# 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[1] (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.

**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 |

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[1] http://www.postgresql.org

## 3. SOFTWARE

([Toomre & Toomre 1972](#))

REFERENCES

Marel, R. P. v. d., Besla, G., Cox, T. J., Sohn, S. T., &
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