Notes for Paper 47, Continued

The homogeneous field equation from ECE theory is:

$$\underline{\nabla} \times \underline{E}^{(a)} + \frac{\partial \underline{B}^{(a)}}{\partial t} = \mu_0 \underline{\tilde{j}}^{(a)} \quad - (1)$$

It was shown in paper 46 that this is the same as:

$$\underline{\nabla} \times \underline{D}^{(a)} + \mu_0 \epsilon_0 \frac{\partial \underline{H}^{(a)}}{\partial t} = \underline{0} \quad - (2)$$

if:

$$\underline{\tilde{j}} = \frac{\partial \underline{M}^{(a)}}{\partial t} - c^2 \underline{\nabla} \times \underline{P}^{(a)} \quad - (3)$$

Here:

$$\underline{D}^{(a)} = \epsilon_0 \underline{E}^{(a)} + \underline{P}^{(a)} \quad - (4)$$

$$\underline{B}^{(a)} = \mu_0 \left(\underline{H}^{(a)} + \underline{M}^{(a)} \right) \quad - (5)$$

In eqn. (2) we may use:

$$\underline{B}^{(a)} = \mu \underline{H}^{(a)} \quad - (6)$$

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

to obtain:

$$\boxed{\frac{\partial \underline{B}^{(a)}}{\partial t} + \frac{\mu \epsilon}{\mu_0 \epsilon_0} \underline{\nabla} \times \underline{E}^{(a)} = \underline{0}} \quad - (8)$$

By comparison of eqns (1) and (8) it is seen that the effect of the homogeneous current $\underline{\tilde{j}}^{(a)}$ is to change the permeability μ and permittivity ϵ of the ECE spacetime. From eqn. (8) the wavenumber is shifted to:

$$k' = \frac{\mu \epsilon}{} k = \omega c \quad - (9)$$

11) From eqn. (9):

$$\kappa = \omega\left(\frac{\mu_0 \epsilon_0}{\mu \epsilon}\, c\right) := \omega v \qquad -(10)$$

where:

$$\boxed{v = \frac{\mu_0 \epsilon_0}{\mu \epsilon}\, c} \qquad -(11)$$

is the phase velocity of the electromagnetic wave when affected by gravitation.

In the dielectric theory of ECE spacetime:

$$\epsilon_r = \frac{\epsilon}{\epsilon_0} = 1 + \chi_E \qquad -(12)$$

$$\mu_r = \frac{\mu}{\mu_0} = 1 + \chi_m \qquad -(13)$$

where χ_E is the electric susceptibility and χ_m is the volume magnetic susceptibility. Materials for which:

$$\chi_m < 0 \qquad -(14)$$

are diamagnetic. Materials for which:

$$\chi_m > 1 \qquad -(15)$$

are paramagnetic. In the presence of absorption both ϵ and μ are complex:

$$\epsilon = \epsilon' + i\epsilon'' \qquad -(16)$$

$$\mu = \mu' + i\mu'' \qquad -(17)$$

So the wavenumber shift (9) and the phase velocity (11) are spectral quantities which depend on the nature of EMG coupling. Therefore many different types of shift may be observed in cosmology.