

Gravitational waves — Exercise sheet n.2

Matteo Breschi

matteo.breschi@uni-jena.de

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Exercise 2.1: Linearized Einstein equations

Compute the Einstein tensor $G_{\mu\nu}$ and the Riemann tensor $R^\mu_{\nu\rho\sigma}$ in weak field approximation,

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} + O(h^2), \quad (1)$$

and write the EFE in terms of $\bar{h}_{\mu\nu}$,

$$\bar{h}_{\mu\nu} = h_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}h. \quad (2)$$

Exercise 2.2: Waves in different frames

Consider the following perturbations in the linearized approximation of GR,

$$h_{\mu\nu} = -(\partial_\mu\zeta_\nu + \partial_\nu\zeta_\mu) \quad (3)$$

where

$$\zeta_\mu(x) = c_\mu e^{-ik_\alpha x^\alpha}, \quad (4)$$

where c_μ is a constant vector and $k^\alpha k_\alpha = 0$ is the wave vector. Show explicitly that perturbation represents a flat space in a different gauge. [Hint: consider the Riemann's tensor]