The Impact of Large-Scale Surveys on Pulsating Star Research
ASP Conference Series, Vol. 203, 2000
L. Szabados & D. W. Kurtz, eds.

The RR Lyrae Period–Amplitude Relation

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Abstract. A study of the period–amplitude relation for RR Lyrae variables in the globular clusters 47 Tucanae, NGC 6441 and M55 confirms a recent finding that the period–amplitude relation for RRab stars with 'normal' light curves is not a function of metal abundance. Evolutionary effects are more important.

1. Introduction

It is generally assumed that the period–amplitude relation for RR Lyrae variables is a function of metal abundance in the sense that for a given amplitude, stars with lower metal abundance have longer periods. However, in a recent investigation of the RRab period–amplitude relation, Clement & Shelton (1999, hereafter CS99) found that the V amplitude for a given period is a function of Oosterhoff type, not metal abundance. Their study was based on CCD observations of RRab stars with 'normal' light curves in the globular clusters M3, M4, M5, M9, M68, M92, and M107. To determine whether a light curve was 'normal' or 'peculiar', they used the compatibility condition of Jurcsik & Kovács (1996) with the updated equations of Kovács & Kanbur (1998). They derived their $P-A$ relation for Oosterhoff type I (OoI) clusters from the principal sequence of RRab stars in M3 and their relation for Oosterhoff type I (OoII) clusters from the RRab stars in M9.

M3 is often considered the prototype for OoI clusters, but CS99 found that it has three bright stars whose positions in the $P-A$ diagram are closer to the OoII relation. They assumed that these three bright stars must be more evolved than the other M3 stars, which are probably ZAHB stars, and therefore concluded that the $P-A$ relation for RRab stars is a function of evolutionary state.

2. New Results

The $P-A$ relation that CS99 derived for OoII clusters was based on their M9 data which included only 6 RRab stars. However, ω Centauri, once considered the prototype for OoII clusters, has many more. Clement & Rowe (1999) have derived an OoII $P-A$ relation based on the 'normal' RRab stars in ω Cen with V brighter than 14.65, stars they assumed to be in a more advanced evolutionary state. (The fainter stars lie closer to the OoI relation.) In Fig. 1, the $P-A$ relations for OoI and OoII stars, based on the M3 and ω Cen data are both

https://doi.org/10.1017/S0252921100057808 Published online by Cambridge University Press

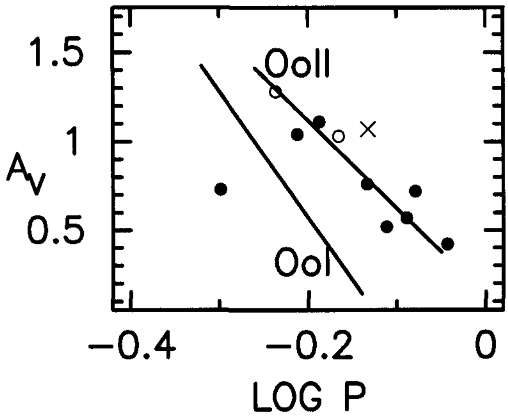

Figure 1. Period–V amplitude relation for OoI and OoII clusters (the solid lines). The plotted points represent the RRab stars in NGC 6441 (solid circles), V9, the only RRab star in 47 Tuc (cross) and V1 and V7, the two RRab stars in M55 that satisfy the Jurcsik & Kovács compatibility condition (open circles).

plotted. Also plotted are data for RRab stars in the clusters 47 Tucanae (Carney, Storm, & Williams 1993), NGC 6441 (Layden et al. 1999) and M55 (Olech et al. 1999). According to Zinn (1985), these three clusters have [Fe/H] values of −0.71, −0.53 and −1.82 respectively. In general, OoII clusters are more metal poor than OoI clusters. However, there are exceptions to this rule, and this is substantiated by the present results. NGC 6441 and 47 Tuc are among the most metal rich clusters, yet all but one of their RRab stars lie close to the OoII relation. In their investigation of 47 Tuc, Carney et al. (1993) concluded that V9 is in an advanced evolutionary state. Most of the RRab stars in NGC 6441 have similar properties. They seem to be post-ZAHB stars. This confirms the CS99 conclusion that evolutionary effects are more important than metal abundance for determining the RRab $P-A$ relation.

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