The Effects of Binary Stars on Inferred Remnant Populations in Globular Clusters

1 Completed Work

Up to this point, I have completed several components of the project. I've now fully implemented a method that allows me to generate mass functions that include binary stars. In particular, this method allows for arbitrary binary fraction and mass ratio distributions. This means that we can generate mass functions that include realistic binary populations tailored specifically to any cluster of our choosing.

Additionally, I have implemented a method to determine how these binary systems would have been observed in the stellar mass function data that we use. When the stellar mass function data is recorded, the authors assume that all stars are single and assign the system a mass based on its luminosity using an isochrone fit to the cluster. This means that binary systems will be counted as a single system with a mass corresponding to the sum of the luminosities of each component. Using MIST isochrones, I replicate this process for our synthetic binaries, calculating first the individual luminosities of the components and then the observed masses given the sum of the luminosities.

2 Remaining Work

The process of fully adapting the GCFit package to work with our modified models requires a bit more work, in particular using the observed masses of the binary systems to adjust the density profiles in the models. After GCFit is fully working with our models the last remaining thing is to actually use our models and fit them to real clusters. In particular, would be most interesting to compare models with and without binaries to each other when they are both fitted to the same data. 47 Tuc is an ideal candidate for this as we already have all the needed data and the binary population is relatively well constrained. Time permitting, NGC 3201 would be another good candidate as it has been observed for several epochs with the MUSE spectrograph, giving us an estimate of its binary population based on radial velocity measurement. As an additional experiment, fitting some models with the black hole content forced to zero but with a larger binary fraction would enable us to test some claims that the dynamical effects of binaries can mimic those of a small population of black holes.

In addition to the remaining work that needs to be implemented, the Methods, Results and Discussion chapter need to be written. The Methods chapter can be mostly written immediately as most of the methods are fully implemented and working. The Results and Discussion chapters require actual results and thus can probably be only planned out and have introductions written. The writing will happen at the same time as the implementation

as much as possible to avoid having three full chapters left to write after the model fits are completed.

3 Updated Timeline

- Get the realistic binary populations working. ✓
  - Implement equal mass binaries. ✓
  - Implement flat q distribution. ✓
  - Implement arbitrary q distribution. ✓
  - Truncate q distribution according to the smallest possible value of q. ✓
- Project Summary. ✓
- Literature Review. ✓
- Integrate models with binaries with GCFit
  - Re-bin models with binaries to reduce the runtime. ✓
  - Keep track of the overall binary populations within the rebinned models. ✓
  - Use isochrones to get the apparent luminosity of the binary systems. ✓
  - Use the "observed mass" of the binary systems in order to re-scale the number density profiles for mass function likelihoods. (Feb 18th)
  - Update GCFit to support the modified models (Feb 18th)
- Fit models (Feb 25th). We can now fit our models with binaries to observations of real clusters. In particular, re-fitting clusters that we've already analyzed with our new models which incorporate binaries should give us a good idea of the effects that realistic binary populations have on our models.
- Methods Section (Ongoing)
- Results Section (Pending Model Fits)
- Discussion Section (Pending Results)
- Thesis Draft (March 18th)
- End date (April 4th)