1 Tertiary-Induced BBH Merger Fraction Simulations

I completed $a_{\text{out,eff}} = [2800, 3600, 4500, 5500, 7000]$, and also am starting calculations for $a_{\text{out,eff}} = [1200, 2000]$ (not yet completed). The other parameters are:

$$[h]m_{12} = 50M_\odot, \qquad m_3 = 30M_\odot, \qquad a_0 = 100\,\text{AU}, \qquad e_0 = 10^{-3},$$
$$q \in [0.2, 1], \qquad e_{\text{out},0} \in [0, 0.9], \qquad \cos I_0 \in [\cos 50^\circ, \cos 130^\circ].$$

All distributions are uniform. The restricted range in I_0 is because the other regions are never octupole-active (at least not at $a_{\text{out,eff}} = 3600$). The resulting merger probabilities as a function of q, defined as

$$f_{\text{merge}} = 100 \times \frac{\cos 50^\circ - \cos 130^\circ}{2} \times \frac{\#\text{ merged}}{\#\text{ run}}, \tag{1}$$

are shown in Fig. 1

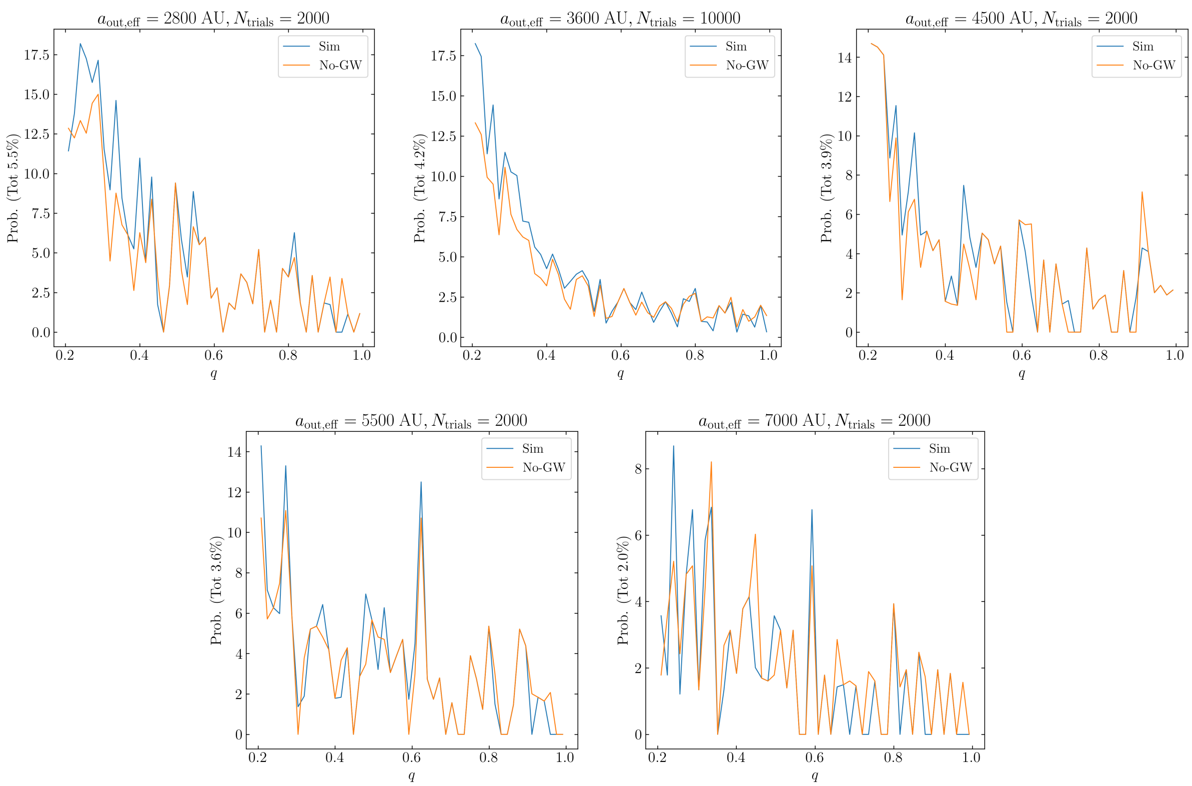

Figure 1: Merger probabilities as a function of q.

The cumulative merger probabilities as a function of $a_{\text{out,eff}}$ are shown in Fig. 2

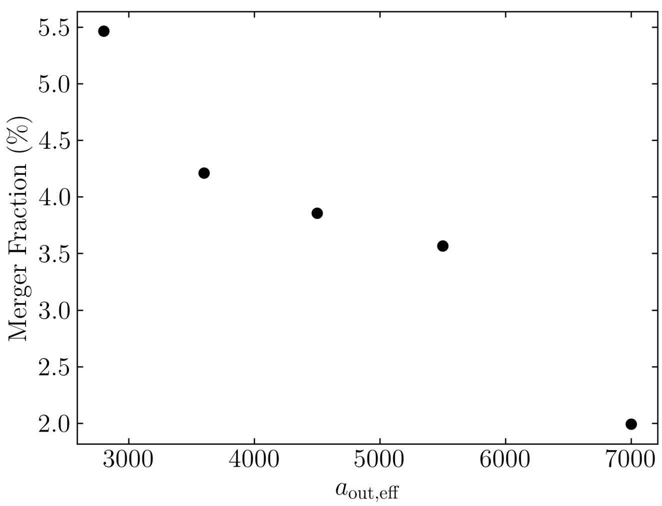

Figure 2: Total merger probabilities as a function of $a_{\text{out,eff}}$.

2 Planet Octupole Simulations

I ran simulations to determine $e_{\max}(I_0)$, where I_0 is the initial mutual inclination between the planets' orbits. The parameters I used were:

$$m_1 = 1M_\odot, \qquad m_2 = m_3 = 1M_J, \qquad a = 5\,\mathrm{AU}, \qquad a_{\mathrm{out}} = 50\,\mathrm{AU},$$
$$e_0 = 10^{-3}, \qquad k_2 = 0.37, \qquad R_2 = R_J.$$

I sampled $I_0 \in [40°, 140°]$, though the upper inclination range doesn't seem always to be sufficient. I tried among $e_2 = [0.1, 0.3, 0.5, 0.6, 0.8, 0.9]$. I also retried all my simulations with

$$m_3 = M_\odot, \qquad a_{\mathrm{out}} = 500\,\mathrm{AU}.$$

This ensures the same quadrupole strength ($\bar{a}_{\mathrm{out,eff}}$) but causes η to decrease by a factor of ≈ 3000, satisfying the test particle approximation. This is for verification against the MLL16 fitting formula. The results are shown in Fig. 3 and 4. Each inclination is run for 3 random choices of ω_i, Ω_i angles, while a total of up to 2000 inclinations are sampled uniformly. The value of $e_{\max}$ in these simulations is $1 - e_{\max} \approx 10^{-3}$, in line with the analytical estimate, suggesting my $\dot{\omega}_{\mathrm{tide}}$ is correct.

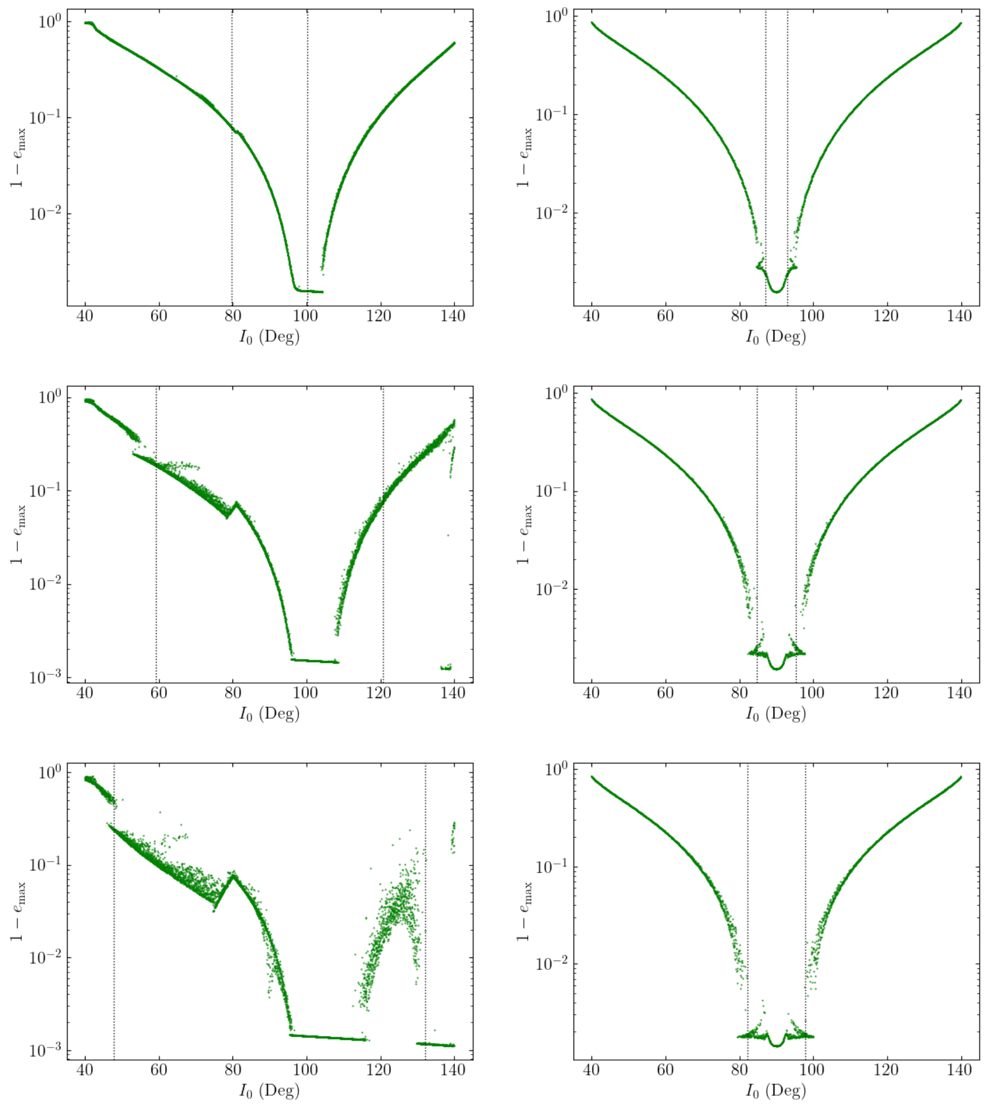

Figure 3: Part 1. Rows are $e_{\rm out} = [0.1, 0.3, 0.5]$, while columns are for the fiducial parameters and for $m_3 = M_\odot$. Dots indicate $e_{\rm max}$ when run over $500t_{\rm LK}$ with apsidal precession (due to both GR and tides) but with no dissipation. Vertical lines are fits from MLL16. Note that $\epsilon_{\rm oct}$ is larger on the left column by a factor of 10.

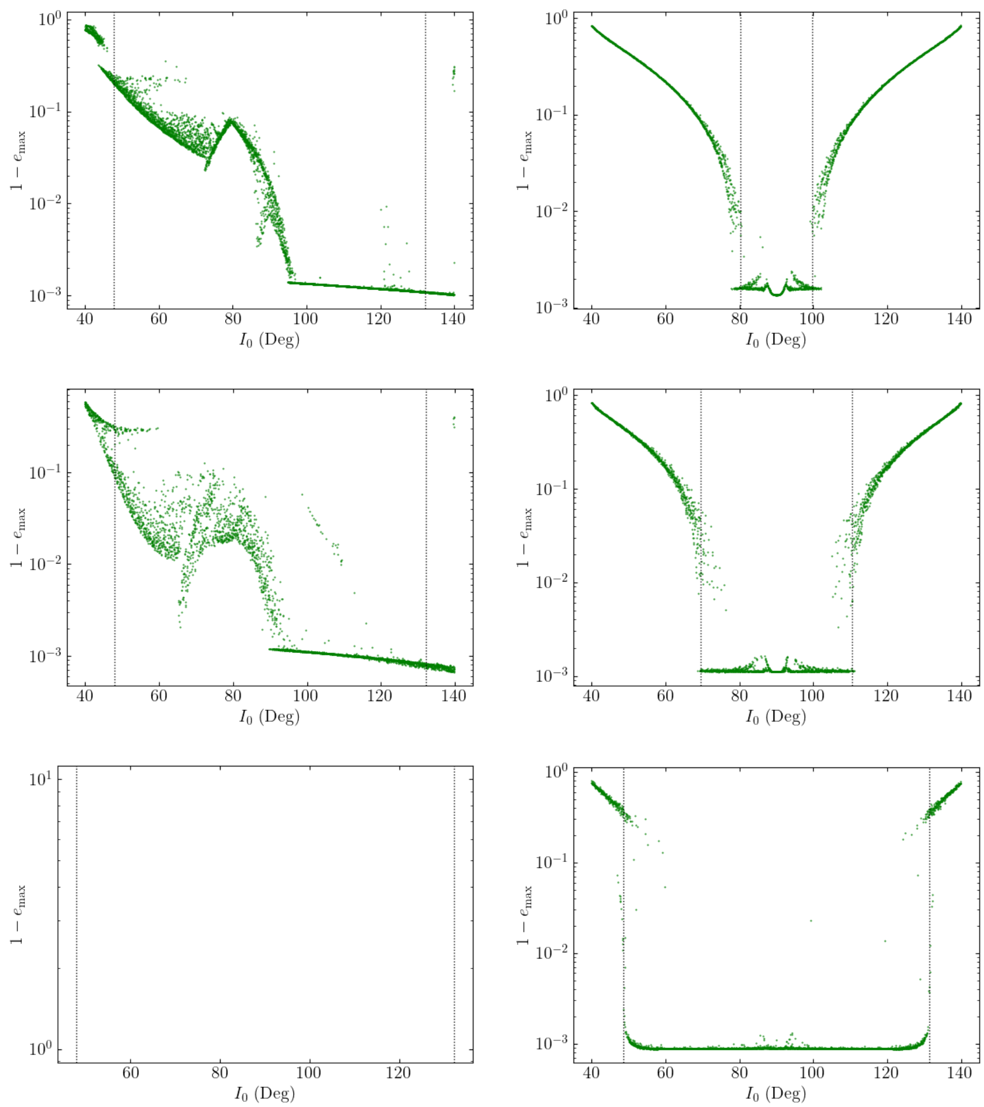

Figure 4: Part 2. Rows are $e_{\text{out}} = [0.6, 0.8, 0.9]$, while columns are for the fiducial parameters and for $m_3 = M_\odot$. No simulations are available for $e_{\text{out}} = 0.9$ and $m_3 = M_J$ yet.