Some clues on the tilt of the Horizontal Branches in metal-rich clusters

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Abstract. We discuss some clues on the large tilt observed in the Horizontal Branch of the metal-rich galactic globular clusters NGC 6388 and NGC 6441. This not yet understood feature is investigated from theoretical and observational sides.

1. Introduction

Recently Brocato et al. (1999) discussed the presence of a tilt of the order of $\Delta V \simeq 0.1 \, mag$ in the HB morphology of the intermediate metallicity globular cluster NGC 6362 [ΔV is the magnitude difference between the top of the blue HB and the fainter magnitude reached by the red HB (RHB)]. On the other hand, much larger tilts ($\Delta V \simeq 0.5 \, mag$) are observed in the metal rich clusters NGC 6388 and NGC 6441 of the inner Milky Way (Rich et al. 1997; Sweigart and Catelan 1998).

In the present work we investigate evolutionary predictions concerning the Color-Magnitude Diagram (CMD) of metal rich HB stars and arguments that can constraint possible explanations of this not yet understood feature.

2. The theoretical side

We computed Zero-Age Horizontal Branch (ZAHB) by adopting Z = 0.002and Z = 0.006 as representative of "metal rich" clusters like 47 Tuc, and Z = 0.02 as a safe upper limit for globular cluster metallicities. As expected, the effective temperature of RHB stars depends on the mixing length assumption: at any given temperature, the luminosity of the red-ZAHB increases when the mixing length increases. At higher metallicities the HB locus moves toward lower effective temperatures and RHB stars are increasingly affected by external convection.

Canonical ZAHBs with metallicity larger than [M/H] = -1 should be affected by a tilt, that increases by: 1) increasing the metallicity; and 2) decreasing the mixing length value. The larger reasonable slope is: $dM_V/d(B-V) \simeq 0.2$ for Z_{\odot} and $\alpha = 1.6$, unfortunately not large enough to account for the observed tilt. Un-canonical frameworks do not seem to enlighten the problem (Raimondo et al. 2002).



Figure 1. HBs of six well populated clusters in Piotto et al. (2002) data-base. The solid line is the slope dV/d(B-V) = 1.5 (see text).

3. The observational side

The CMDs of NGC 6441 and NGC 6388 (Fig. 1) show that the lower envelope of the HB is sloped as $dV/d(B-V) \sim 1.5$. We tried to explain this feature as a result of differential reddening or as due to a peculiar metallicity spread. Our attempts were not conclusively successful (Raimondo et al. 2002). Moreover, if one analyzes the CMDs of the metal rich globular clusters in the Padova HST snapshot data-base (Piotto et al. 2002) it can be seen (Fig. 1) that the clusters more metal rich than 47 Tuc show a tilted RHB with a slope $dV/d(B-V) \sim 1.5$.

4. Conclusions

The large tilt of the RHB of NGC 6441 and NGC 6388 seems to be a feature observed in many metal rich clusters. Up to now, a fully satisfactory explanation is not yet found. More precise observations (i.e. FLAMES@VLT) are urgently needed to properly constraint our understanding of metal rich stellar systems.

References

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