41(1): Gravitational Plane Waves

The ECE2 equations of gravitational physics are given in UFT318 and in the notation of that paper:

$$\underline{\nabla} \cdot \underline{g} = \underline{\kappa} \cdot \underline{g} = 4\pi G \rho_m \quad -(1)$$

$$\underline{\nabla} \times \underline{g} + \frac{\partial \underline{\Omega}}{\partial t} = -\left(c\kappa_0 \underline{\Omega} + \underline{\kappa} \times \underline{g}\right) = \frac{4\pi G}{c} \underline{J}_\Omega \quad -(2)$$

$$\underline{\nabla} \cdot \underline{\Omega} = \underline{\kappa} \cdot \underline{\Omega} = \frac{4\pi G}{c} \rho_\Omega \quad -(3)$$

$$\underline{\nabla} \times \underline{\Omega} - \frac{1}{c^2} \frac{\partial \underline{g}}{\partial t} = \frac{\kappa_0}{c} \underline{g} + \underline{\kappa} \times \underline{\Omega} \quad -(4)$$

$$= \frac{4\pi G}{c^2} \underline{J}_m \quad -(5)$$

These equations give a great variety of different types of gravitational radiation.

The field potential relations are:

$$\underline{g} = -\underline{\nabla} \Phi - \frac{\partial \underline{Q}}{\partial t} + 2\left(c\omega_0 \underline{Q} - \Phi \underline{\omega}\right) \quad -(6)$$

$$\underline{\Omega} = \underline{\nabla} \times \underline{Q} + 2\, \underline{\omega} \times \underline{Q} \quad -(7)$$

The mass / current density is:

$$J_m^\mu = \left(c\rho_m, \underline{J}_m\right) \quad -(8)$$

and the potential four vector is:

$$\underline{Q}^\mu = \left(\Phi, c\underline{Q}\right) \quad -(9)$$

If it is assumed that the gravitational equivalent of the magnetic charge / current density is zero, then the equations simplify to:

$$\underline{\nabla} \cdot \underline{\Omega} = 0 \quad -(10)$$

$$\underline{\nabla} \times \underline{g} + \frac{\partial \underline{\Omega}}{\partial t} = \underline{0} \quad -(11)$$

$$\underline{\nabla} \cdot \underline{g} = \underline{\kappa} \cdot \underline{g} = 4\pi G \rho_m \quad -(12)$$

$$\underline{\nabla} \times \underline{\Omega} - \frac{1}{c^2} \frac{\partial \underline{g}}{\partial t} = \underline{\kappa} \times \underline{\Omega} = \frac{4\pi G}{c^2} \underline{J}_m \quad -(13)$$

These have the same structure as the ECE2 equations of electromagnetism:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(14)$$

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(15)$$

$$\underline{\nabla} \cdot \underline{E} = \rho_e / \epsilon_0 \quad -(16)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} = \mu_0 \underline{J}_e \quad -(17)$$

Eqs. (14) ~~and~~ – (17) are the Maxwell Heaviside field equations in a space which correctly uses non-zero torsion and curvature. These equations are all derived from the Jacobi Cartan Evans (JCE) identity of UFT313, which is the final version of UFT88.

The traditional "vacuum equations" of electromagnetic theory are:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(18)$$

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(19)$$

$$\underline{\nabla} \cdot \underline{E} = 0 \quad -(20)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2}\frac{\partial \underline{E}}{\partial t} = \underline{0} \quad -(21)$$

However, these equations ignore the existence of the geometry of the vacuum, now known to be populated by vacuum wave / particles. Accepting the structure (18) - (21) for the sake of argument, the plane wave solutions are -(22)

$$\underline{E} = \frac{E^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j}\right) \exp\left(i\left(\omega t - \underline{\kappa} \cdot \underline{r}\right)\right)$$

$$\underline{B} = \frac{B^{(0)}}{\sqrt{2}} \left(i\underline{i} + \underline{j}\right) \exp\left(i\left(\omega t - \underline{\kappa} \cdot \underline{r}\right)\right) \quad -(23)$$

In eqs. (22) and (23) $\underline{\kappa}$ denotes wave-vector, and is not to be confused with

$$\kappa_0 := 2\left(\frac{q_0}{r^{(0)}} - \omega_0\right) \quad -(24)$$

and

$$\underline{\kappa} := 2\left(\frac{\underline{q}}{r^{(0)}} - \underline{\omega}\right) \quad -(25)$$

of the field equations

4) The complex conjugates of eqs. (22) and (23) are:

$$\underline{E}^* = \frac{E^{(0)}}{\sqrt{2}} \left(\underline{i} + i \underline{j} \right) \exp\left(-i\left(\omega t - \underline{\kappa} \cdot \underline{r}\right)\right) \quad -(26)$$

$$\underline{B}^* = \frac{B^{(0)}}{\sqrt{2}} \left(-i \underline{i} + \underline{j} \right) \exp\left(-i\left(\omega t - \underline{\kappa} \cdot \underline{r}\right)\right) \quad -(27)$$

The $\underline{B}^{(3)}$ field is:

$$\underline{B}^{(3)} = -\frac{i}{B^{(0)}} \underline{B} \times \underline{B}^* \quad -(28)$$

$$= -\frac{i}{B^{(0)}} \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ i & 1 & 0 \\ -i & 1 & 0 \end{vmatrix} \frac{B^{(0)2}}{2}$$

$$= B^{(0)} \underline{k}$$

The inference of the $\underline{B}^{(3)}$ field led to O(3) electrodynamics and ECE theory, and several Nobel Prize nominations. The field was inferred in Nov. 1991 to account for the inverse Faraday effect.

It is easily checked that the plane waves are a solution of the Faraday law of induction (19) as follows:

$$\underline{\nabla} \times \underline{E} = \frac{E^{(0)}}{\sqrt{2}} \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ \partial/\partial X & \partial/\partial Y & \partial/\partial Z \\ e^{i\phi} & -ie^{-i\phi} & 0 \end{vmatrix} \quad -(29)$$

) where

$$\phi := \omega t - \kappa Z \quad - (30)$$

so

$$\underline{\nabla} \times \underline{E} = \frac{\kappa E^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j} \right) e^{i\phi} \quad - (31)$$

$$= \kappa \underline{E}$$

and

$$\frac{\partial \underline{B}}{\partial t} = \frac{B^{(0)} \omega}{\sqrt{2}} \left(-\underline{i} + i\underline{j} \right) e^{i\phi} \quad - (32)$$

where

$$E^{(0)} = c B^{(0)} \quad - (33)$$

Assuming that

$$\kappa = \frac{\omega}{c} \quad - (34)$$

the plane waves obey eq. (19), Q.E.D.

If it is assumed that photon mass is finite, as implied by the $\underline{B}^{(3)}$ field, then eq. (34) is no longer true.

It follows from the above electromagnetic theory that the traditional view of the "vacuum gravitational field equations" is:

$$\underline{\nabla} \cdot \underline{\Omega} = 0 \quad - (35)$$

$$\underline{\nabla} \times \underline{g} + \frac{\partial \underline{\Omega}}{\partial t} = \underline{0} \quad - (36)$$

$$\underline{\nabla} \cdot \underline{g} = 0 \quad - (37)$$

and

6)

$$\underline{\nabla} \times \underline{\Omega} - \frac{1}{c^2} \frac{\partial \underline{g}}{\partial t} = 0 \quad - (38)$$

The gravitational plane wave are therefore:

$$\underline{g} = \frac{g^{(0)}}{\sqrt{2}} (\underline{i} - i\underline{j}) e^{i\phi} \quad - (39)$$

$$\underline{\Omega} = \frac{\Omega^{(0)}}{\sqrt{2}} (i\underline{i} + \underline{j}) e^{i\phi} \quad - (40)$$

where

$$\phi = \omega t - \kappa Z \quad - (41)$$

The gravitational $\underline{\Omega}^{(3)}$ field is:

$$\underline{\Omega}^{(3)} = - \frac{i}{\Omega^{(0)}} \underline{\Omega} \times \underline{\Omega}^* \quad - (42)$$

The force of attraction between two masses m_1 and m_2 is

$$\underline{F}_g = - \frac{m_1 m_2 G}{r^2} \underline{e}_r \quad - (43)$$

where the Newton constant G is:

$$G = 6.6726 \times 10^{-11} \, Nm^2 kg^{-2} \quad - (44)$$

The force of attraction between two charges e_1 and e_2 is:

$$\underline{F}_{em} = - \frac{e_1 e_2}{4\pi \epsilon_0 r^2} \underline{e}_r \quad - (45)$$

So:

7) $$|\underline{F}_g| = 4\pi\epsilon_0 G |\underline{F}_{em}| \quad - (46)$$

where
$$4\pi\epsilon_0 = 1.112650 \times 10^{-10} \, J^{-1} C^2 m^{-1}$$

if we use unit mass and charges and the same separation distance r. So

$$F_g = 6.6726 \times 1.112650 \times 10^{-21} F_{em}$$
$$= 7.42427 \times 10^{-21} F_{em} \quad - (47)$$

So gravitational waves are twenty one orders of magnitude weaker than electromagnetic waves.

In order to detect them, a resonance mechanism is needed, so an Euler Bernoulli structure must be looked for.