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From a recipe by Flanagan & Hughes

popularized by Poisson & Will, evangelized by Inan

Physical Degrees of Freedom of the Linear Gravitational Field

$$g_{\mu\nu} \simeq \eta_{\mu\nu} + h_{\mu\nu} \quad , \quad |h_{\mu\nu}| \ll 1$$

$$c^4 G_{\mu\nu} = 8\pi G T_{\mu\nu}$$

Spatial scalar $\quad \Psi \equiv \psi - c^2 6^{-1} \nabla^2 B$

Magnetic 3-vector $\quad A_k \equiv V_k + 4^{-1} \partial_t B_k \quad , \quad \partial_k A^k = 0$

Newtonian scalar $\quad \Phi \equiv U + \partial_t V + \partial_{tt} B/2$

6 Physical Degrees of Freedom

1 – elliptical $\quad \nabla^2 \Psi = -4\pi G \rho$

$\nabla^2 A_k = -4\pi G J_k \quad$ *2 – elliptical*

1 – elliptical $\quad \nabla^2 \Phi = -4\pi G (\rho + 3 P c^{-2} + 3 c^{-2} \partial_t J)$

$c^4 (\nabla^2 - \partial_{tt}) h^{TT}_{mk} = -16\pi G T^{TT}_{mk} \quad$ *2 – radiative*

$$\nabla^2 J = -\partial_t \rho$$

$$\nabla^2 \theta^k = -\partial_t J^k$$

$$2 \nabla^2 \theta = -3(\partial_t J + P)$$

Choose coordinates

$$h_{tt} \equiv 2 c^{-2} U$$

$$h_{tk} \equiv -4 c^{-3} V_k - c^{-1} \partial_k V \quad , \quad \partial_k V^k \equiv 0$$

$$h_{mk} \equiv 2 c^{-2} \psi \delta_{mk} + (\partial_{mk} - 3^{-1} \delta_{mk} \nabla^2) B + c^{-2} (\partial_m B_k + \partial_k B_m) + h^{TT}_{mk}$$

$$\partial_k B^k \equiv 0 \quad , \quad \partial_m h^{mk}_{TT} \equiv 0 \equiv \delta_{mk} h^{mk}_{TT}$$

Specify sources

$T^{tt} \equiv \rho c^2 \quad$ Energy density

$T^{tk} \equiv (J^k + \partial^k J) c \quad , \quad \partial_k J^k \equiv 0 \quad$ Momentum density

$$T^{mk} \equiv P \delta^{mk} + (\partial^{mk} - 3^{-1} \delta^{mk} \nabla^2) \theta + \partial^m \theta^k + \partial^k \theta^m + T^{mk}_{TT}$$

$$\partial_k \theta^k \equiv 0 \quad , \quad \partial_m T^{mk}_{TT} \equiv 0 \equiv \delta_{mk} T^{mk}_{TT}$$

Linear Gravity Cafe – "*where the first order is always good*"

Kids' gauge-invariant placemat – ask your server for crayons!