Mem. S.A.It. Vol. 87, 681

Memorie della

Building blocks of the Milky Way halo

C. Chung, Y.-W. Lee, and M. Pasquato

Department of Astronomy and Center for Galaxy Evolution Research, Yonsei University, Seoul 120-749, Republic of Korea, e-mail: chung@galaxy.yonsei.ac.kr

Abstract. Recently, Deason et al. suggested that the number ratio between blue stragglers (BSs) and blue horizontal branch stars (BHBs) can be used as a population indicator of various stellar systems. Using this number ratio, they suggested that the Milky Way outer halo formed mostly from dwarf spheroidals rather than globular clusters (GCs). However, we demonstrate that this result is biased because they neglect the effect of BHB stars from helium-enhanced second-generation population on the number ratio. We also perform dynamical evolution models and found that the high BS-to-BHB ratio observed in the outer halo fields is most likely due to the preferential removal of the first-generation stars in GCs. Therefore, the BS-to-BHB number ratio is not a good population indicator for claiming that more massive dwarf galaxies are the main building blocks of the Milky Way outer halo.

Key words. stars: abundances – stars: evolution – stars: horizontal branch – globular clusters: general – Galaxy: halo

1. Introduction

Figure 1 shows how the number of BHB stars changes with the presence of helium enhanced second generation (SG) stars. Out of 200 model HB stars in each color magnitude diagram (CMD), 41 and 4 stars are placed inside the BHB selection box in the models with and without SG stars, respectively. If we adopt the typical number ratio between BS and HB stars to be $N_{BS}/N_{HB} \sim 0.3$ (Momany et al. 2007), the N_{BS}/N_{BHB} ratio in our models ranges from 1.46 to 15.00 depending on the SG stars. The high N_{BS}/N_{BHB} ratio (from 4.9 to 6.4) observed in the outer halo field (Deason et al. 2015) is equally well reproduced by a small number of BHB stars in our model. This means that the presence of the helium enhanced SG stars also controls the N_{BS}/N_{BHB} ratio in the mean metallicity of outer halo fields $\langle[\mathrm{Fe/H}]\rangle = -1.5$.

2. Preferential removal of the first generation stars in GCs

Figure 2 shows our dynamical evolution model based on NBODY6 (Aarseth 2003) for GCs and the simulated GC loses preferentially more FG stars than SG stars. Due to the unvirialized initial conditions, the immediate expulsion of stars takes place within few crossing times, but these are for both FG and SG stars. After the initial loss of stars, since the GC expands outside of Roche lobe, the slower mass-loss is instead affecting FG stars preferentially.

We run as a check for the case of isolated simulations but the isolated simulations show that FG and SG stars are removed equally. The reason for this is that FG stars are generally located in the external regions of the cluster where they are more easily stripped away.

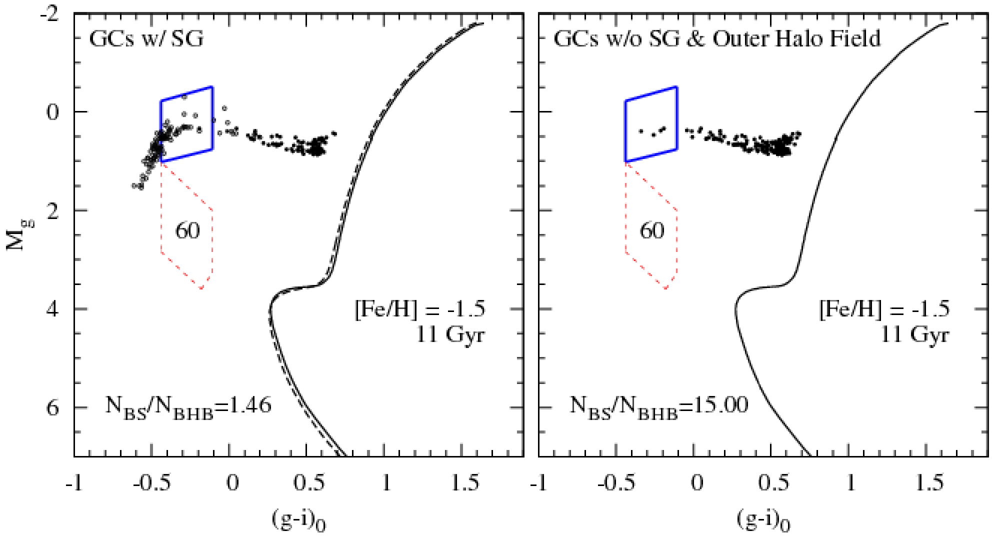

Fig. 1. Synthetic CMD models and their N_{BS}/N_{BHB} ratios for stellar systems with and without helium enhanced SG stars. Solid and dashed lines are model isochrones for the FG (Y = 0.23) and SG populations (Y = 0.28), respectively. The filled and open circles are for FG and SG HB stars, respectively. We follow the selection boxes of Deason et al. (2015) for BHB (blue box) and BS stars (red dashed box). In our model, the field stars in the outer halo are similar to the GCs without SG stars.

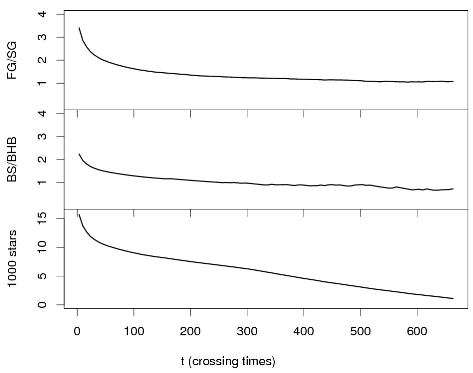

Fig. 2. Dynamical evolution of a simulated GC. The top panel shows the evolution of FG/SG over time, and the middle panel shows the resulting N_{BS}/N_{BHB} ratio of the GC. The bottom panel shows the total number of stars (FG + SG) in the simulation as a function of the crossing time. The time is measured in units of the initial crossing time. A monotonically decreasing behavior is observed, with FG/SG nearing 1 at the end of the simulation, and this illustrates a preferential removal of FG stars.

Readers are referred to Chung et al. (2016) for all details of models described in this paper.

Acknowledgements. Y.W.L. acknowledges support from the National Research Foundation of Korea to the Center for Galaxy Evolution Research. M.P. acknowledges support from Mid-career Researcher Program (No.2015-008049) through the National Research Foundation (NRF) of Korea.

References

Aarseth, S. J. 2003, Gravitational N-Body Simulations, (Cambridge Univ. Press, Cambridge, UK)

Chung, C., Lee, Y.-W., & Pasquato, M. 2016, MNRAS, 456, L1

Deason, A. J., Belokurov, V., & Weisz, D. R. 2015, MNRAS, 448, L77

Momany, Y., Held, E. V., Saviane, I., et al. 2007, A&A, 468, 973