The Effects of Binaries on Recovered Remnant Populations

1 Motivation and Rationale

Current, state-of-the-art equilibrium models typically assume that all stars are single and make no effort to include the dynamical effects of binary systems. The highest mass binary systems are of comperable mass to the heaviest white dwarfs and neutron stars and should also mass segregate at a similar rate. Having a large centrally concentrated population of binaries could very well reduce the need for a large central population of heavy remnants. By including the dynamical effects of binaries in our models we hope to recover more accurate remnant populations for present day globular clusters.

Binary populations in globular clusters are, in general, not very well constrained. Even for clusters for which we have large photometric surveys and multi-epoch radial velocity measurements, we are often only able to observe binary systems with high mass ratios. This results in loose constraints on the total binary fraction and weak constraints on the mass ratio distribution above $q = 0.5$, with essentially no constraints on the mass ratio distribution for $q < 0.5$. There are a few options in the literature for likely mass ratio distributions, the one with the most observational motivation being a flat mass ratio distribution where all values of q are equally likely. Other options include random sampling from the IMF or adopting the observed mass fraction distribution from the solar neighbourhood. By adopting a mass ratio prescription and binary fraction we can generate a realistic population of binaries that is likely to mimic those found in present day clusters.

2 Methodology

Because of the high densities and old ages of globular clusters, we can safely assume that all long period, loosely bound binaries have been ionized. This allows us to treat binary star systems as a single system for the purposes of our models, a binary system of two $0.5M_{\odot}$ stars should behave like a single star of $1M_{\odot}$. This means that in order to replicate the effects of binary stars in our models we can simply shift some of the stars in our binned mass function into bins of higher mass according to the chosen binary population.

When we fit these modified models to observations, we need to take special care when comparing to the available stellar mass function data. The method used to collect the mass function data is to assume all observed stars are single stars and to assign each star a mass based on its luminosity. This means that when we compare our models to the data we will

need to convert the dynamical mass of the binaries into an "observed mass" which is related to the total luminosity of the binary system. These binary bins will then contribute to the single star bin which is closest to the "observed mass" of the binary bin for the purposes of computing mass function likelihoods.

3 Timelime

- Get the realistic binary populations working (Nov 12th)
  - Implement equal mass binaries ✓
  - Allow for custom mass ratio distributions
  - Implement random sampling from a Kroupa IMF
  - Implement solar neighbourhood q distribution
- Project Summary (Nov 1st). Ongoing throughout the first term.
- Toy models (Nov 19). We can run a few models with realistic binary populations and compare them to models without binaries. This will let us look at the effects of the binary systems without needing to fit models to real data.
- Use mass-luminosity relations to get the apparent mass of the binary system in order to fit on MF data (Dec 3rd)
- Modify the GCfit code to allow for the mass function to be fit to the observed mass of the binary system (Jan 14th)
- Fit models (Jan 28th). Once we've modified the mass function fitting to work with binaries, we can fit our models with binaries to real observations of clusters and see how the model parameters and remant populations change with the inclusion of binaries.
- Literature Review (Jan 31st) This should be done in parallel with the above.
- Progress Report (Feb 7th)
- Thesis Draft (March 18th) This should pick up where the literature review left off.
- End date (April 4th)