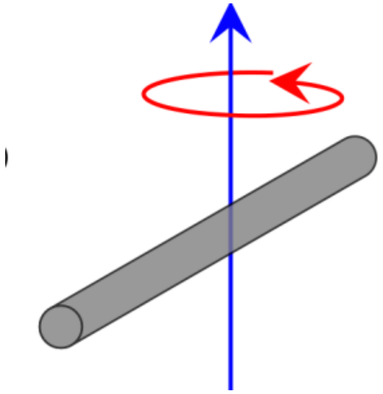
Coalescing Compact binaries: Q&A session

Build A Detector workshop, June 3rd, 2021

Homework 1

- Spinning rod of length 10 meters, spinning at 10Hz and mass of 1 ton located on Moon. Calculate the GW amplitude.



- Use Quadrupole formula:

  The amplitude of GW : $h \sim \frac{2G}{rc^4}(ML^2f^2)$

$$h = \frac{2G}{rc^4}\frac{d^2Q}{dt^2}$$

M = 1000 kg, L =10 m

Spin frequency, f: 10Hz

Distance to the moon, r ~ 1 light second

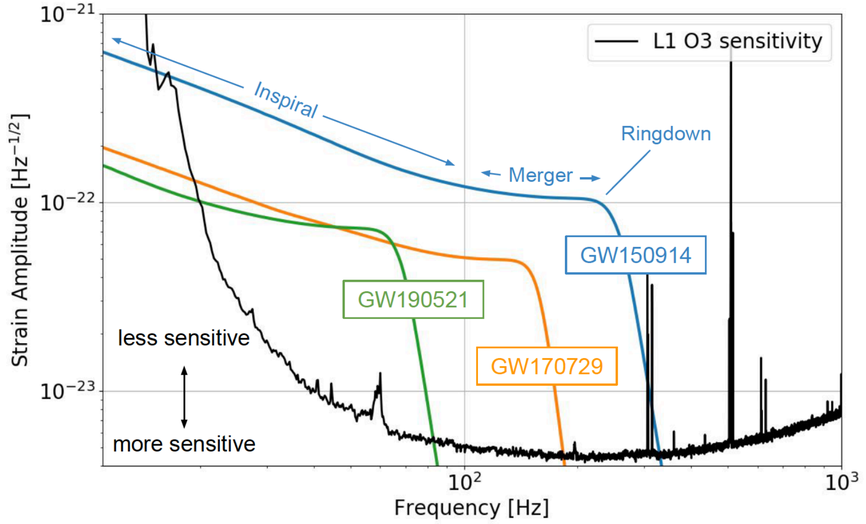
$$h \sim 10^{-46}$$

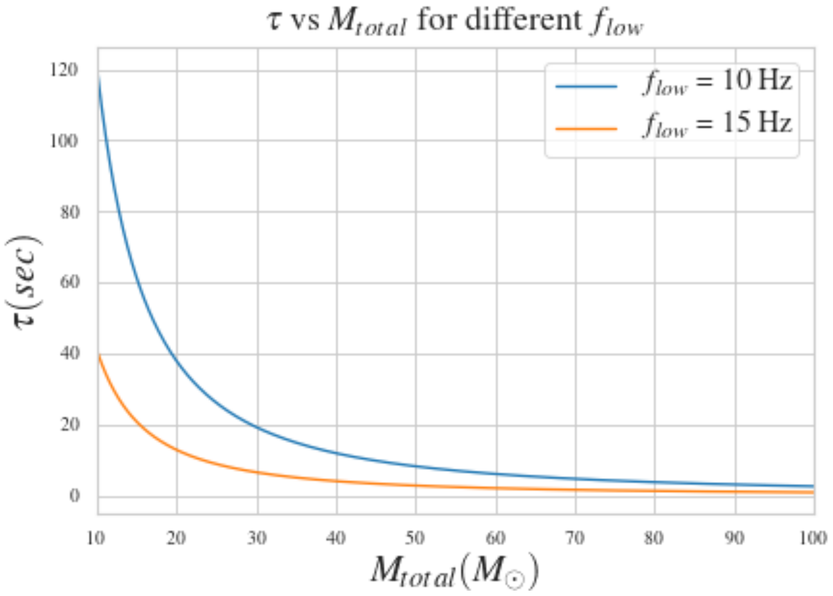
Homework 2

- Plot the signal duration of the inspiral phase as a function of the total M of the binary system
- Assume the lower cut off frequency as 15 Hz.
- The gravitational wave frequency evolves with respect to time as $f_{GW}^{-8/3}(t) = \frac{(8\pi)^{8/3}}{5}\left(\frac{GM_c}{c^3}\right)^{5/3}(t_c - t)$
- Signal enters the detector when $f_{GW} = f_{Low}$
- The inspiral signal duration is

$$\tau = \frac{5}{(8\pi)^{8/3} f_L}\left(\frac{GM_c f_L}{c^3}\right)^{-5/3}$$

$$M_c \sim \mu^{3/5} M^{2/5} \sim (0.25)^{0.6} M$$





Resource Material

- GW open science page — https://www.gw-openscience.org/about
- Review article: Physics, Astrophysics and Cosmology with gravitational waves by B. S. Sathyaprakash and B. F. Schutz
- The basics physics of the binary black hole merger GW150914, LVK Annalen der Physik, Volume 529, Issue 1-2, January 2017
- Textbooks:
  - Gravitational-Wave Physics and Astronomy by Jolien Creighton and Warren Anderson, Wiley Series in Cosmology
  - Gravitational Waves: Vol1: Theory and Experiments by Michele Maggiore