On the Mass-to-Light Ratios of Galactic Globular Clusters

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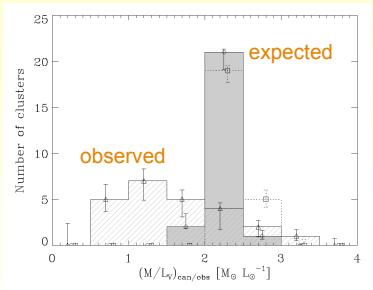
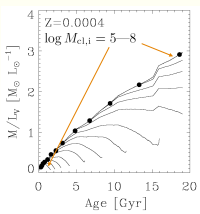
Problem

Problem: observations of the Galactic globular cluster (GC) system reveal **reduced mass-to-light ratios** (M/Ls) for their respective metallicities [4,5,8]. On average, the drop is **25±6%.**This has been argued to arise from dynamical cluster dissolution [4,5]. **Can these claims be verified for individual GCs?**



(All figures are taken from Kruijssen & Mieske 2009)

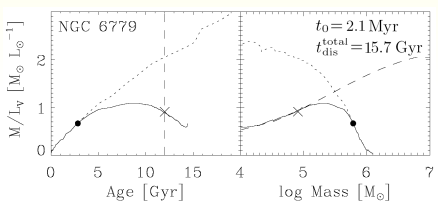


Background: ***N*-body simulations** of dissolving clusters and theoretical analyses of two-body relaxation suggest that **low-mass stars are preferentially ejected** from clusters [1]. Due to the high M/L of these stars compared to more massive ones, **this reduces the mass-to-light ratios** of clusters that have suffered strong dissolution.

Solution: predict model mass-to-light ratios for GCs of which **orbital parameters** [3] and **dynamical M/L** [8] are known. Do the observed and predicted mass-to-light ratios match?

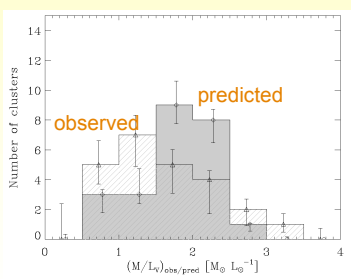
Method

Model ingredients:
- A **cluster evolution model** that includes **(a)** stellar evolution (Padova isochrones [2]), **(b)** dynamical dissolution (see [5,7]) and **(c)** the **preferential loss of low-mass stars** (as in [5])
- **Dissolution timescales** due to tidal evaporation and disc and bulge shocks [3,6]
- A Kroupa (2001) stellar initial mass function
- Overlap in samples from [3] and [8] yields **24 GCs** for consideration in our study



Method: for each GC in the sample, derive its dissolution timescale and integrate models for the appropriate metallicities and initial GC mass to obtain the observed present-day mass and mass-to-light ratio.

Results



Results: when accounting for low-mass star depletion, the average predicted mass-to-light ratio drop is **20±2%**, thus in 1σ-accordance with the observations. The average ratio of observed and predicted M/L is 1.02±0.11. Most disagreement arises due to a likely **underestimation of the observed M/L** in [8]: it is derived from *central* velocity dispersions, which can be affected by mass segregation.

Conclusions: The **reduced mass-to-light ratios** of Galactic globular clusters can be explained by **low-mass star depletion** ensuing from cluster dissolution and two-body relaxation. In the paper, we also predict low-mass **mass function slopes** that allow for observational verifications of our predicted mass-to-light ratios [6].

References

References:

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[8] McLaughlin & Van der Marel 2005, ApJS, 161, 304