Close Encounters of Stars in the Solar Neighborhood

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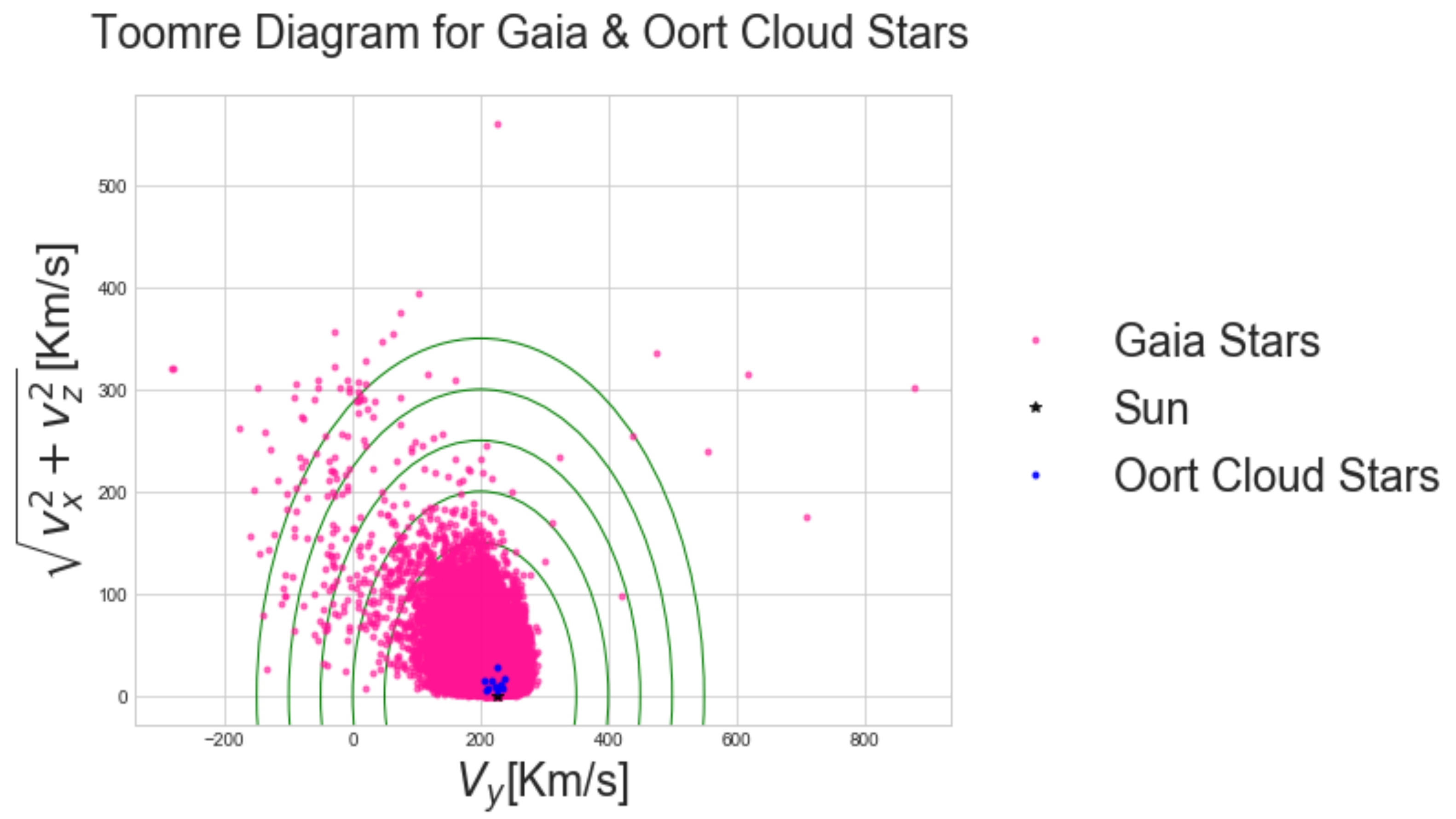
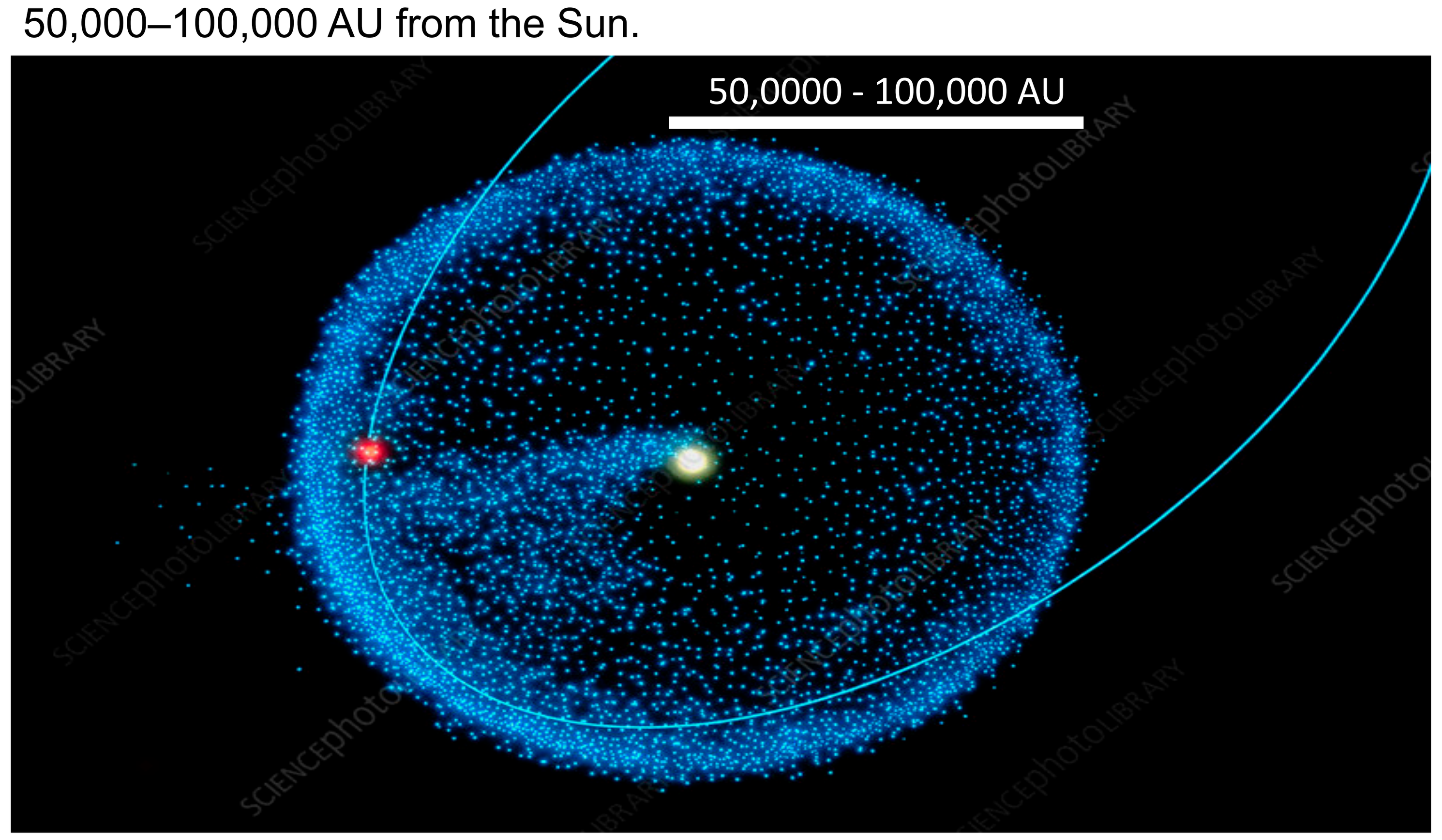
Introduction

Rogue stellar pertubers have been cited as an explanation for the sphericalization and disruption of our Solar Systems' Oort Cloud (*Oort 1950*). In order to understand more about the dynamics of our own Solar Systems' past and future, we search for close encounters between stars similar to our Sun.

We present results from our search for stellar encounters of stars with possible Oort Clouds that may have debris disks. We used two sets of stars: a group of 10 stars with evidence of Oort clouds from, *Baxter et al. 2018* and the 74,066 stars with complete positions and velocities in Gaia DR2 (*Gaia Collaboration et al. 2018*) within 100 parsecs of the sun.



Figures 2 & 3. Figure 2 (above) represents the velocities of all the stars in each set and their kinematical features. Figure 3 (below) is a representation of our solar system and what an Oort Cloud looks like when being perturbed by a star. The Oort Cloud may extend to 50,000–100,000 AU from the Sun.



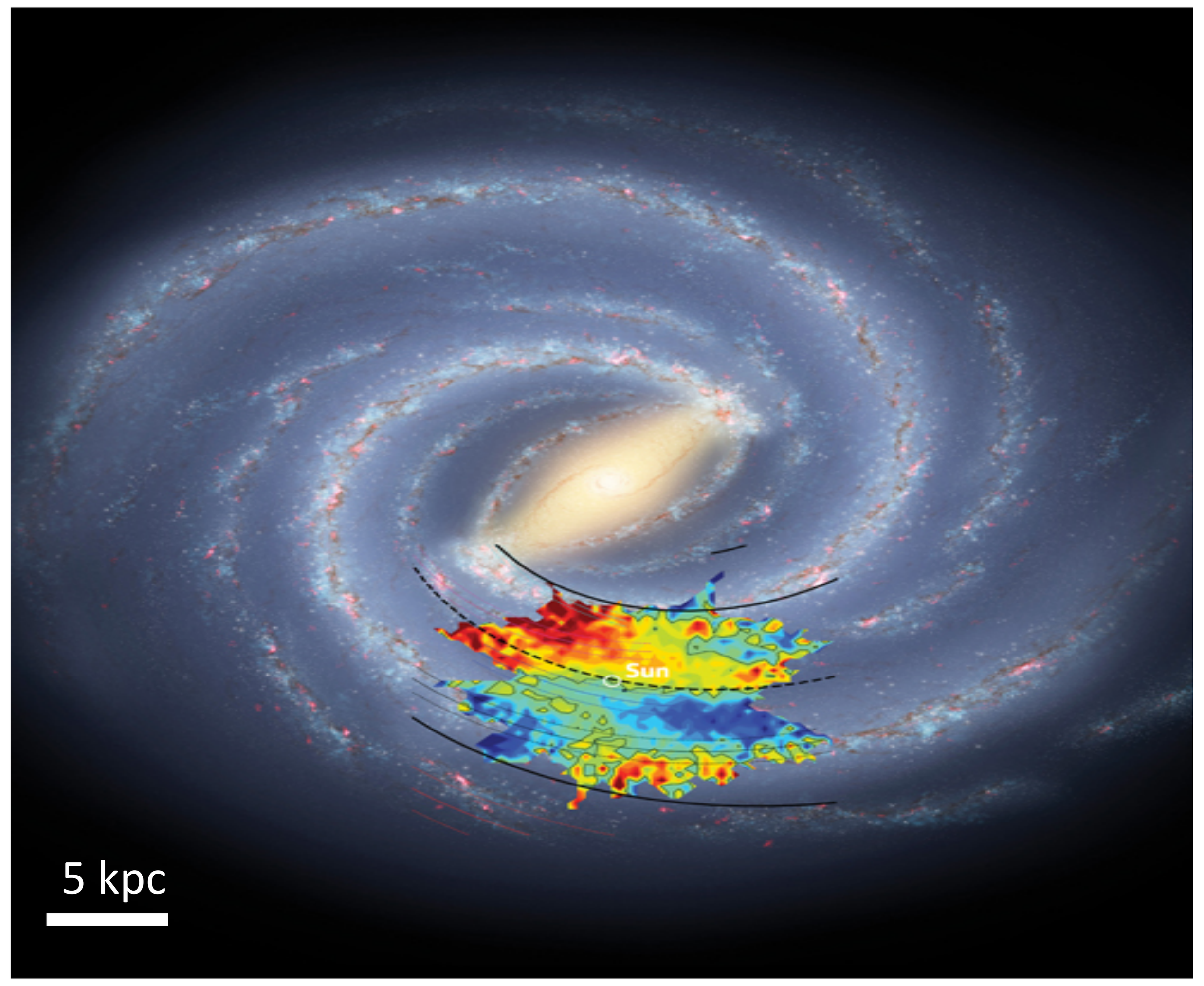


Figure 1. This is a visual representation of the area in the Milky Way that Gaia covers. This area contains the positions and velocities of roughly 1.7 billion Milky Way stars. We employ a search for stars close to our sun (labeled in the center of the coloring).

Orbit Classifications

We integrated each star's orbit in a model of the Galactic potential 15 million years into the past and future and searched for stars in the Gaia DR2 subsample that will pass within 1.5 parsecs of any of the target stars with possible Oort Clouds.

We then use Monte Carlo sampling to compute 95 percent confidence intervals for the perihelion distance of each encounter, the time at which it occurred, and the relative velocity at the time of closest approach.

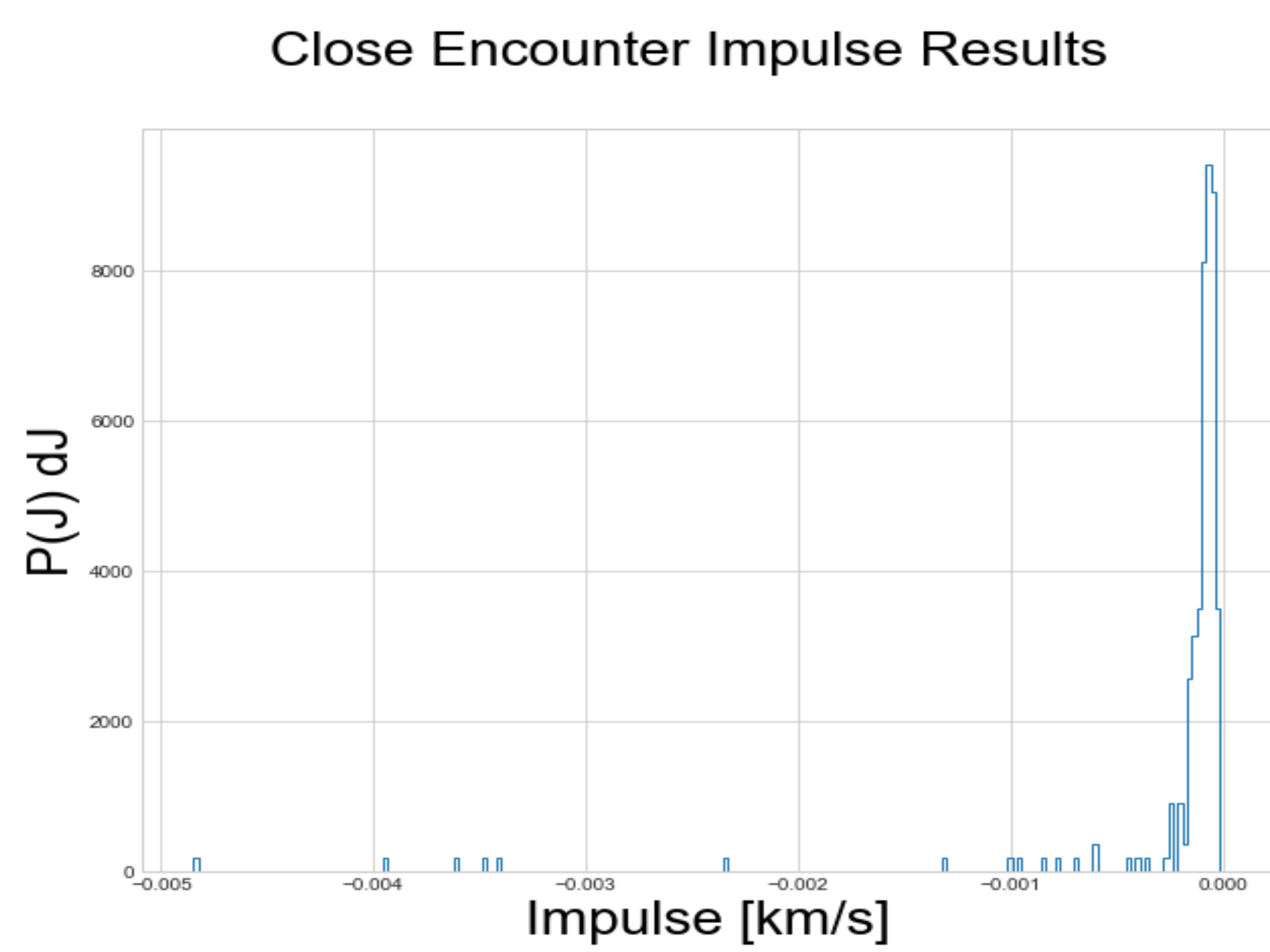


Figure 5. The plot to the left shows the distribution of impulse values assuming that every star in our encounter list is 1 Solar Mass.

Results

Figure 4 shows the perihelion distance and perihelion time for all encounters with the 10 Oort Cloud stars. We find that a typical star in our target sample experiences between 16 and 34 close encounters over the 30 Myr window, of which 87% come within 10^5 AU. Of all the encounters in our results, 12% are within 3^5 AU.

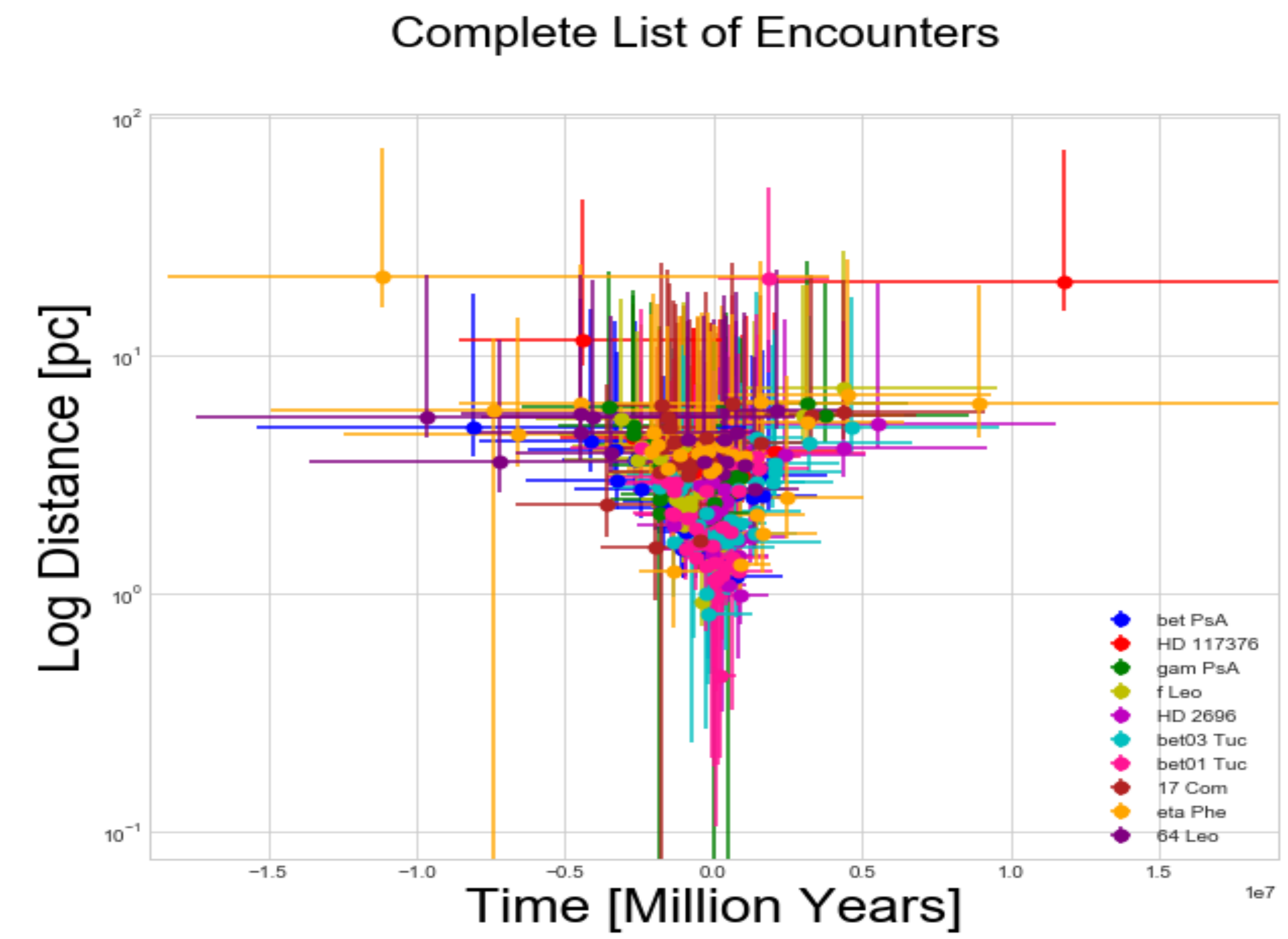


Figure 4. This is a graph of all the close encounters between our target and perturber stars. Each star is identified by its name in SIMBAD.

Impulse Calculations

To conclude our search we computed the impulse calculations for the debris disks surrounding each system. (seen in figure 5 to the left)

When computing the impulse values for each encounter we found that our results were consistent with predictions from the theory stating that the interactions we studied will gradually symmetrize the orbits of the comets in the cloud (*Bailer-Jones et al. 2018*). We find that most perturber stars have the ability to alter a comets orbital inclination and perihelion distance to its host star.

Summary

Using these two sample data sets, we explored close encounters of stars with possible Oort Clouds with nearby stars in the solar neighborhood.

We found that every star in our target sample will have several encounters over a 30 million year window. This is significant because if our target stars have Oort Cloud like debris disks, the gravitational presence from another star can cause disturbances in that stellar system.

Acknowledgements

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References

Bailer-Jones et al. 2018, Baxter, E; C. Blake; and B. Jain, 2018., Oort 1950

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