Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
Proceedings IAU Symposium No. 343, 2019
F. Kerschbaum, M. Groenewegen & H. Olofsson, eds.

doi:10.1017/S1743921318006348

To Be or Not to Be: EHB Stars and AGB Stars

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Abstract. The formation of EHB stars is linked to the lives of AGB stars by indications that such EHB/sdB stars might form in globular clusters with multiple populations linked to AGB evolution. Observations of massive globular clusters, such as ω-Centauri (Bedin *et al.* 2004, Piotto *et al.* 2005) suggest that single EHB stars might form from He-enhanced progenitors (D'Antona *et al.* 2005, D'Antona & Caloi 2008, Lee *et al.* 2005) in environments enriched by AGB ejecta. The studies conducted by Han *et al.* (2002), Han *et al.* (2003), and Han *et al.* (2007) have been able to provide a strong case for the binary formation of EHB/sdB stars in the Galactic field, though binary formation channels in globular clusters is uncertain. Simulations presented here are an extension of the simulations of Han *et al.* (2002) and Han *et al.* (2003), for low metallicities to examine the binary EHB population in globular clusters.

Keywords. EHB, AGB, helium-enrichment, star

1. Overview, Calculations, Results, and Conclusions

Various scenarios have been proposed by which EHBs may form. One compelling single star formation mechanism in globular clusters (GCs) for EHB (sdB) stars suggests that they are formed as the result of helium-enhanced ($Y > 0.25$, $(\Delta Y/\Delta Z) \sim 100$) progenitor stars (D'Antona *et al.* 2005, D'Antona & Caloi 2008), the result of earlier epochs of star formation in the cluster from gas enriched by the AGB ejecta, thought to be the case from observing multiple populations of stars in GCs such as ω-Centauri and NGC 2808 (Piotto *et al.* 2005), many displaying a Na-O anti-correlation (Carretta *et al.* 2006). Other single star formation scenarios invoke either high stellar winds during the RGB phase of evolution (D'Cruz *et al.* 1996) before the He-flash, or a delayed He-flash after rapid mass loss (Sweigart 1997). Then again, mass-loss scenarios because of binary interactions (Mengel, Morris & Gross 1976) could account for some EHBs through either common envelope (CE) ejection, or stable RLOF, or through the merger of two He WD stars in binaries as seen in studies done by Han *et al.* (2002) and Han *et al.* (2003). Here, detailed binary population synthesis calculations have been conducted by Brown following the methodology of Han *et al.* (2002) and Han *et al.* (2003) to examine EHB/sdB formation from binaries in GCs with multiple populations. A simple model GC is constructed with two populations having the same helium abundance but different metallicities $Z = 0.0001$ at 13 Gyr and $Z = 0.001$ for 1 and for 6 Gyr. In Fig. 2, the binary model produces EHB stars in the proper region of the CMD, but the fraction of binary EHBs is too high at $f \gtrsim 0.50$, even considering EHBs from the merger channel. This highlights the disparity in EHB/sdB binary fraction between the Galactic field ($f \sim 2/3$; Maxted *et al.* 2001) and in globular clusters ($f \lesssim 0.04 - 0.14$; Moni Bidin *et al.* 2011). In comparison, single EHBs produced via He-enrichment, seen in the model of Lee *et al.* (2005) (see Fig. 1),

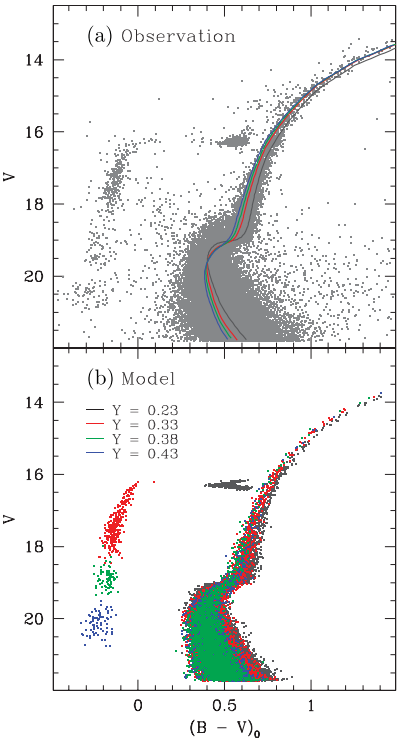

Figure 1. EHB model of Lee *et al.* (2005).

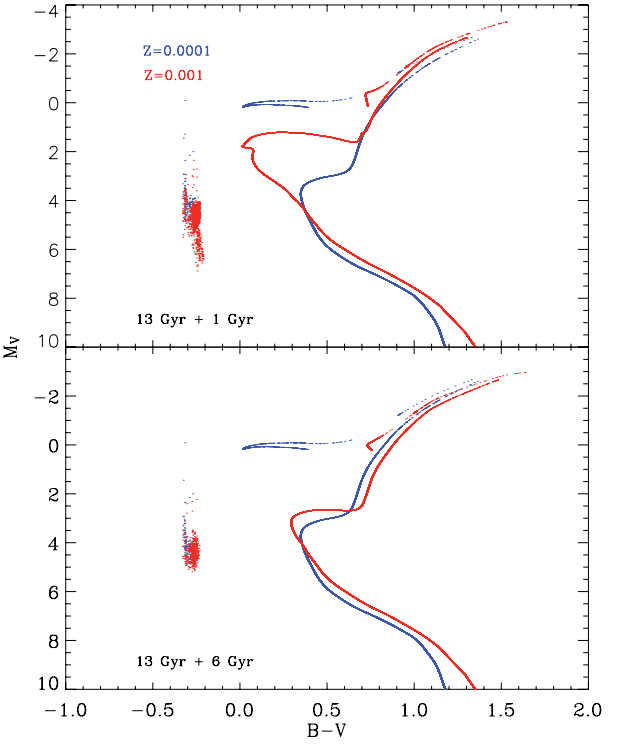

Figure 2. Binary EHB model.

https://doi.org/10.1017/S1743921318006348 Published online by Cambridge University Press

make this a compelling scenario. It may be the case that diverse formation mechanisms for EHBs may indeed be operative in GCs.

References

Bedin, L.R., Piotto, G., Anderson, J., Cassisi, S., King, I.R., Momany, Y., & Carraro, G. 2004, *ApJ* (Letters), 605, L125

Carretta, E., Bragaglia, A., Gratton, R.G., Leone, F., Recio-Blanco, A., & Lucatello, S. 2006, *A& A*, 450, 523

D'Antona, F., Bellazzini, M., Caloi, V., Pecci, F.F., Galleti, S., & Rood, R.T. 2005, *ApJ*, 631, 868

D'Antona, F., & Caloi, V. 2008, *MNRAS*, 390, 693

D'Cruz N., Dorman B., Rood R., & OConnell, R. 1996, *ApJ*, 466, 359

Han, Z., Podsiadlowski, P., Maxted, P.F.L., Marsh, T.R., & Ivanova, N. 2002, *MNRAS*, 336, 449

Han, Z., Podsiadlowski, P., Maxted, P.F.L., & Marsh, T.R. 2003, *MNRAS*, 341, 669

Han, Z., Podsiadlowski, P., & Lynas-Gray, A.E. 2007, *MNRAS*, 380, 1098

Lee, Y.W., Joo, S.J., Han, S.I., Chung, C., Ree, C.H., Sohn, Y.J., Kim, Y.C., Yoon, S.J., Yi, S.K., & Demarque, P. 2005, *ApJ* (Letters), 621, L57

Maxted, P.F.L., Heber, U., Marsh, T.R., & North, R.C. 2001, *MNRAS*, 326, 1391

Mengel, J., Norris, J., & Gross, P. 1976, *ApJ*, 204, 488

Moni Bidin, C., Villanova, S., Piotto, G., & Momany, Y. 2011, *A&A*, 528, A127

Piotto G., Villanova S., Bedin L.R., Gratton R., Cassisi, S., Momany, Y., Recio-Blanco, A., Lucatello, S., Anderson, J., King, I.R., Pietrinferni, A., & Carraro, G. 2005, *ApJ*, 621, 777

Sweigart, A.V. 1997, *ApJS* 474, L23

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