Homework 6 — pdf portion

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ASTR 400B

February 28, 2025

4 Questions

1. According to the simulation, MW and M31 will have two close encounters before finally merging on the third encounter.

2. At the risk of sounding obvious, the magnitude of the slope of the separation between the galaxies gives the speed values, since velocity is the derivative of displacement. This value spikes during the close encounter before rapidly falling to 0 as the galaxies decelerate, stop, and begin accelerating towards each other again. This graph corroborates our last answer too, as there are 3 peaks for the 2 close encounters and the merger.

3. MW and M31 merge 6.29 Gyr in the future per the simulation. I found this value from the end of the third bounce using `plt.show()`. At this time, M33, while approaching the galaxy merger, temporarily "pauses" ($v_{\mathrm{M33}} \sim 60\,\mathrm{km/s}$) before continuing its orbit.

4. After 6 Gyr, the orbital decay is roughly ~ 20 kpc/Gyr. Assuming a constant decay rate and a starting value of 75 kpc, M33 will merge with the MW+M31 remnant ~ 4 Gyr after the 6 Gyr benchmark, or 10 Gyr in the future. This doesn't appear to happen according to this simulation, which instead suggests the decay rate itself slowly decreases, elongating the time before merger for M33.