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Fate of Stars at Sun's Location in the M31 Disk

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1. INTRODUCTION

With the procession of time, particles spread out in a galactic disk change velocity and position. The interaction by merger of galaxies also affect the status of these particles. The study of particles captured or ejected from mergers allows the formation of theories to the evolution of galaxy structures in the universe.

Simulating the merger of M31 and M33, our neighbors, informs predictions of the change in observable system over time. To understand how our Sun has moved through the Milky Way, we can look to the migrations of similar stars in these other galaxies. This also informs us about the change to similar galaxies and what we should expect to observe from their mergers in the universe.

A star's position in its parent galaxy is not stationary. The rotation, angular velocity, mass distribution, and interactions with nearby systems influence star location throughout time. Stars undergo their own precession and wandering much like planets do around their host star. The observed orbital velocity of stars as a function of its distance to the center of the galaxy does not match with Kepler's Laws.

The current proposed solution to problem of different theoretical and observed results has to do with the existence of dark matter. The lack of observed decreasing orbital velocity with increasing radius from galactic center is that invisible dark matter halos surround the galaxy and this extra mass causes orbital velocity to level-off further from the galactic center (Figure 1)

2. PROPOSAL

2.1. *Questions*

Using the known values for our Sun's mass, radius and velocity in the Milky Way provided in (Martínez-Barbosa et al. 2015), we can extend this to similar particles that exist in M31. Then the radial velocity and other forces on the particles will need to be accounted with the current model for the change in the structure of M31 over time. This calculation will need to be produced in two ways: with and without dark matter. This is to check that the current dark matter theories in the field correspond to what is observed in the simulation. This will also tell us about the change in the density of stars in the radii chosen.

2.2. *Simulations*

With the provided data, the code will limit particles in M31 that have similar mass and radius of about eight kpc from the center of the galaxy. This means the galactic center of M31 needs to be estimated first which in itself is a value that can vary depending greatly. The proper motion of particles in M31 should be included to account for change of the galaxy over time. Then the merger of M33 and M31 and the change to their mass velocity distributions should also be calculated to measure how this event will affect the solar-like particles we selected. To compare the simulation ran, figures comparing the radius from galactic center and velocity of the particles over time should be included, much like in (van der Marel et al. 2012). The correct particle types will also need to be selected, first limiting halo particles as these account for dark matter regions in the galaxy, then repeating the simulation to account for the dark matter to see if this produces a result similar to (Kafle et al. 2018).

2.3. *Figures*

The simulation should produce a result much like this one: Figure 1

2.4. *Hypothesis*

The position of sun like particles in M31 will change over time as they drift away from the galactic center. They may even become unbound due to change in magnitude in velocity due to the merger. With the velocities of stars not decreasing at these greater radii, the particles should continue to move away from the eight kpc range at a steady rate. The structure of M31 may then be an elliptical galaxy by the end of the merger with M33. This result will help us to construct a theory for what should happen to our solar system and galaxy with the eventual merger of the Milky Way and M31.

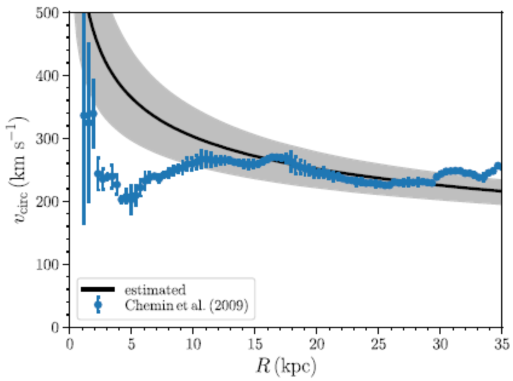

Figure 1. From (Kafle et al. 2018): Circular velocity curve of the M31. Blue dots with error bars are measured values by (Chemin et al. 2009) using HI emmision line observations whereas grey shade with black solid line is our best estimate.

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Martínez-Barbosa et al. (2015) van der Marel et al. (2012) Kafle et al. (2018) Chemin et al. (2009)