Homework 7 — pdf portion

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ASTR 400B

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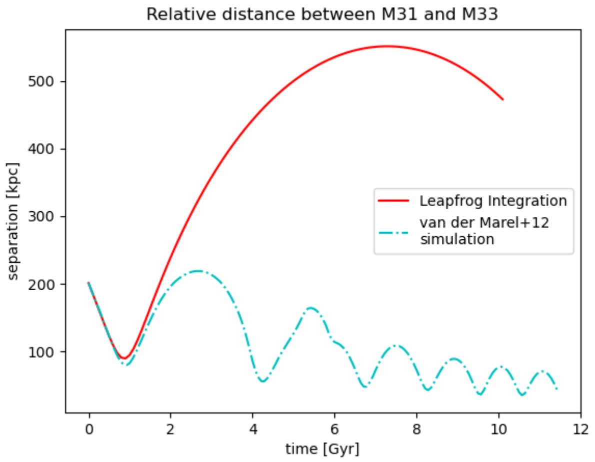
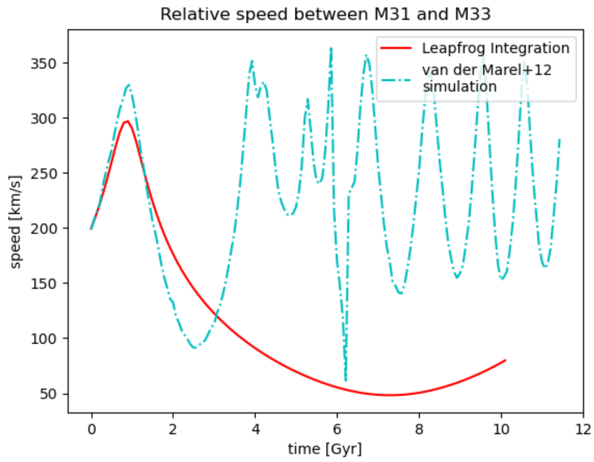
5 Questions

1. 



2. The leapfrog simulation conducted assuming point-like galaxies witnessed one close encounter before rapidly receding from one another, similar to the orbit of binary stars with a high ellipticity. At around 7 Gyr, in the future, the galaxies briefly stop relative to one another and begin moving towards each other.

   Meanwhile, the N-body simulation begins similarly, but depicts an orbit that is decaying with five close encounters within 10 Gyr and an ever decreasing aphelion.

   The velocity plots corroborate this, with the Leapfrog integrator showing one velocity spike at the close encounter before racing away and eventually stopping and returning. Meanwhile, the N-body simulation plots a much more sporatic speed evolution.

3. As I mentioned in the previous question, our point-like acceleration method assumes galaxies operate like compact binaries or a planetary orbit. This approximation is useful when the center of mass of the galaxies is far, but during the first close encounter, the gravitational force between individual stars and halo particles in each galaxy becomes significant, greatly reducing the relative velocity between each galaxy in a processes called dynamical friction.

4. To consider MW in our leapfrog orbital integrator, we would need to consider the acceleration between MW and M31 as well as the acceleration between M33. This would have the effect of creating a 3-body simulation. Note that since MW and M31 would behave like point-like particles, they would not merge as we expect, so this simulation would also predict a very different result from the individual particle simulation.