1) 116(4): The Complete Inhomogeneous Laws of Dynamics

These are:

$$\boxed{\begin{aligned} &\underline{\nabla} \cdot \underline{g} = 4\pi G \rho \\ &\underline{g} = c^2 \left(T^{010} \underline{i} + T^{020} \underline{j} + T^{030} \underline{k} \right) \\ &\rho = J^{0}{}_{1}{}^{10} + J^{0}{}_{2}{}^{20} + J^{0}{}_{3}{}^{30} \end{aligned}}$$

— (1)

and

$$\boxed{\begin{aligned} &\underline{\nabla} \times \underline{h} - \frac{1}{c} \frac{\partial \underline{g}}{\partial t} = 4\pi G \underline{J} \\ &\underline{h} = c^2 \left(T^{332} \underline{i} + T^{113} \underline{j} + T^{221} \underline{k} \right) \\ &\underline{g} = c^2 \left(T^{110} \underline{i} + T^{220} \underline{j} + T^{330} \underline{k} \right) \\ &\underline{J} = J_x \underline{i} + J_y \underline{j} + J_z \underline{k} \\ &J_x = J^{1}{}_{0}{}^{01} + J^{1}{}_{2}{}^{21} + J^{1}{}_{3}{}^{31} \\ &J_y = J^{2}{}_{0}{}^{02} + J^{2}{}_{1}{}^{12} + J^{2}{}_{3}{}^{32} \\ &J_z = J^{3}{}_{0}{}^{03} + J^{3}{}_{1}{}^{13} + J^{3}{}_{2}{}^{23} \end{aligned}}$$

— (2)

These are found from the equation:

$$D_\mu T^{\kappa\mu\nu} = R^{\kappa}{}_{\mu}{}^{\mu\nu} \quad - (3)$$

2)

expressed as:

$$\partial_\mu G^{\kappa\mu\nu} = 4\pi G J^{\kappa}{}_{\mu}{}^{\mu\nu} \quad -(4)$$

The field tensor is:

$$G^{\kappa\mu\nu} = \begin{bmatrix} 0 & G^{\kappa 01} & G^{\kappa 02} & G^{\kappa 03} \\ G^{\kappa 10} & 0 & G^{\kappa 12} & G^{\kappa 13} \\ G^{\kappa 20} & G^{\kappa 21} & 0 & G^{\kappa 23} \\ G^{\kappa 30} & G^{\kappa 31} & G^{\kappa 32} & 0 \end{bmatrix} = \begin{bmatrix} 0 & -g^{\kappa}_{x} & -g^{\kappa}_{y} & -g^{\kappa}_{z} \\ g^{\kappa}_{x} & 0 & -h^{\kappa}_{z} & h^{\kappa}_{y} \\ g^{\kappa}_{y} & h^{\kappa}_{z} & 0 & -h^{\kappa}_{x} \\ g^{\kappa}_{z} & -h^{\kappa}_{y} & h^{\kappa}_{x} & 0 \end{bmatrix}$$

$$-(5)$$

<u>Duality Transform</u>

The dual transform gives the homogeneous field equations as follows:

$$D_\mu \tilde{T}^{\kappa\mu\nu} = \tilde{R}^{\kappa}{}_{\mu}{}^{\mu\nu} \quad -(6)$$

$$\partial_\mu \tilde{G}^{\kappa\mu\nu} = 4\pi G \tilde{J}^{\kappa}{}_{\mu}{}^{\mu\nu} \quad -(7)$$

where:

$$\tilde{G}^{\kappa\mu\nu} = \begin{bmatrix} 0 & \tilde{G}^{\kappa 01} & \tilde{G}^{\kappa 02} & \tilde{G}^{\kappa 03} \\ \tilde{G}^{\kappa 10} & 0 & \tilde{G}^{\kappa 12} & \tilde{G}^{\kappa 13} \\ \tilde{G}^{\kappa 20} & \tilde{G}^{\kappa 21} & 0 & \tilde{G}^{\kappa 23} \\ \tilde{G}^{\kappa 30} & \tilde{G}^{\kappa 31} & \tilde{G}^{\kappa 32} & 0 \end{bmatrix} = \begin{bmatrix} 0 & h^{\kappa}_{x} & h^{\kappa}_{y} & h^{\kappa}_{z} \\ -h^{\kappa}_{x} & 0 & -g^{\kappa}_{z} & g^{\kappa}_{y} \\ -h^{\kappa}_{y} & g^{\kappa}_{z} & 0 & -g^{\kappa}_{x} \\ -h^{\kappa}_{z} & -g^{\kappa}_{y} & g^{\kappa}_{x} & 0 \end{bmatrix}$$

$$-(8)$$

3)

i.e.

$$\boxed{\begin{aligned} \underline{\nabla} \cdot \underline{h} &= 4\pi G \tilde{\rho} \\ \underline{h} &= c^2 \left(\tilde{T}^{010} \underline{i} + \tilde{T}^{020} \underline{j} + \tilde{T}^{030} \underline{k} \right) \\ \tilde{\rho} &= - \left(\tilde{J}^{0}{}_{1}{}^{10} + \tilde{J}^{0}{}_{2}{}^{20} + \tilde{J}^{0}{}_{3}{}^{30} \right) \\ &= \tilde{J}^{0}{}_{1}{}^{01} + \tilde{J}^{0}{}_{2}{}^{02} + \tilde{J}^{0}{}_{3}{}^{03} \end{aligned}}$$

$$- (9)$$

and :

$$\underline{\nabla} \times \underline{g} + \frac{1}{c} \frac{\partial \underline{h}}{\partial t} = 4\pi G \underline{\tilde{J}} \quad - (10)$$

where:

$$\underline{g} = c^2 \left(\tilde{T}^{332} \underline{i} + \tilde{T}^{113} \underline{j} + \tilde{T}^{221} \underline{k} \right)$$

$$\underline{h} = c^2 \left(\tilde{T}^{101} \underline{i} + \tilde{T}^{202} \underline{j} + \tilde{T}^{303} \underline{k} \right)$$

$$\underline{\tilde{J}} = \tilde{J}_x \underline{i} + \tilde{J}_y \underline{j} + \tilde{J}_z \underline{k}$$

$$\tilde{J}_x = \tilde{J}^{1}{}_{0}{}^{01} + \tilde{J}^{1}{}_{2}{}^{21} + \tilde{J}^{1}{}_{3}{}^{31}$$

$$\tilde{J}_y = \tilde{J}^{2}{}_{0}{}^{02} + \tilde{J}^{2}{}_{1}{}^{12} + \tilde{J}^{2}{}_{3}{}^{32}$$

$$\tilde{J}_z = \tilde{J}^{3}{}_{0}{}^{03} + \tilde{J}^{3}{}_{1}{}^{13} + \tilde{J}^{3}{}_{2}{}^{23}$$

4)

The Free Field or Vacuum Laws

$$\boxed{\begin{aligned} \underline{\nabla} \cdot \underline{g} &= 0 \\ \underline{\nabla} \times \underline{h} - \frac{1}{c}\frac{\partial \underline{g}}{\partial t} &= \underline{0} \\ \underline{\nabla} \cdot \underline{h} &= 0 \\ \underline{\nabla} \times \underline{g} + \frac{1}{c}\frac{\partial \underline{h}}{\partial t} &= \underline{0} \end{aligned}} \quad -(11)$$

In this case there is no matter present; i.e.:

$$\boxed{\begin{aligned} \partial_\mu G^{\kappa\mu\nu} &= 0 \\ \partial_\mu \tilde{G}^{\kappa\mu\nu} &= 0 \end{aligned}} \quad -(12)$$

Matter is defined in ECE theory by:

$$J^{\kappa}{}_{\mu}{}^{\mu\nu} \neq 0 \quad -(13)$$

and in general:

$$\tilde{J}^{\kappa}{}_{\mu}{}^{\mu\nu} \neq 0 \quad -(14)$$

where

$$\boxed{J^{\kappa}{}_{\mu}{}^{\mu\nu} = \frac{c^2}{4\pi G}\left(R^{\kappa}{}_{\mu}{}^{\mu\nu} - 4\,\omega^{\kappa}{}_{\mu\lambda} T^{\lambda\mu\nu}\right)}$$

$$-(15)$$