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RR Lyrae variables in GGCs: distribution of periods and synthetic models.

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Abstract. We present some applications of our Synthetic Horizontal Branches (SHB) simulations, aimed to reproduce the peculiar period distributions of RR Lyrae belonging to the Galactic Globular Clusters M3 and M5. We show some evidence, supporting the importance of SHBs in obtaining parameters such as the mass distribution inside the instability strip.

Key words. Galaxy: Globular Clusters – Stars: Population II – Stars: RR Lyrae

1. Introduction

Since Oosterhoff (1939), pulsation periods of RR Lyrae variables in Galactic Globular Clusters (GGCs) have been the crossroad of several empirical and theoretical investigations (e.g. Rood 1973; Catelan 2004). Periods are robust observables to constrain evolutionary predictions. We know that the pulsation is governed by the physical properties of stellar structures, thus providing independent access to the evolutionary features of low-mass stars.

On this basis, we attempted a direct connection between pulsation and evolutionary theories, by investigating the behavior of up-to-date low-mass stellar models evolving through the central He burning, Horizontal Branch (HB), evolutionary phase. We accomplished this goal by adopting our synthetic HB (SHB) procedure (see Castellani et al. 2005 and references therein).

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2. Selected clusters: M3 & M5

In order to investigate whether canonical HB models and pulsational predictions (periods and instability boundaries, see Di Criscienzo et al. 2004) do account for the observed peaked distribution of RR Lyrae periods in M3, we performed a detailed set of numerical experiments.

At variance with previous findings, we found that by assuming a suitable bimodal mass distribution, "canonical" models can still provide a plausible explanation of the observed period distribution for the RR Lyrae stars in M3. In particular, our best SHB fit model attain a Kolmogorov-Smirnov (KS) similarity of 99.9%. Such a model relies on a gaussian mass distribution centered on M=0.68 $M_{\odot}$ with a dispersion as narrow as $\sigma \sim 0.005$, plus a flat mass distribution of about 200 stars, distributed over the range of masses 0.65 to 0.61 $M_{\odot}$. This component gives a marginal contribution in terms of variable stars ($\leq$ 10%), but it is re-

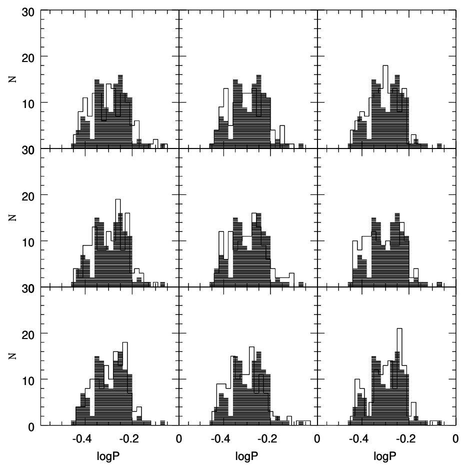

Fig. 2. Same as Fig. 1, but for nine simulations of M5 period distribution.

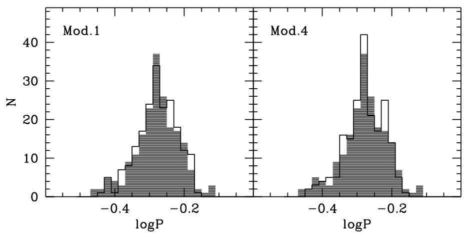

Fig. 1. The comparison between our two best simulations and the observed period distribution (shaded histogram) of M3 variables.

quired to mimic the observed rich population of blue HB stars present in M3.

However, one finds that canonical models outnumber the observed number of red HB stars ($\sim$110, see Catelan 2004) by roughly a factor of two. On the other hand, the predicted ratio between the number of RR Lyrae stars and red HB stars depends on several astrophysical parameters, such as the shape of the mass distribution and/or the temperature range covered by evolutionary tracks. In particular, by adopting a truncated gaussian (i.e., by neglecting all HB masses larger than the mean mass) we obtain a number of red stars similar to the observed ones, while keeping a KS similarity of 82% .

Interestingly, it appears that different mass distributions are needed to mimic the period distributions of variables in different clusters. Preliminary numerical experiments support the evidence that a good fit of the period distribution in M5 might be obtained with a flat mass distribution on the HB, and stellar masses ranging from 0.61 to 0.70 $M_{\odot}$ (see Fig. 2).

3. Conclusions

SHB appears to be a very powerful approach to compare predicted and empirical period-distribution of cluster RR Lyrae stars. Morover, and even more importantly, this approach provides the unique opportunity to constrain the mass distribution inside the instability strip. Current simulations support the evidence that a gaussian mass distribution provides a plausible explanation for the period distribution in several GGCs. However, preliminary results indicate that the period distribution of M5 RR Lyrae stars might be explained by adopting a flat mass distribution.

We also plan to apply the same approach to stellar systems which host a sizable sample of RR Lyrae stars and present either a complex star formation history such as the dwarf spheroidal galaxies in the Local Group, or a well-defined spread in chemical composition such as Omega Cen.

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