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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. The project will use computational techniques to measure the changes in position and velocity data of the sun-like particles. The analysis outlined in this paper will involve comparing the motion observed to models of Andromeda's motion and using statistical techniques to determine the most likely motion of the sun-like particles.

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. According to (Sparke & Gallagher 2010), a galaxy is a massive system of stars, gas, and dust that are held together by gravity. (Sparke & Gallagher 2010) also explains galaxy evolution referring to the processes that shapes the formation and evolution of galaxies over time. Stars at the sun's location in the Andromeda Galaxy, or any other galaxy, are subject to the gravitational forces of the other stars and the distribution of dark matter within the galaxy. By measuring the movement of these stars over time, astronomers can understand the distribution of mass in the galaxy and how it changes with time. If stars at the sun's location in the Andromeda Galaxy are found to be moving in a certain direction, it could indicate the presence of a dense concentration matter. Studying the movement of stars in galaxies also provides insights into the physical processes that govern the behavior of galaxies, such as mergers with other galaxies, interactions with the intergalactic medium, and star formation. By understanding these processes, astronomers can build simulations of galaxy evolution that can be used to test predictions about the future evolution of galaxies.

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.

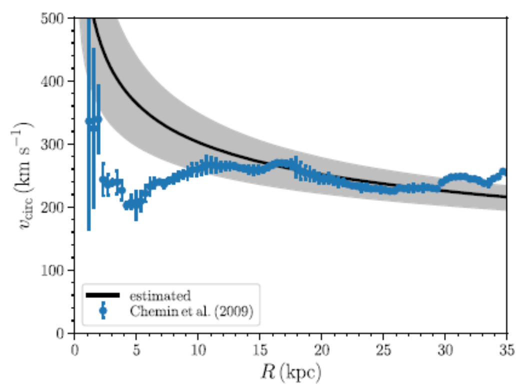

Figure 1. From (Kafle et al. 2018): Circular velocity curve of the M31. Blue dots with error bars are measured values by (Chemin et al. 2009) using HI emmision line observations whereas grey shade with black solid line is our best estimate.

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. How do interactions with neighboring galaxies and the intergalactic medium affect the movement of stars in the Andromeda Galaxy? These interactions can affect the movement of stars in the Andromeda Galaxy, but the exact mechanisms are not well understood. Improving our observational and computational techniques can help us better understand the movement of stars in the galaxy and answer some of the open questions. (Figure 1)

2. THIS PROJECT

The project will use computational techniques to measure the changes in position and velocity data of the sun-like particles. The analysis will involve comparing the motion observed to models of Andromeda's motion and using statistical techniques to determine the most likely motion of the sun-like particles.

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. 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.

REFERENCES

Chemin, L., Carignan, C., & Foster, T. 2009, ApJ, 705, 1395, doi: 10.1088/0004-637X/705/2/1395

Kafle, P. R., Sharma, S., Lewis, G. F., Robotham, A. S. G., & Driver, S. P. 2018, MNRAS, 475, 4043, doi: 10.1093/mnras/sty082

Martínez-Barbosa, C. A., Brown, A. G. A., & Portegies Zwart, S. 2015, MNRAS, 446, 823, doi: 10.1093/mnras/stu2094

Sparke, & Gallagher. 2010, Galaxies in the Universe: An Introduction (Cambridge University Press)

van der Marel, R. P., Besla, G., Cox, T. J., Sohn, S. T., & Anderson, J. 2012, ApJ, 753, 9, doi: 10.1088/0004-637X/753/1/9