GENERAL RELATIVITY WS 2017/2018
Technische Universität München
January 31, 2018

Exercise Sheet 13*

The solutions to the following problem set should be handed in by Monday the 5th of February at 8:30 a.m. at the postbox next to PH 3218.

Mock Exam

1 Short Questions

1. Consider a distant source of gravitational waves with a characteristic length R and speed v. How is the octupole moment contribution suppressed in comparison to the quadrupole?

2. Assume you observe a certain star just at the edge of the sun. Where is this star really located with respect to you and the sun (assuming there are no massive objects on the way besides the sun)?

2 Problems

1. Show that the following Lagrangian leads to the linearized gravity Einstein's equations (assume $h_{\mu\nu}$ is a symmetric tensor):

$$\mathcal{L} = \frac{1}{2}\left[\partial_\mu h^{\mu\nu}\partial_\nu h - \partial_\mu h^{\rho\sigma}\partial_\rho h^{\mu}{}_{\sigma} + \frac{1}{2}\eta^{\mu\nu}\partial_\mu h^{\rho\sigma}\partial_\nu h_{\rho\sigma} - \frac{1}{2}\eta^{\mu\nu}\partial_\mu h\,\partial_\nu h\right] \tag{1}$$

2. Consider a shell of matter which is rotating slowly, with M, R and Ω being its mass, radius and angular velocity respectively.

   (a) Show that the gravito-electric field, $\vec{G}$, vanishes and compute the gravito-magnetic field $\vec{H}$, with the definitions given in the lecture.

   (b) Calculate the rotation of a freely falling observer when he is located in the interior of the shell (**Lense-Thirring effect**).

3. Compute the modifications to the formula for the power radiated by gravitational waves from a binary system with comparable masses m_1, m_2 orbiting each other in a Keplerian orbit of eccentricity e and semi-major axis a.

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