Gravitational Wave Exercises @ Jena

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Exercises for the Gravitational Waves course. The exercise sheets can be found on the webpage.

1 Quadrupole approximation

The procedure to find the quadrupole approximation for the GW emitted by a Newtonian system is in the form:

1. determine the density $\rho(\vec{x}, t)$;
2. calculate the trace-free inertia tensor $Q^{ij}(t)$;
3. calculate the gravitational wave strain h_{ij}.

Two point particles

The density in this case will be a sum of two delta-functions, whose locations rotate around an axis — let us fix it to be the z axis for simplicity, and also let us suppose that we are on the $z = 0$ plane:

$$\rho(\vec{x}, t) = m\delta(\vec{x} - \vec{x}_1(t)) + m\delta(\vec{x} - \vec{x}_2(t)) \,, \tag{1.1}$$

where

$$\vec{x}_1(t) = \begin{bmatrix} \cos(\omega t + \phi) \\ -\sin(\omega t + \phi) \\ 0 \end{bmatrix} \qquad \text{and} \qquad \vec{x}_2(t) = -\vec{x}_1(t) \,. \tag{1.2}$$