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NGC 6304: a metal rich cluster with RR Lyrae?

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Abstract. We have carried out a new search for variable stars in the metal-rich bulge globular cluster NGC 6304 ([Fe/H] = −0.59) using CCD observations obtained at CTIO. We used two data sets: one was taken on the 0.9m in May and June of 1996, and the second was taken on the 1m Yalo telescope in February and March of 2002. We have identified and obtained BVI light curves for 11 RR Lyrae stars, including 6 RRab and 5 RRc stars within the tidal radius of the cluster, and partial light curves for several long-period variables. Most of the RR Lyrae stars had been previously discovered, although not always recognized to be RR Lyrae type variables. We are able to exclude several RR Lyrae stars as probable field stars. In light of the large number of long-period RRab stars recently discovered within the metal-rich globular clusters NGC 6388 and NGC 6441, it is noteworthy that two of the possible RRab have periods greater than 0.8 days. The nature of these long-period RR Lyrae and the question of their membership will be discussed.

Key words. globular clusters: individual(NGC 6304) – RR Lyrae variable

1. Introduction

RR Lyrae stars (RRL) are a powerful tool for determining not only distances, but also understanding the internal structure of stars, and providing clues to the history of the objects that contain them. Thus, it is necessary to understand the properties of RRL in different settings. In this study, we looked at the metal-rich bulge globular cluster NGC 6304. It is notable because it has a high metallicity, [Fe/H] = −0.59, and previous studies have found RRL near the cluster (Hesser & Hartwick 1976; Hartwick et al. 1981; Valenti et al. 2003). Several theoretical models have been proposed

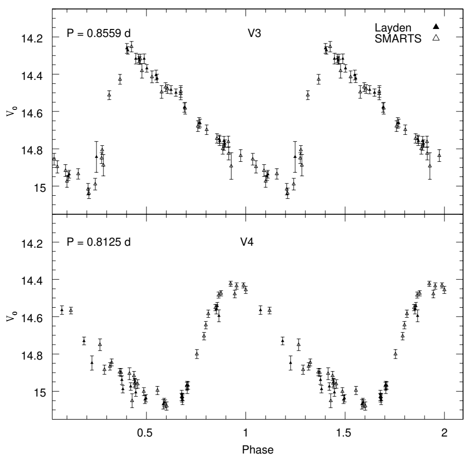

Fig. 1. These are the light curves for the two 0.8 day RR Lyrae near NGC 6304.

Table 1. RR Lyrae near NGC 6304

Star #	Type	Period	Member
V1	RRab	0.4724	Nonmember
V2	RRab	0.3990	Nonmember
V3	RRab	0.8559	Likely
V4	RRab	0.8125	Likely
V7	RRab	0.5758	Nonmember
HH1247	RRc	0.3379	Very likely
HH4209	RRc	0.3938	Likely
HBH67	RRab	0.4667	Nonmember
Va46	RRc	0.2997	Nonmember
NV1	RRc	0.3698	Likely
NV2	RRc	0.3135	Not Likely

to explain how a metal-rich cluster could have RRL; this is one aspect of the 2nd parameter problem. The metal-rich globular clusters NGC 6388 and NGC 6441 have recently been found to contain RRL with unusually long periods (Pritzl et al. 2003 and references within). We will report on a new search for variable stars in NGC 6304.

2. Reduction Methods

We used two methods to analyze these data. The first method was to use the DAOPHOT/ALLFRAME package (Stetson 1994). This method fits point spread functions to each star. The second used the ISIS image subtraction package (Alard 2000). Due to problems with the YALO CCD data, however, we ultimately relied mainly on DAOPHOT.

3. Results and Discussion

Table 1 contains periods for the 11 RRL that were found within the tidal radius of NGC 6304. The question of membership is complicated by the issue of differential reddening. The reddening of the RRab stars can be calculated because they have a constant color at minimum (Guldenschuh et al. 2005). Based on this correction we can eliminate many of the RRab as not being at the horizontal branch level leaving only V4 and V3, the two 0.8 day RRabs, as possible members. We cannot calculate reddening for the RRc in the same way, so determining nonmembers is harder. The light curves for the two 0.8 day stars are shown in Fig 1. One can see that there are shape differences between the two RRL, which may be indicative of V4 being an anomalous Cepheid instead of a RRL. To more precisely determine membership of the RRL, we hope to better understand the differential reddening through dust maps or color-color diagrams. It may take spectroscopy, however, to finally settle the membership question.

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