ASTR400B HW6

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1 Questions

1. Depending on which troughs in separation can be considered close encounters before the galaxies merge together, there will be three close encounters. On the third close encounter the galaxies will have merged, as indicated by the fairly consistent minimal separation and minimal relative velocity for the rest of the simulation time.

2. When separation is maximized, relative velocity is minimized. This makes sense from a general energy conservation argument. As separation increases, gravitational potential energy increases (becomes less negative), and since overall energy must be conserved, kinetic energy - and therefore relative velocity - must decrease since mass stays constant (at least for now).

3. M31 and MW merge at roughly 6.5 Gyr, indicated by the lowest separation distance which is visible in the log plot. After this point, M33's orbit begins to decay because the maximum separation decreases after every cycle, but the velocity of M33's orbit stays fairly consistent and periodic, which indicates that it slowly starts to spiral inwards.

4. The decay rate decreases after every succesful apocenter, but assuming that the first decay rate measure is accurate, it is $\frac{(108.1 \text{ kpc} - 88.2 \text{ kpc})}{(8.922 \text{ Gyr} - 7.509 \text{ Gyr})} = 14.08$ kpc/Gyr. At this rate, it will take 75 kpc /(14.08 kpc/Gyr) = 5.327 Gyr for M33 to merge with the combined remnant.