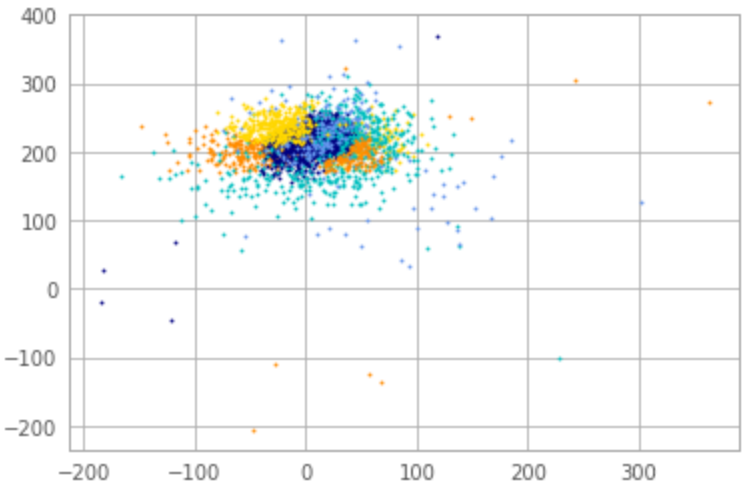
I continued my work from last quarter by switching to data from the Gaia data release 2, refining my query with cuts made by Trick et al. in their 2018 paper, *"The Galactic Disc in Action Space as seen by Gaia DR2."* These cuts from section 2.1 of the paper include a maximum parallax error of 0.05, and a maximum astrometric excess noise of 0.2. The plots in this paper were used as a reference to my own, particularly figures 2 and 4.. I also continued to check my coordinate transformations and was able to successfully implement a transformation into galactocentric coordinates. I researched several methods of doing this, including the Python library "GALPY", which is meant for use with galactic dynamics. I ended up using the coordinates package from Astropy, as it was easier for me to understand and use, rather than attempting to use an entirely new library.

While I was working on figuring out the coordinate transformations, I noticed the query I was using for the Gaia database was "parallax > 300", which meant I was querying for objects beyond 300 pc, instead of within. I fixed this error, which increased the length of the data table I was working with from ~39,000 rows to ~420,000 rows. I proceeded to create plots to visualize the data, including 2D and 3D plots of velocity space, kernel density estimate plots, and k-means.



A plot of a 3000-row random subsample of the data with a Bayesian Gaussian mixture model.

Given that the data table I was now working with was close to half a million rows, I implemented a random subsample of 3000 rows to make computations quicker. I then proceeded to apply Gaussian mixture models to the data, using the Python package Scikit-Learn, specifically the Gaussian mixture model ellipsoid example. Using code from this example required additional packages: intertools and linalg from scipy. I made plots of both the full and random subsample of the data for a Gaussian mixture model, and a Bayesian Gaussian mixture model. These plots reveal some substructure within the data, but not clearly enough to identify particular clusters (as it is in figures 4 and 5 of Trick et al.). Further investigation is required.