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The globular cluster NGC 6652*

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Abstract. We have carried out BVRI and Gunn z CCD photometry for the globular cluster NGC6652 which had no previous colour magnitude study. This cluster, which is projected close to the bulge minor axis at $\approx 11°$ from the center, has a CMD morphology suggesting a moderately high metallicity of [Fe/H] ≈ -0.9. The Horizontal Branch is red with the possibility of a few members in the RR Lyrae gap. The cluster appears to have several blue stragglers. We derive a reddening of E(B-V) $= 0.10 \pm 0.02$ and a distance of $d_{\odot} = 9.3$ Kpc. The turnoff is reached and we obtain ΔV(TO-HB) = 3.35±0.16 suggesting that it is slightly younger than the average age of Galactic globular clusters.

Key words: globular clusters: individual: NGC 6652 – Hertzsprung-Russel diagram

1. Introduction

NGC 6652 = GCL-98 = ESO395SC11 has coordinates $\alpha_{1950} = 18^h32^m29^s$, $\delta_{1950} = -33°02.0'$. It is projected not far from the Galactic center at $l = 1.54°$, $b = -11.38°$. Structurally the cluster is very compact with a concentration parameter $c = 1.95$ (Peterson & Cameron Reed 1987). However it does not appear to have a post collapse core (Djorgovski & King 1986).

No colour magnitude diagram (CMD) is available in the literature for NGC 6652. Most information on the cluster properties comes from integrated photometric and spectroscopic studies (Zinn 1980; Bica & Pastoriza 1983; Zinn & West 1984; Bica & Alloin 1986); the cluster seems to be moderately metal-rich, similar to 47 Tuc, with E(B-V) ≈ 0.10. Among the variable stars in the cluster field, none seems to be RR Lyrae associated to NGC 6652 (Hazen 1989).

In the present work we provide Johnson-Cousins BVRI and Gunn z photometry for the cluster and an offset field at 7′ south of the cluster.

In Sect. 2 the observations are presented. In Sect. 3 the cluster and field CMDs are discussed. In Sect. 4 the basic cluster parameters are derived. Concluding remarks are given in Sect. 5.

2. Observations

NGC 6652 was observed in June 1990 with the ESO Danish 1.54m telescope, under photometric conditions. The telescope was equipped with a 512 × 512 pixel thinned RCA CCD, ESO # 5. The pixel size is $30 \times 30\mu$, corresponding to $0.47'' \times 0.47''$ projected on the sky. The total field of view is $2.5' \times 4.0'$. A V image of the cluster is shown in Fig. 1. B, V, R, I filters in the Johnson-Cousins system and Gunn z were used. The log-book of observations is given in Table 1. An offset field located at 7′ south was also observed for the study of field contamination.

The images were reduced at the ESO–Garching computer center, with the Midas package. After bias and flatfield corrections, images taken through the same filter and the same exposure time were re-centered and co-added to increase the dynamical range. The instrumental magnitudes were obtained with Daophot II in Midas environment. These magnitudes were calibrated using Landolt (1983) standard stars, observed during the same night, following the same procedure described in detail in Ortolani et al. (1993).

The B and V colour terms are respectively 0.13 and 0.04, whereas no colour term is present in I. The zero point error of our photometry is largely dominated by the aperture correction because of the lack of bright, well isolated stars in the rather low Galactic field of the cluster. From comparison of aperture corrections in different colours, we estimate a typical error of ±0.04 mag. The relative stellar photometric errors are as well dominated by crowding effects, as discussed in Ortolani et al. (1990, 1992, 1993) by means of artificial star analysis. From frame to frame comparisons we derived ϵ(B-V) ≈ 0.01 to 0.05 for the range $15 < V < 19$ in the field, and ϵ(B-V) ≈ 0.06 to 0.09 for the cluster. The results of the photometry are available by ftp from the CDS: see the Editorial in A&A 266, E1 (1992).

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* Observations collected at the European Southern Observatory, La Silla, Chile

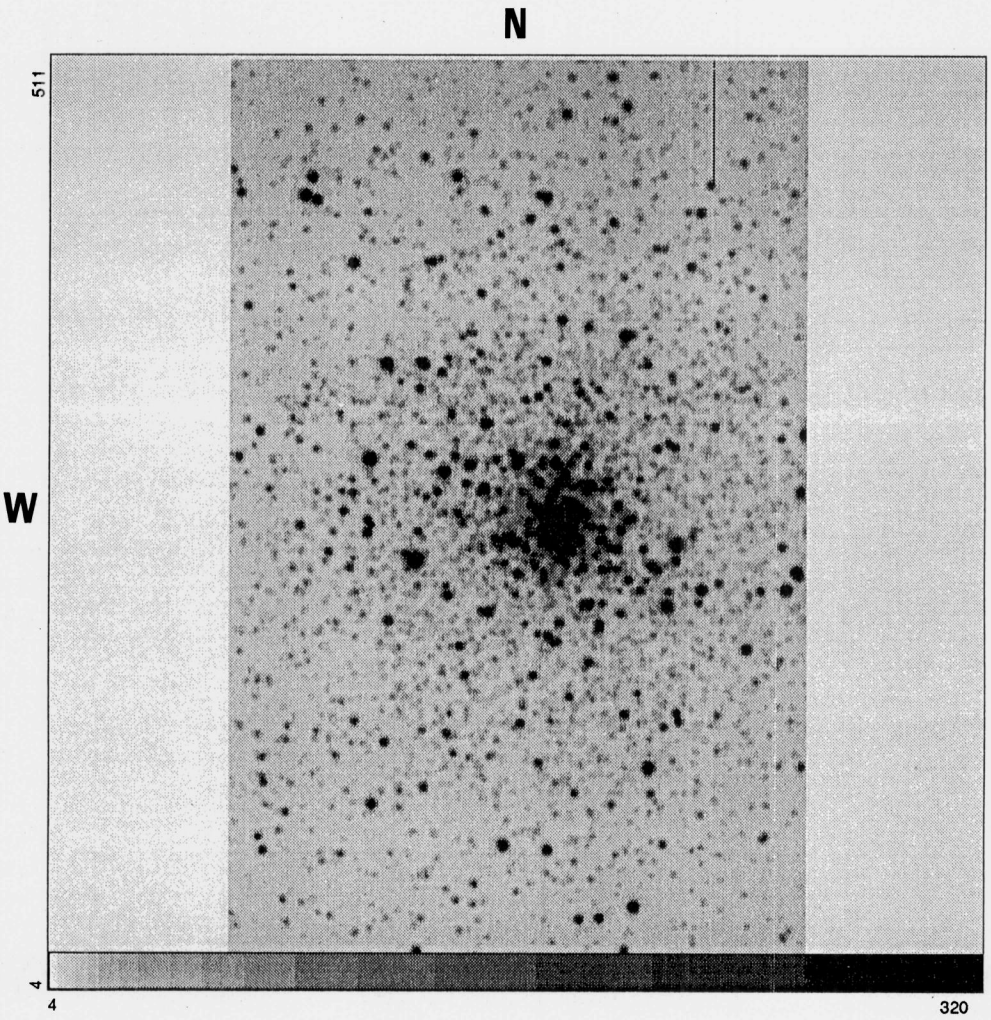

Fig. 1. V frame of NGC 6652 of size $2.5' \times 4.0'$. Axes are in pixels

3. The cluster CMD analysis

In Figure 2 we present a V vs (B-V) CMD for the whole cluster frame. The main cluster features resemble those of 47 Tuc (Hesser et al. 1987; Aurière & Ortolani 1988). The Horizontal Branch (HB) is red and shows a compact appearance. Some stars are present in the gap region. The CMD is deep and the main sequence (MS) and turnoff (TO) are reached. A well defined Blue Stragglers (BS) sequence is also seen just above the turn-off (TO). The same BS, marked with a circle in Fig. 2, are also identified with a circle in Fig. 3, where the X and Y coordinates of all measured stars brighter then $V < 18.5$ are shown. It can be seen that 8 of the 15 BS candidates are concentrated within $25''$ from the cluster center. These 8 stars have a bigger cross in Fig. 2. In Fig. 4 a V vs (B-V) CMD corresponding to a central extraction of radius $r < 14''$ is shown, where BS are still clearly seen.

In Fig. 5 we present the $7'$ south offset field CMD. It is essentially free of disk MS contamination, due to its $\approx -11°$ Galactic latitude. This field represents the bulge population at moderate latitudes. The bulge MS is detected with a depth rather than a differential reddening effect, since the bulk of its population should be slightly foreground to the cluster and reddening is

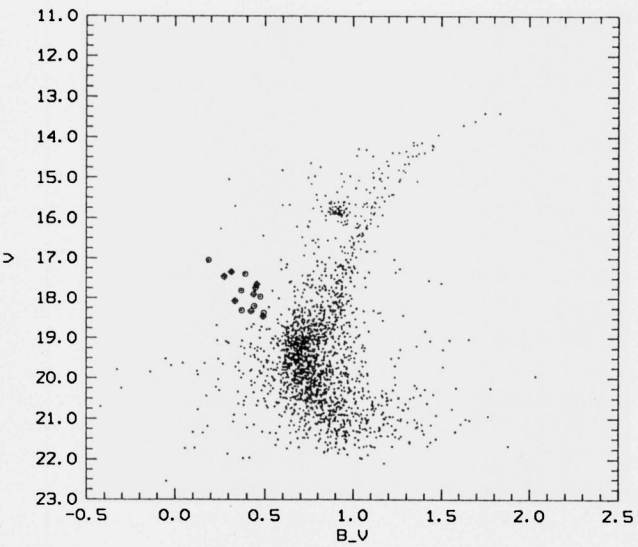

Fig. 2. V vs (B-V) CMD for the cluster whole frame. Circles identify BS candidates while the circled big crosses are blue stragglers located within $25''$ from the cluster center

Table 1. Log-book of the observations

filter	Date	UT	exp. time (s)	seeing
V	19.06.90	8^H22^M	45	1.2″
V	”	8^H25^M	540	1.3″
B	”	8^H36^M	900	1.4″
B	”	8^H54^M	900	1.4″
B	”	9^H12^M	120	1.3″
I	”	9^H16^M	25	1.6″
I	”	9^H19^M	25	1.7″
I	”	7^H55^M	300	1.3″
R	21.06.90	7^H26^M	15	1.5″
R	”	7^H30^M	240	1.2″
I	”	7^H37^M	15	1.1″
I	”	7^H40^M	15	1.1″
I	”	7^H42^M	180	1.1″
I	”	7^H47^M	180	1.1″
z	”	7^H53^M	20	1.1″
z	”	7^H57^M	180	1.1″
Field				
V	20.06.90	7^H25^M	30	1.3″
B	”	7^H32^M	120	1.3″
V	”	7^H38^M	480	1.3″
B	”	7^H49^M	1200	1.6″
R	21.06.90	8^H09^M	30	1.1″
R	”	8^H11^M	300	1.1″
I	”	8^H21^M	30	1.1″
I	”	8^H25^M	30	1.1″
I	”	8^H31^M	180	1.1″
I	”	8^H36^M	180	1.1″
R	”	8^H41^M	30	1.1″

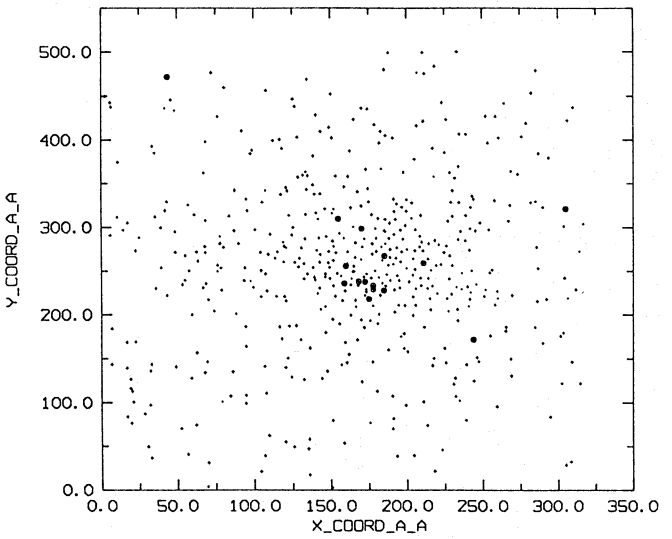

Fig. 3. *X* and *Y* positions of all the measured cluster stars brighter than V = 18.5. Circles are the BS candidates identified in Fig. 2

small (Sect. 4.2). In the offset field, no relevant contamination is present at the disk MS locus. Consequently the stars in the cluster CMD (Fig. 2) at that locus appear to be blue stragglers.

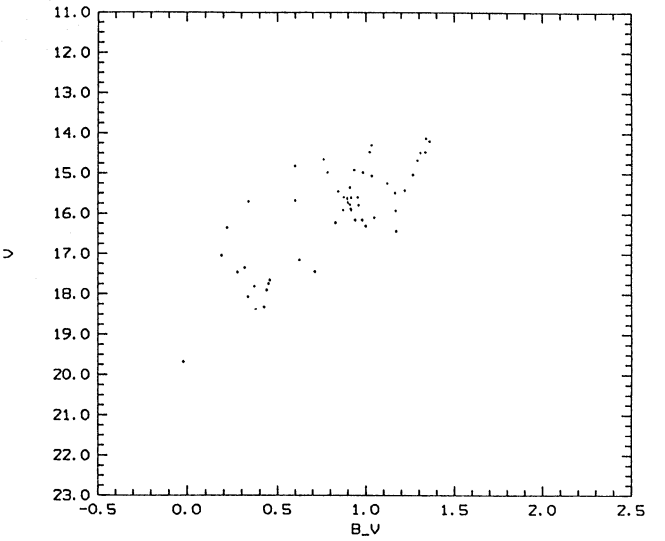

Fig. 4. V vs (B-V) CMD for a $r = 14''$ central extraction

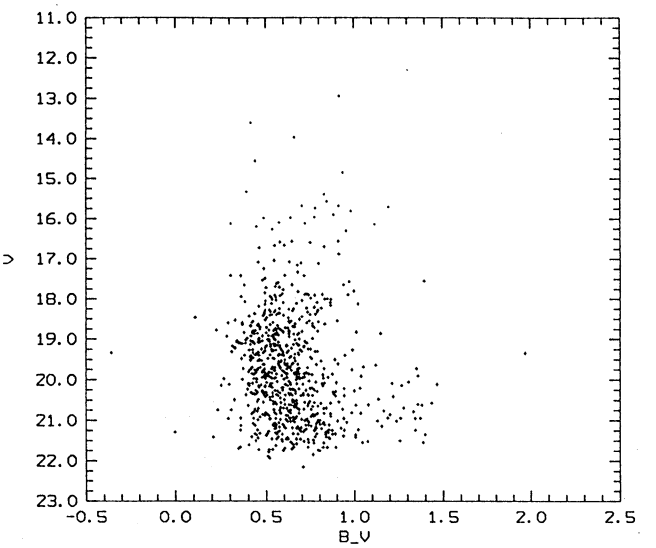

Fig. 5. V vs (B-V) CMD for the offset field at 7′ south

NGC 6652 is a good object for further blue stragglers studies. This effect may be connected to its compactness.

Unfortunately, none of the RR Lyrae stars studied by Hazen (1989) are in our cluster frame. In the CMD are present some stars at the HB gap region which might be cluster members. Moreover, two are located slightly above the red HB level. The latter locus in metal-rich clusters appears to be the position for occurrence of RR Lyrae, like in the case of 47 Tuc (Carney et al. 1993).

In Figs. 6a,b we show cluster V vs (V-I) and I vs (V-I) CMDs. In the former, the TO is clearly detected, whereas in the latter it is at the limit. The evolutionary sequences: subgiant branch (SGB), RGB, asymptotic giant branch (AGB) and red HB are very well defined.

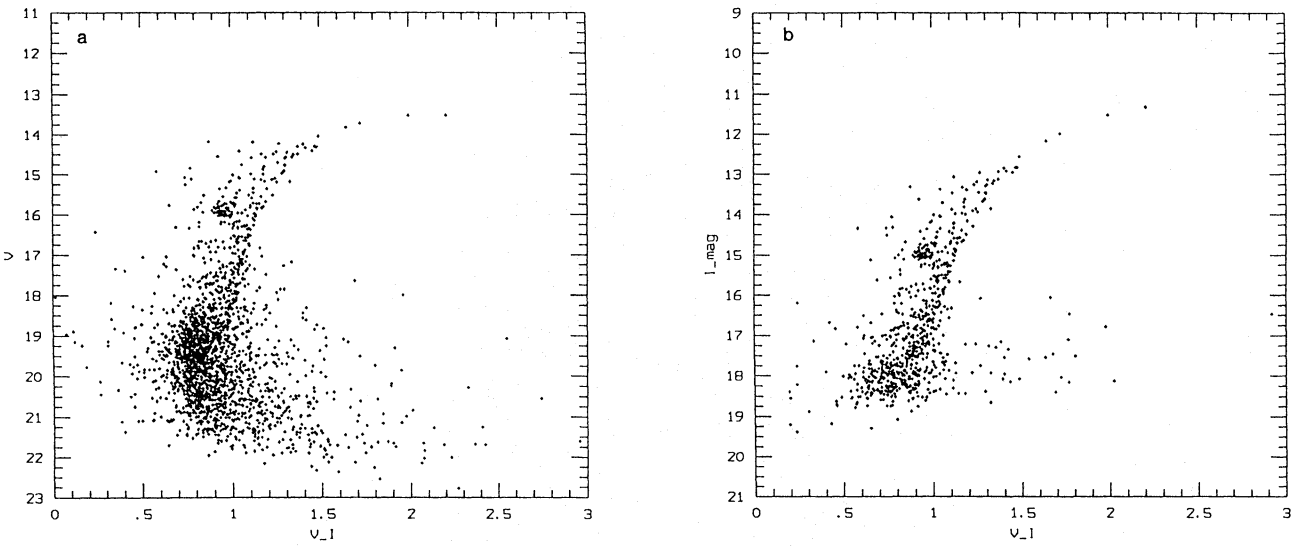

Fig. 6. Cluster (**a**) V vs (V-I) (**b**) I vs (V-I) CMDs for whole frame

4. Cluster parameters

4.1. Metallicity

Using the criterion defined by Ortolani et al. (1991) for the RGB inclination as a function of metallicity, we conclude that its metallicity is lower than that of 47 Tuc, since NGC 6652 RGB in V vs (V-I) and I vs (V-I) (Figs. 4a,b) is steeper in the sense of weaker blanketing. The NGC 6652 red HB indicates that the cluster is not metal poor. It is compact (Sect. 3), whereas red HBs in intermediate metallicity clusters tend to be extended like in NGC 362 (Bolte 1987).

Equivalent widths of strong metallic features in the integrated spectrum of NGC 6652 (Bica & Alloin 1986) are intermediate between those of 47 Tuc and NGC 362, but in the mean closer to 47 Tuc. Adopting Zinn & West (1984) metallicities for 47 Tuc ([Fe/H] = -0.71) and NGC 362 ([Fe/H] = -1.27) , NGC 6652 would be placed at a metallicity of about [Fe/H] ≈ -0.9, which compares well with Zinn & West's photometric value for the cluster itself.

4.2. Reddening and distance

The reddening is derived from a comparison with the compact red HB of 47 Tuc, since both are similar, obtaining E(B-V) = 0.10±0.02; this value is in good agreement with integrated light estimates (Sect. 1).

The HB level $V_{HB} = 15.85 \pm 0.04$, combined to the above reddening and an absolute HB magnitude value $M_V^{HB} = 0.7$ for [Fe/H] = -0.9 (Buonanno et al. 1989), we obtain a true distance modulus $(m\text{-}M)_o = 14.85$ and a distance from the Sun $d_\odot = 9.3$ kpc. Thus the cluster is considerably closer than estimated previously from bright giants (Webbink 1985). The Galactocentric coordinates of the cluster, using 8.0 kpc for the distance to the Galactic center (Feast 1987), are $X = -1.1$, $Y = 0.2$ and $Z = -1.8$ kpc (negative X means the other side of the Galaxy).

4.3. Age

The clear detection of the TO (Figs. 2, 4a) allows one to estimate the cluster age, by means of the V magnitude difference between TO and HB ΔV(TO-HB). The cluster TO appears somewhat blurred by the field MS contamination (the field TO is at V $\approx$ 19.0 and (B-V) $\approx$ 0.50), but a clear ridge helps define the cluster TO (Fig. 2, and also Fig. 4a), resulting $V_{TO} \approx 19.20 \pm 0.15$. We thus deduce $\Delta V(TO\text{-}HB) \approx 3.35 \pm 0.16$, suggesting the NGC 6652 might be slightly younger than the average of Galactic halo globular clusters, characterized by $\Delta V(TO\text{-}HB) = 3.55 \pm 0.09$ (Buonanno et al. 1989).

5. Concluding remarks

For the first time CMDs are presented for NGC 6652. By means of CCD photometry, we find that the cluster CMD morphology consists of red HB, and we detect well defined sequences for MS, TO, SGB, RGB, AGB and blue stragglers.

We derive the following cluster parameters: metallicity [Fe/H] ≈ -0.9, age probably slightly younger than the average of halo globular clusters, and distance d $\approx$ 9.3 kpc.

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