \mu_r \epsilon_r . \quad -(18)$$

The refractive index is also a function of 4-D space-time, the structure of ECE spacetime. Cosmological red shifts and the Eddington type of experiments show that gravitation influences light through eqn. (11). Such an influence may also occur in the close vicinity of an electron in a circuit, because near an electron, the scalar curvature can be very large, and electric and magnetic field strengths very intense.

Under the conditions in which the Faraday law of induction is usually tested:

$$\left.\begin{array}{l} \epsilon_r \rightarrow 1, \\ \mu_r \rightarrow 1, \\ n \rightarrow 1, \end{array}\right\} \quad - (19)$$

and eqn. (11) reduces to:

$$\underline{\nabla} \times \underline{E}^a + \frac{\partial \underline{B}^a}{\partial t} = \underline{0}. \quad - (20)$$

In order to find the effect of gravitation on ~~the~~ wave nature of light, solutions of eqn. (11) are needed. To find these solutions eqn. (20) is used as a "baseline equation". It is known that for

$$a = (1), (2), (3) \quad - (21)$$

there exist solutions of eqn. (20) such as:

$$\underline{E}^{(1)} = \frac{E^{(0)}}{\sqrt{2}} (\underline{i} - i\underline{j}) \exp(i(\omega t - \kappa Z)) \quad - (22)$$

$$\underline{B}^{(1)} = \frac{B^{(0)}}{\sqrt{2}} (i\underline{i} + \underline{j}) \exp(i(\omega t - \kappa Z)), \quad - (23)$$

for an e/m or light wave propagating in Z.

From eqn. (23):

$$\frac{\partial \underline{B}^{(1)}}{\partial t} = i\omega \underline{B}^{(1)}, \quad - (24)$$

$$= \frac{\omega B^{(0)}}{\sqrt{2}} (-\underline{i} + i\underline{j}) \exp(i(\omega t - \kappa Z))$$

$$= -\frac{\omega B^{(0)}}{\sqrt{2}} (\underline{i} - i\underline{j}) \exp(i(\omega t - \kappa Z))$$

) From eqn. (22):

$$\underline{\nabla} \times \underline{E}^{(1)} = \frac{E^{(0)}}{\sqrt{2}} \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ \partial/\partial X & \partial/\partial Y & \partial/\partial Z \\ e^{i\phi} & -ie^{i\phi} & 0 \end{vmatrix} \quad -(25)$$

where:

$$\phi = \omega t - \kappa Z. \quad -(26)$$

Therefore:

$$\underline{\nabla} \times \underline{E}^{(1)} = \frac{E^{(0)}}{\sqrt{2}} \left(i \frac{\partial}{\partial Z} e^{i(\omega t - \kappa z)} \underline{i} + \frac{\partial}{\partial Z} e^{i(\omega t - \kappa z)} \underline{j} \right)$$

$$= \frac{E^{(0)}}{\sqrt{2}} \kappa \left(\underline{i} - i\underline{j} \right) e^{i\phi}$$

$$= -i \frac{E^{(0)}}{\sqrt{2}} \kappa \left(i\underline{i} + \underline{j} \right) e^{i\phi}. \quad -(27)$$

From eqns (24) and (27), eqn. (20) is true if:

$$\omega B^{(0)} = \kappa E^{(0)}, \quad -(28)$$

i.e if

$$E^{(0)} = cB^{(0)} \quad -(29)$$

and

$$c = \frac{\omega}{\kappa}. \quad -(30)$$

Therefore one solution of eqn. (20) is a wave with phase velocity c.

6)

In order to find a solution of eqn. (11), identify the phase as :

$$\phi = \frac{1}{\mu_r}\omega t - \epsilon_r \kappa Z \qquad -(31)$$

where for simplicity μ_r and ϵ_r are scalars, or functions only of X and Y. This means that :

$$\frac{\partial}{\partial t} e^{i\phi} = \frac{i\omega}{\mu_r} e^{i\phi}, \qquad -(32)$$

$$\frac{\partial}{\partial Z} e^{i\phi} = -i\epsilon_r \kappa e^{i\phi}. \qquad -(33)$$

The solutions of eqn. (11) are then : $-(34)$

$$\underline{B}^{(1)} = \frac{B^{(0)}}{\sqrt{2}}\left(i\underline{i} + \underline{j}\right) \exp\left(i\left(\frac{\omega}{\mu_r}t - \epsilon_r \kappa Z\right)\right)$$

and

$$\underline{E}^{(1)} = \frac{E^{(0)}}{\sqrt{2}}\left(\underline{i} - i\underline{j}\right) \exp\left(i\left(\frac{\omega t}{\mu_r} - \epsilon_r \kappa Z\right)\right)$$

$-(35)$

provided that

$$\boxed{\frac{\omega}{\mu_r} B^{(0)} = \epsilon_r \kappa E^{(0)}.} \qquad -(36)$$

Therefore the shifts observed in cosmology are governed by eqn. (36). There are ...

7.)

ways of interpreting eqn. (36). It can for example be written as:

$$\frac{\omega}{\mu_r \epsilon_r} B^{(0)} = \kappa E^{(0)} \quad -(37)$$

$$= \frac{\omega}{n^2} B^{(0)}.$$

A red shift <u>at a given constant</u> <u>κ</u> is therefore

$$\boxed{\omega \rightarrow \frac{\omega}{n^2}} \quad -(38)$$

Since:

$$n^2 \geqslant 1 \quad -(39)$$

the shift in ω is always in the lower frequency direction, i.e. <u>always</u> <u>a red shift</u>.

Alternatively eqn. (37) can be written as:

$$\omega B^{(0)} = n^2 \kappa E^{(0)} \quad -(40)$$

and <u>for a given ω</u>, κ is increased to $n^2 \kappa$.

Thirdly, eqn. (36) can be interpreted as:

$$\omega \rightarrow \frac{\omega}{\mu_r}, \quad \kappa \rightarrow \epsilon_r \kappa \quad -(41)$$

or fourthly as:

$$\omega \rightarrow \frac{\omega}{\epsilon_r}, \quad \kappa \rightarrow \mu_r \kappa. \quad -(42)$$

In all cases, the frequency is <u>red shifted</u>.

8) Finally, from eqn. (36):

$$\frac{E^{(0)}}{B^{(0)}} = \frac{1}{n^2}\frac{\omega}{\kappa} = \frac{1}{n^2}c. \quad -(43)$$

The phase velocity of the wave is changed to:

$$v = \frac{1}{n^2}c. \quad -(44)$$

Since:

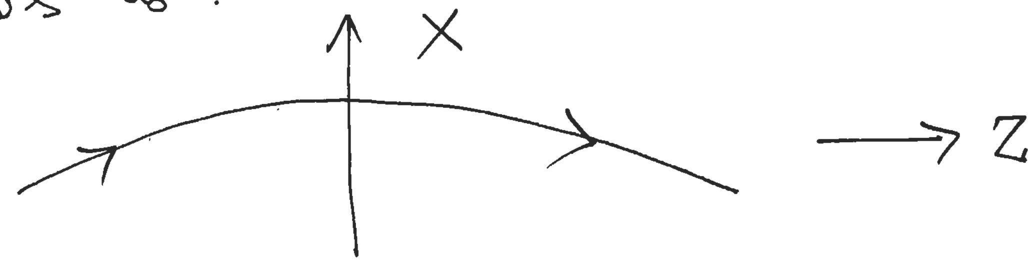
$$n = n(X, Y) \quad -(45)$$

all these changes depend on X and Y. If the light beam is for the sake of illustration, a conic section, then n is path dependent. The Eddington effect is then described by the path the light takes in grazing the sun. This path is defined by the central part of ECE field theory, which is the EH field theory of the gravitational attraction of a photon by the sun. This is well known to give twice the Newtonian result for the angle of deflection.

This means that the plane wave is deflected. Instead of propagating in Z

9) it propagates as:

Fig (1)



and there are components of $\underline{K}$ in X and Z:

$$\underline{K} = K_X \, \underline{i} + K_Z \, \underline{k} \quad - (46)$$

and new solutions of eqn. (11) must be found. This will be the next stage of the calculation. The refractive index is the function $f(X, Z)$ illustrated in Fig (1). It is the function describing the orbit in the EH limit of ECE theory. This is a well known function calculated from the Schwarzschild metric or some other EH metric.

Major Conclusions

1) The cosmological shifts are defined by eqn. (11), they indicate the effect of gravitation on light.

2) The most general form of the Faraday law of induction is eqn. (11).

3) The Eddington effect is a refractive index effect.