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Research Assignment 2

Malhar Dave

1. INTRODUCTION

The sun is 8 kpc away from the centre of our milky way, and there are innumerable stars a similar distance away from the centres of other galaxies in the Universe. Of all of these galaxies,we focus on M31 and M33, the fascinating spiral galaxies in our local group, and analyse what will happen to particles in these galaxies at a similar distance as the sun is from the centre of the milky way when the inevitable merge occurs.

Studying the fate of stars such as the sun in merging galaxies can help us understand the processes that lead to the formation rate and evolution of stellar populations, which is a critical aspect of galaxy evolution.

According to van der Marel et al. (2012) , the Sun will most likely migrate outward during the merger process, compared to its current distance from the Galactic Center, with a small but significant probability that it will migrate out to very large radius. No candidate suns become entirely unbound from the MW-M31 merger remnant in the simulation.

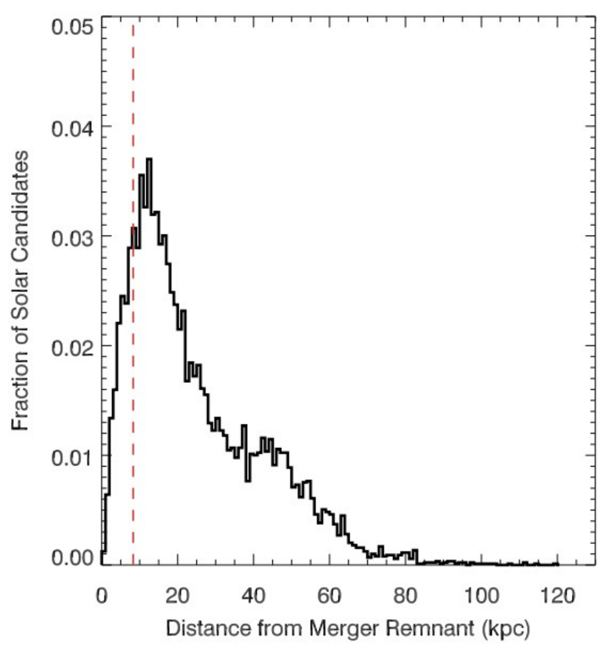


Figure 1. The given figure, from van der Marel et al. (2012), showcases that the radial distribution of candidate suns was analyzed with respect to the center of the MW-M31 remnant at the end of a 10 billion year N-body simulation. The majority of candidate suns migrated outward during the merger process (starting from the current distance of the Sun from the Galactic Center).

While we are focused on the galaxy merger happening in our distant future, one open ended question might be about what happened to the milky way in its past, but that will be too wide in scope for our project. When it comes to our topic in particular, Cox & Loeb (2008) consider 700 particles as candidate Suns, while van der Marel et al. (2012) uses 8786 particles that meet a certain criteria, so a question that does arise is how the difference in criteria influences the results in our data. It is also to be noted that Cox & Loeb (2008) had a lower number because of resolution issues at the time, but it might be more desirable to have a less computationally intensive project.

As shown by Schiavi et al. (2020), in the next 4.3 billion years, the Milky Way and Andromeda galaxies will approach each other closely and eventually merge over a period of 10 billion years. While the predicted timing of their initial encounter is in line with previous estimates, the merger will happen later that previously thought. We can use such new insights to our advantage and build on the methods raised in the first two papers mentioned.

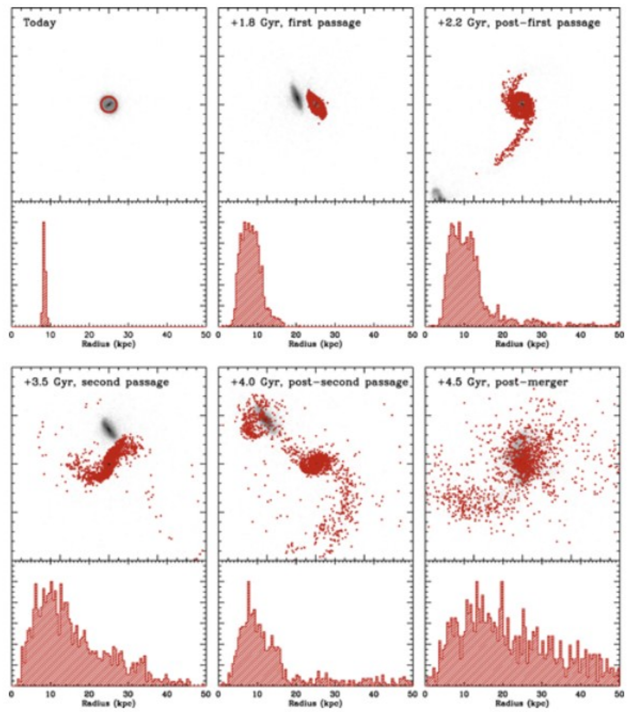


Figure 2. The given figure, from Cox & Loeb (2008), displays the potential position of the Sun during different phases of the merger between the Milky Way and M31. The top panel shows the future tracks of all stellar particles with a current radius of 8 ± 0.1 kpc, marked with a red cross. The bottom panel is a histogram showing the radial distance of these particles from the center of the Milky Way.

2. PROPOSAL AND QUESTIONS

2.1. *Specific question to address*

To continue my research based on my open ended questions, I will be seeing how I can select particles in M31/M33's disk that are similar to the sun and analyse them.

2.2. *Approach*

After importing the relevant modules, and with our dataset for given galaxies, we create a base by identifying the model to be used for the galaxies.

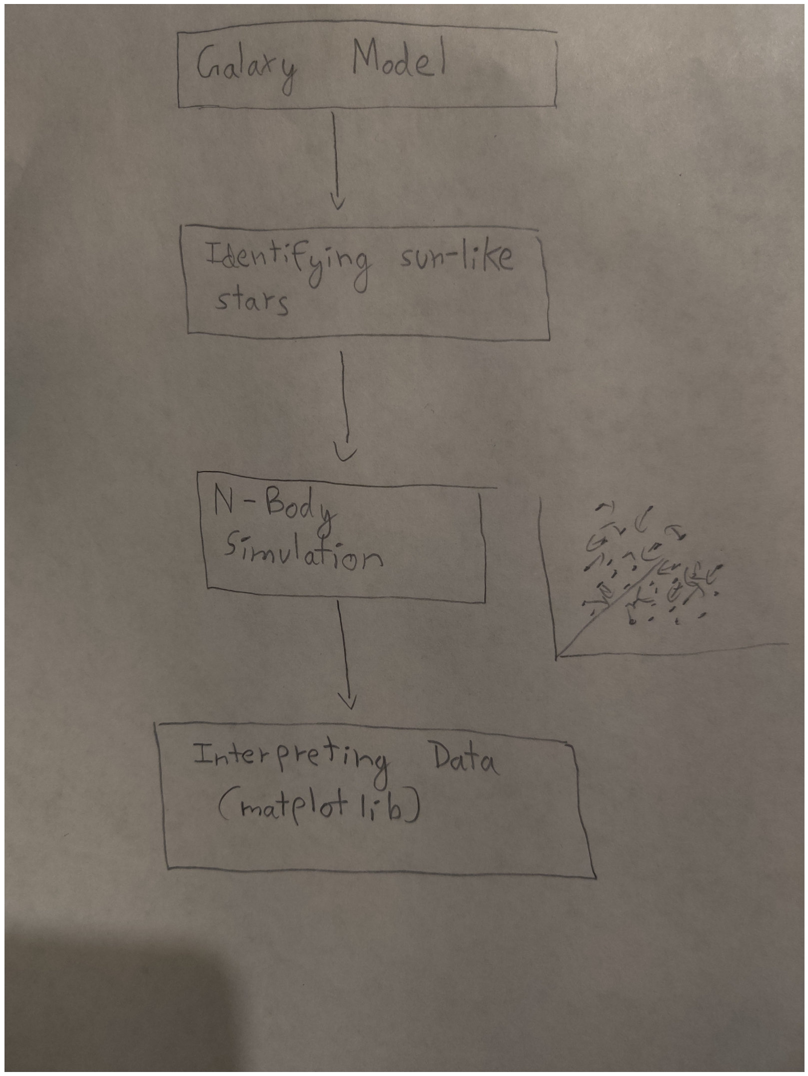
We can narrow down on potential Sun-like star candidates. For a specific time, we filter our data set with properties such as distance from the galactic center in kpc and velocity.

After this process, there is a chance to have complete utilization of the matplotlib library , as it will be an effective way to illustrate candidate suns and differentiate them from the rest of the stars, assuming we have a relatively low number of sun candidates, but if we have a high number of sun candidates, then it would be necessary to save this step for later.

Since we have to do this for a large number of stars, it would not be advisable to carry an iterative loop. Instead we have to perform an N-Body simulation instead. This will require a significant amount of computational resources and time, depending on the complexity of the simulation and the resolution of the data.

Finally, we will interpret this data using sources like matplotlib, in a similar way as compared to the second figure attached.

2.3. *Illustration*



2.4. *Hypothesis and reason for it*

I expect there to be between 100 and 10000 such sun-like particles, because all the papers seem to hint towards this range being an acceptable amount of particles to get practical results. When it comes to the position the sun is mostly likely to be in, that has been discussed more than adequately in the given papers and I hope to get my results to be close to that of the two papers related to the Sun that have been discussed.

REFERENCES

Cox, T. J., & Loeb, A. 2008, Monthly Notices of the Royal Astronomical Society, 386, 461, doi: 10.1111/j.1365-2966.2008.13048.x

Schiavi, R., Capuzzo-Dolcetta, R., Arca-Sedda, M., & Spera, M. 2020, Astronomy &amp Astrophysics, 642, A30, doi: 10.1051/0004-6361/202038674

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