Problem Set - 2

Compact Binary Evolution, Rates and Population Modelling

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Problem 1:

Simulating a Population of Binaries

1. The mass function of stars was first posited by Edwin Salpeter in 1955. While there are many updated models for the mass function, we use the Salpeter mass function for illustration purposes. The mass function $\xi(m)$ is given by
$$\xi(m) \propto m^{-2.35}.$$
Draw samples from this mass function for the primary mass in the binary. Assume that the minmum mass of stars under consideration is $20M_\odot$ and maximum mass is $150M_\odot$.

2. Assume that the distribution of mass ratio $q = m_2/m_1$ (ie. smaller mass divided by larger mass) is uniform. That is, $p(q) =$ constant, with limits 0.25 to 1.

3. Calculate the remnant mass by assuming
$$M_{\rm remnant} = M^{\alpha}_{\rm initial};\ \alpha = 0.75.$$
This power-law prescription is rather heuristic, and you can try to play around by changing the power law exponent.

4. Opik's law models the distribution of initial separation a as $\frac{dP}{da} \propto 1/a$ ie. $\frac{dP}{d(\log a)} \propto 1$. Hence, this corresponds to sampling a from a logUniform distribution. We will use the upper and lower limits as $10R_\odot$ and $10^5 R_\odot$.

5. Put all the above together to calculate the time delay distribution. Use functions written in Problem Set 1.