Relations of the Light-Curve Parameters of RRab Stars in Globular Clusters

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The widely used photometric metallicity formula presupposes that a unique combination of the light-curve parameters exists that gives a constant, cluster-by-cluster different value for globular clusters. In order to check the validity and the accuracy of any such formula, a database of the V-band light-curve parameters of regular RRab stars in Galactic globular clusters is collected and analysed. Preliminary results and conclusions are presented.

1 Introduction

The $(P, \varphi_{31}) \rightarrow$ [Fe/H] relation, deduced for fundamental mode RRL stars in Jurcsik & Kovács (1996), provided a very effective tool to estimate metallicity content of the stars from photometric information alone. Although, the formula was originally based on using V-band light curves (LC) of Galactic field RRab stars, it was successfully applied to get approximate [Fe/H] values of RRL stars in globular clusters (GC), the Galactic bulge, and other galaxies. Further works extended the method to other photometric bands broadening its applicability. Summaries of the published photometric metallicity formulae are given by Ngeow et al. (2016) and by Skowron (2018). The aim of our study is to examine the validity and accuracy of any metallicity formula applied in an indirect method, i.e., by checking the existence and the limits of any homogeneity value of globular clusters deduced from the light-curve information of RRab stars.

2 The 'Homogeneity Parameter' of Globular Clusters

Globular clusters are considered to be relatively homogeneous in some of their parameters (e.g., [Fe/H], age, Y, etc.). Without specifying actually which property (or combination of properties) this is, we suppose that a *homogeneity parameter*, C_i, characterizes each cluster, and this parameter is encoded in the LCs of RRab stars.

Data: LCs of RRab stars in 35 Galactic GCs (without ω Cen) are compiled; the database comprises of V-band Fourier parameters of ~ 600 variables. Blazhko stars are omitted but the data sets are too short to detect modulation in several cases.

Method: Using the period and the Fourier parameters of the LCs, a formula is searched that gives C_i values, on average, for each GC with the smallest scatter.

3 Results

In the first approximation, the derived C_i-s correlate with the *metallicities* of the clusters taken from Carretta et al. (2009) and the 2010 edition of the Harris (1996)

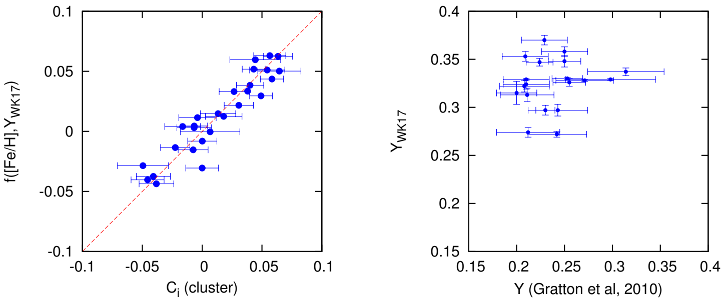

Fig. 1: Correlation of the cluster C_i parameters with a linear function of the [Fe/H] and $Y_{\rm WK17}$ (Wagner-Kaiser et al., 2017) contents of the clusters (left-hand panel). It has to be noted also that the $Y_{\rm WK17}$ values do not correlate with the Y values published by Gratton et al. (2010) (right-hand panel) or with any other values published in the literature.

catalogue. However, the discrepancy between the best-fitting linear formula and the actual regression curve is obvious even excluding the two outlier clusters (NGC 6388, 6441) from the sample. Using [Fe/H] alone, the cluster C_i-s can be reproduced with 0.022 rms scatter.

Browsing through all the available databases of cluster parameters (chemical composition, age, horizontal-branch morphology, etc) as second (or third) parameter candidates, an improvement in the fitting of the C_i-s with cluster parameters can be achieved only if a combination of the [Fe/H] and the Y (He abundance) values given in Wagner-Kaiser et al. (2017) is used (left-hand panel in Fig. 1). The C_i-s of the clusters can be reproduced then with 0.012 rms scatter (NGC 6388 and NGC 6441 are also included in this plot), while the C_i values of the clusters span a range of 0.12. However the adaptability of the $Y_{\rm WK17}$ values might be doubtful, as shown in the right-hand panel of Fig. 1. Further studies are in progress.

References

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