Gravitational Waves

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1 Very General Equations

e.g., notes from COTB 2014, Holz.

$$g_{\alpha\beta}(x) = \eta_{\alpha\beta} + h_{\alpha\beta}(x) \tag{1}$$

$$h_{\alpha\beta} = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} f(t - z) \tag{2}$$

Quadrupole formula gives the total power radiated in gravitational waves:

$$L_{\text{GW}} = \frac{G}{5c^5} \left\langle \dddot{I}_{ij} \dddot{I}^{ij} \right\rangle \tag{3}$$

Luminosity of GW sources:

$$L_{\text{GW}} \sim \frac{c^5}{G} \sim \frac{2 \times 10^{42}}{7 \times 10^{-11}} \sim 10^{52} \text{ Joules} \tag{4}$$

2 Detecting GWs

2.1 Pulsar timing arrays

- 10^{-6} - 10^{-9} Hz.

- Sensitive to supermassive binary black holes with orbital periods of months.