

## ASTR400B Project Report, Spring 2020

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### ABSTRACT

A summary to be inserted here

#### 1. INTRODUCTION

The simulation of Milky Way–M31–M33 orbital evolution was described previously (Marel et al. 2012). That paper included an extensive analysis of both N-body simulations and semi-analytic orbit integrations. The present study uses data from the same N-body simulation to carry out further computational analysis.

#### 2. DATA

Data from one N-body simulation in (Marel et al. 2012) was supplied in text-file format by one of the original authors. This included position and velocity data for each particle at the current epoch ( $t = 0$ ) and 800 future timesteps. For ease of analysis, this was all transferred to the open source database PostgreSQL<sup>1</sup> (approximately 1.35 billion records). The same database was used to store computed summary data during the analysis.

Particle counts for each time point are shown in Table 1 and total masses in Table 2.

The coordinate system is approximately centered on the Milky Way at  $t = 0$ . The center of mass (CoM) of all particles in the system is not fixed over time, moving at an average of (35.9, -26.7, 27.5) km/s with some minor fluctuations due to numerical approximations. In contrast, the total angular momentum of the system is very small at all time points.

#### 3. SOFTWARE

The work in this report was carried out in Python using standard package. Full details are available online<sup>2</sup>

#### 4. RESULTS

##### 4.1. Trajectories

##### 4.2. Close approach

(Toomre & Toomre 1972)

### REFERENCES

- Marel, R. P. v. d., Besla, G., Cox, T. J., Sohn, S. T., & Anderson, J. 2012, The Astrophysical Journal, 753, 9, doi: [10.1088/0004-637X/753/1/9](https://doi.org/10.1088/0004-637X/753/1/9)  
Toomre, A., & Toomre, J. 1972, The Astrophysical Journal, 178, 623, doi: [10.1086/151823](https://doi.org/10.1086/151823)

<sup>1</sup> <http://www.postgresql.org>

<sup>2</sup> Code [https://github.com/colinleach/400B\\_Leach](https://github.com/colinleach/400B_Leach)  
documentation <https://400b-leach.readthedocs.io>

**Table 1.** Particle counts

Galaxy	DM Halo	Disk	Bulge	Total
MW	250,000	375,000	50,000	675,000
M31	250,000	600,000	95,000	945,000
M33	25,000	46,500	0	71,500
Local Group	525,000	1,021,500	145,000	1,691,500

**Table 2.** Aggregate masses ( $M_{\odot} \times 10^{12}$ )

Galaxy	DM Halo	Disk	Bulge	Total
MW	1.975	0.075	0.010	2.060
M31	1.921	0.120	0.019	2.060
M33	0.187	0.009	0.000	0.196
Local Group	4.082	0.204	0.029	4.316