Using the Gaia Space Telescope Data to Calculate Mass and Tidal Disruption in NGC 7099.

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Abstract
Globular clusters play a key role in understanding the stellar evolution and history of the Milky Way galaxy. These dense groups of stars are some of the oldest objects in the universe, and their properties can help constrain the Milky Way’s past interactions. To add to this larger conversation, this project aims to assign membership of stars to the globular clusters NGC 7099 to determine its mass and identify extratidal stars. This is done using the Gaia Space Telescope, operated by the European Space Agency, which provides measurements of the position, parallax, proper motions, and magnitudes for over a billion stars in the Milky Way. This will be used to measure the properties of NGC 7099 and learn more about its past with the galaxy.

Introduction
Globular clusters are a large spherical grouping of stars that can contain well over a million stars and are known to hold key information in the history of the galaxy in which it was formed.

Objectives
The goal of the project is to visually and qualitatively analyze globular cluster NGC7099 using Gaia data to:
1. Determine the mass of globular cluster NGC 7099.
2. Look for and examine the possibility of tidal stars.

Methods
Globular cluster NGC 7099 lays within the Milky Way and is specifically located at Ra: 325,09217 and Dec: -23.17986. These coordinate points allow for the specific data of the cluster to be collected from the Gaia database.

- Data collected by Gaia gives specific measurements of parallax, proper motions, positions, and motions of each star traced within the specific location.
- The raw data provided by the Gaia space telescope is placed into the coding language python, which allows a visual representation of the star cluster throughout the cleaning process.
- From analyzing the stars in the Python, we have been able to get rid of foreground stars and narrow down the data to stars that have a potential membership to the cluster.

Methods continued
- The final cut made in proper motion space used the average and standard deviation of the star’s proper motion. All stars with a proper motion more than 3 standard deviations from the average were removed. The statistics were then recalculated and this process repeated until the number of stars did not change concluding with a final number of 594.
- By dividing tidal radius (0.1209°) by G and multiplying by the velocity² this results in the mass of the cluster which is 6.53x10² solar masses.

Results
- Extra tidal stars were evaluated to be any stars that have a larger radii then the tidal radius of 0.1 mas. After this cut it is observed that globular cluster NGC 7099 has 16 possible extratidal stars.

Conclusions
- We were able to determine the mass of globular cluster NGC7099, but the value received is lower than expected. This could be due to the calculation of the tidal radius and velocity of the stars being underestimated which will lead to the lower mass value.
- However, globular cluster NGC 7099 showed promise in containing 16 possible extratidal stars, but further work is needed to officially confirm their grouping. And, once confirming the presence of extra tidal stars they will be good probes to use for determining the stellar evolution of the Milky Way.

Acknowledgements
I’d like to thank Dr. Nitya Kallivayalil for all of her support this summer and allowing me to come and be apart of her awesome research team. I’d like to thank Paul Zivick for really guiding me through out this project and LANS for giving me the space to share the hard work we have done over the summer.

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Figure 1. M13 – the “Great Globular Cluster” in Hercules

- For a long time astronomy was underdeveloped in techniques which limited research only to observing the night sky.
- However as developments of telescopes and programs such as Gaia and Hubble began to surface, the range in astrometric knowledge expanded.
- Gaia Space Telescope maps out the parallax, proper motions, position, and motion of stars. The advancement of technology used by Gaia allows more in depth analysis of globular clusters, and stars in general, by providing greater accuracy to what is occurring within outer space. Allowing astronomers to make more accurate inferences surrounding galaxies such as the milky way.

Groups of stars above magnitude 18 have to high of a proper motions error and are assumed to be not apart of the cluster.

The next cut was the CMD which is a measure of the stars temperature. This cut, which provided insight into where the stars are located visually, used a Python tool to single out the clusters stars and further assign membership making the final proper motion cuts easier.

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