Octupole Merger Window Update

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October 27, 2020

1 Simulation

I implemented the equations from Appendix A of Liu et. al. 2015, LK oscillations in orbital elements, and added GW dissipation to a_1, e_1, and apsidal precession in ω_1. The fiducial parameters are:

$$m_{12} = 50M_\odot, \qquad m_3 = 30M_\odot, \qquad a_{1,0} = 100\,\mathrm{AU},$$
$$a_2 = 6000\,\mathrm{AU}, \qquad e_{1,0} = 10^{-3}, \qquad e_{2,0} = 0.6.$$

I ran an example simulation using $I_{\mathrm{tot},0} = I_{1,0} + I_{2,0} = 93.5^\circ$, initial angles $\Omega_{1,0} = \Omega_{2,0} + \pi = \omega_{1,0} = 0$, $\omega_{2,0} = 0.7$ rad, and masses $m_1 = 30M_\odot$, $m_2 = 20M_\odot$, so resembling Fig. 10 of LL18. The resulting evolution of the orbit is shown in Fig. 1.

2 Population

I then swept over $I_{\mathrm{tot},0} \in [91^\circ, 95^\circ]$ for mass ratios $q = 1.0, 0.7, 0.5, 0.4, 0.3, 0.2$. I used 60 different initial inclinations, and for each initial inclination, I randomly chose $\Omega_{1,0}$, $\omega_{1,0}$, and $\omega_{2,0}$ five times. The resulting merger times are shown below in Fig. 2.

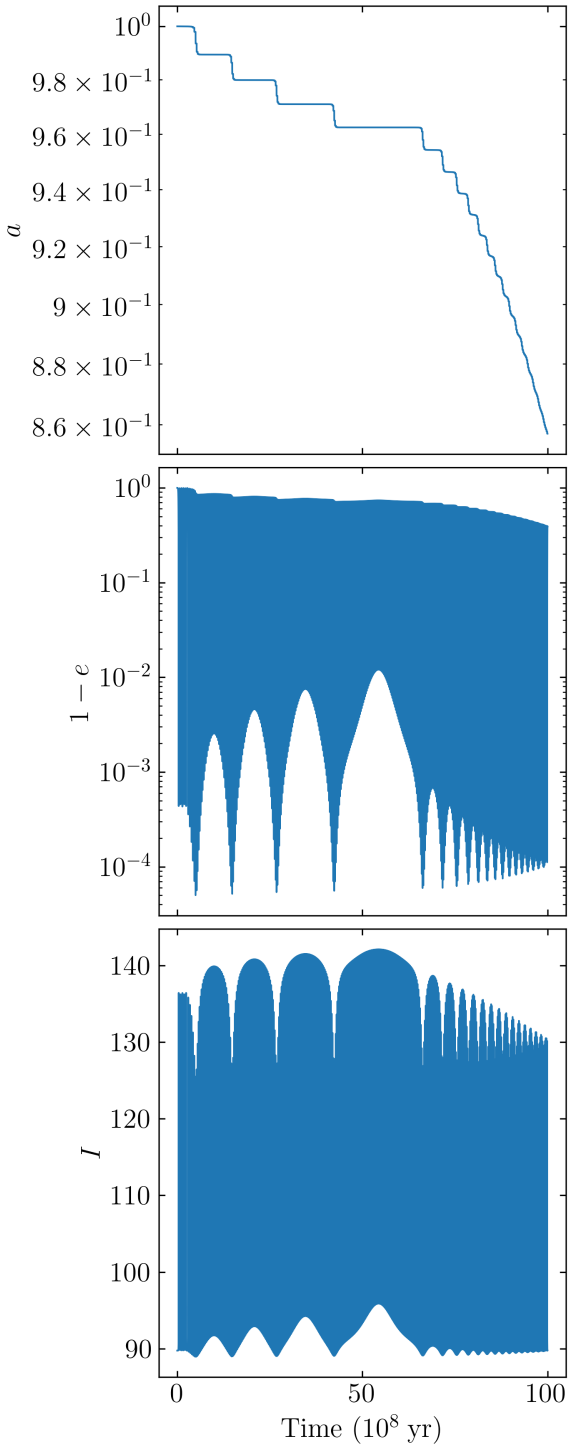

Figure 1: Fiducial simulation using same params & ICs as Fig. 10 of LL18, but with completely different results (failing to merge in 10^{10} yr). However, it bears noting that for $q = 0.7, I_{\rm tot,0} = 93.5°$ (this simulation has $q = 2/3$), I got many simulations merging in a few 10^8 yr, see Fig. 2, so it is possible this is just an abnormally long lived IC.

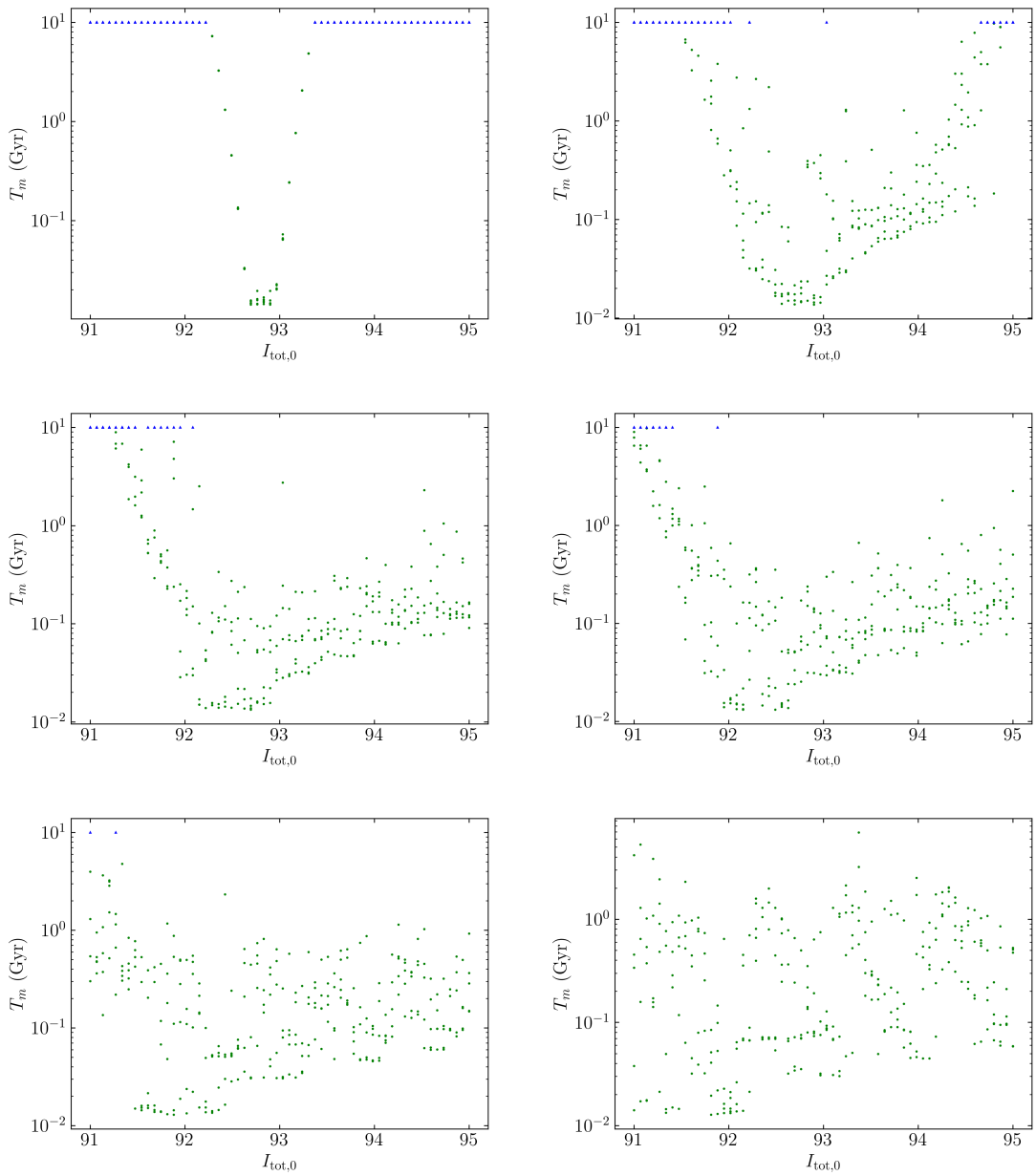

Figure 2: Merger times with varying q using the fidicual parameters, where every initial mutual inclination is retried 5 times with different Ω, ω. In order: $q = 1.0, 0.7, 0.5, 0.4, 0.3, 0.2$. Blue points denote systems that do not merger within a Hubble time 10 Gyr, while green points denote systems that do. The qualitative trend seems to agree with Fig. 9 of LL18, where as $\epsilon_{\rm oct}$ is increased, the merger window grows towards larger inclinations first.