Gravitational waves — Exercise sheet n.6

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Exercise 6.1: Energy of a binary system

Consider two point-particles with different masses in Newtonian circular orbit.

- Compute the GW energy radiated by the system, defined as

$$E = \frac{c^4}{32\pi G} \int d^3x \, \langle \partial_0 h_{ij} \partial_0 h_{ij} \rangle \, ; \tag{1}$$

  ;

- In Newtonian approximation, the radiated power $\dot{E}$ can be expressed as

$$\dot{E} = P = \frac{32}{5} \frac{G}{c^5} \mu^2 m^{3/4} \Omega^{10/3} \, . \tag{2}$$

  Starting from basic argumentation, we can related the energy E with the orbital frequency Ω, as $E \propto \Omega^{2/3}$, which leads to

$$\frac{2}{3} \frac{\dot{\Omega}}{\Omega} = \frac{\dot{E}}{E} \, . \tag{3}$$

  Compute the evolution of the GW frequency.