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VI photometry of the galactic cluster Berkeley 66⋆,⋆⋆

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Abstract. A colour magnitude diagram (CMD) extending to $V \simeq 19$ mag is given for 444 stars in the region of the galactic cluster Berkeley 66. The V and I photometry of a nearby field is also reported. This object appears very faint, highly contaminated by foreground stars and very reddened. The apparent distance modulus $(m - M)$ and the colour excess E_{V-I} are guessed to be 17.5 and 1.1, respectively, with an uncertainty of at least 30%. Adopting these values the comparison of the CMD with theoretical isochrones from the Padova group provides an age around 1.0 Gyr.

Key words: open clusters: Berkeley 66 — HR diagram

1. Introduction

In this paper we present CCD VI photometry for the galactic cluster Berkeley 66. Berkeley 66 was discovered by Setteducati & Weaver (1962) in their search for unknown stellar clusters in the galactic disk. They suggested that the cluster has an angular diameter of about 7.′0 and it is very faint, the typical magnitude for the brightest stars being $V \simeq 16$.

The equatorial and galactic coordinates for the 1950.0 equinox are $\alpha = 03^{\rm h}0\overset{\rm m}{.}4$, $\delta = +58°34'$ and $l = 139\overset{\circ}{.}42$, $b = +0\overset{\circ}{.}23$, respectively. In the Berkeley catalogue it is included in the sample of possible clusters, and since then no other studies have been performed to our knowledge.

This analysis is a part of a project aiming at collecting good photometric data for unstudied or poorly studied intermediate age and old open clusters. In the case of Berkeley 66 the selection of the target object has been done following the suggestion of Phelps et al. (1994), who listed in their Table 4 a sample of potentially old still unstudied clusters. Berkeley 66 is also designated as C 0304 + 583 and OCL 373, and classified of $III\ 1\ r$ Trumpler type.

Berkeley 66 has been recently studied by Phelps & Janes (1996). A comparison with this work is given in the conclusions of the paper.

In Sect. 2 we present observations and data reduction; in Sect. 3 we describe the CMD of Berkeley 66 and derive its fundamental parameters. Finally Sect. 4 give some concluding remarks.

2. Observations and data reduction

This section, and the related tables and figures are available electronically at "http://www.ed-phy.fr".

3. Color magnitude diagram and cluster parameters

The radial $(V, V-I)$ CMD for all the stars detected in the field of Berkeley 66 is shown in Fig. 2 while Fig. 3 shows the same field in the $(I, V - I)$ radial CMD. In both figures, panel (a) represent the total sample centered on the cluster core, while panels (b), (c) and (d) refer to a subsample inside an annular region of 100 arcsec, between 130 and 260 arcsec, and outside 260 arcsec, respectively. As it appears, particularly in Fig. 2b (see also Fig. 1 for a 2D representation of the object), Berkeley 66 is a dispersed object in the sense that there is no clear concentration of stars and only a radial CMD can reveal its presence. Outside 130 arcsec from its center, the stars belonging to this object are blended with the field and their colour-magnitude distribution is very similar to that of Fig. 4 where we show the $(V, V - I)$ and $(I, V - I)$ CMDs of the stars detected in the comparison field.

The trend shown by our stars sample is typical for clusters of intermediate age, like NGC 2158, NGC 7789 and NGC 1245 (Carraro & Patat 1994). The majority of the stars distribute along a tilted line extending for 8 magnitudes, which is the cluster MS contaminated by the MS of

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⋆ Based on observations carried out at Pino Torinese Observatory, Torino, Italy.

⋆⋆ Table 2 is available only in electronic form at the CDS via anonymous ftp 130.79.128.5.

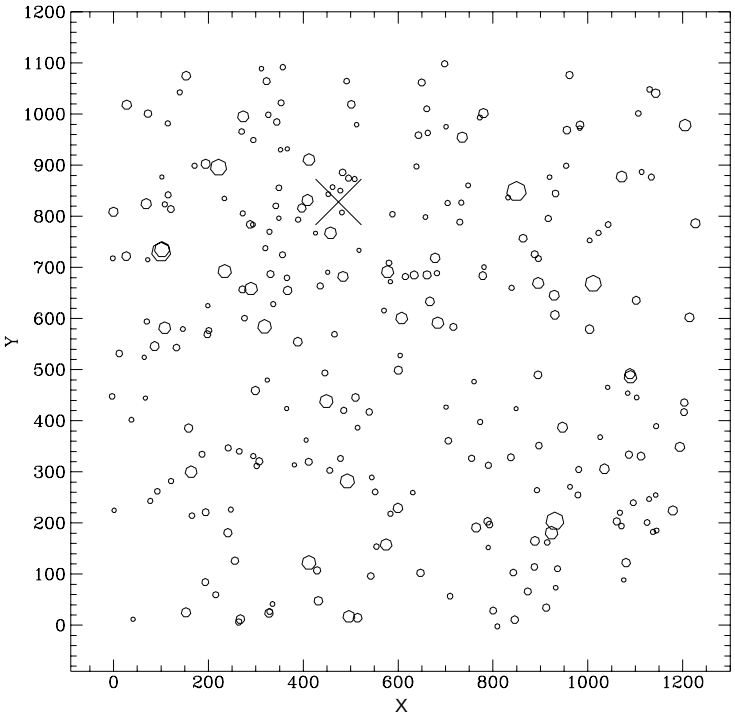

Fig. 1. Finding chart for the stars detected in the field of Berkeley 66. The dimensions of open circles is a function of the V magnitude

the galactic disk field stars. The broadness of the sequence can be attributed to this contamination of interlopers and to the effect of differential reddening, quite common for clusters deeply embedded in the galactic disk. The TO is not detectable both due to this contamination and to the magnitude limit of this sample.

Centered at $V \simeq 17.50$, $(V-I) \simeq 2.2$ is the clump of He burning stars, whose spread can be still attributed to contamination and differential reddening.

In order to obtain the fundamental paramenters of the cluster we proceeded in the following way.

A hint on the colour excess E_{B-V} of the cluster is derivable looking at Neckel & Klare (1980) absorption maps in the neighborhood of the cluster. In this case the most suitable relation is in Fig. 2b, 30. The selective absorption A_V turns out to be about 3.3 mag, which provides a color excess $E_{B-V} \simeq 1.0$ mag and $E_{V-I} \simeq 1.6$ mag, respectively. Obviously one must use caution in using this result because it does not refer to the precise position of the cluster. This value has to be considered as an upper limit. In fact looking at Fig. 2b, 30 in Neckel & Klare (1980) a value $E_{B-V} \simeq 0.6$ mag can be found.

As for the distance modulus $(m-M)$ we use the luminosity of the clump as standard candle (Phelps et al. 1994).

So doing we get a value of 17.50 mag, with an uncertainty of 1.0 mag, linked to the intrinsic spread showed by the clump stars.

Adopting these values it is possible to obtain a guess for the age by fitting the cluster CMD with theoretical isochrones (Bertelli et al. 1994), although the problem remains we don't know the metal abundance of Berkeley 66.

Provided the cluster lies inside the disk, a natural solution is to assume a solar metal content ($Z = 0.020$ in our scale).

The result of the fitting is shown in Fig. 5, from which an age of 1.0 Gyr can be derived. As for the colour excess we find a best fit value $E_{V-I} \simeq 1.1$ mag, corresponding to $E_{B-V} \simeq 0.7$ mag, actually lower than the estimate quoted above.

4. Concluding remarks

In this work we have presented preliminary photometry for Berkeley 66, an unstudied open cluster. The data here presented don't allow us to obtain reliable estimates of the cluster fundamental parameters, due to the magnitude limit reached by our survey.

The TO is suspected to be around $V \simeq 18.5 - 19.00$, but only a deeper photometry can say the last word. In

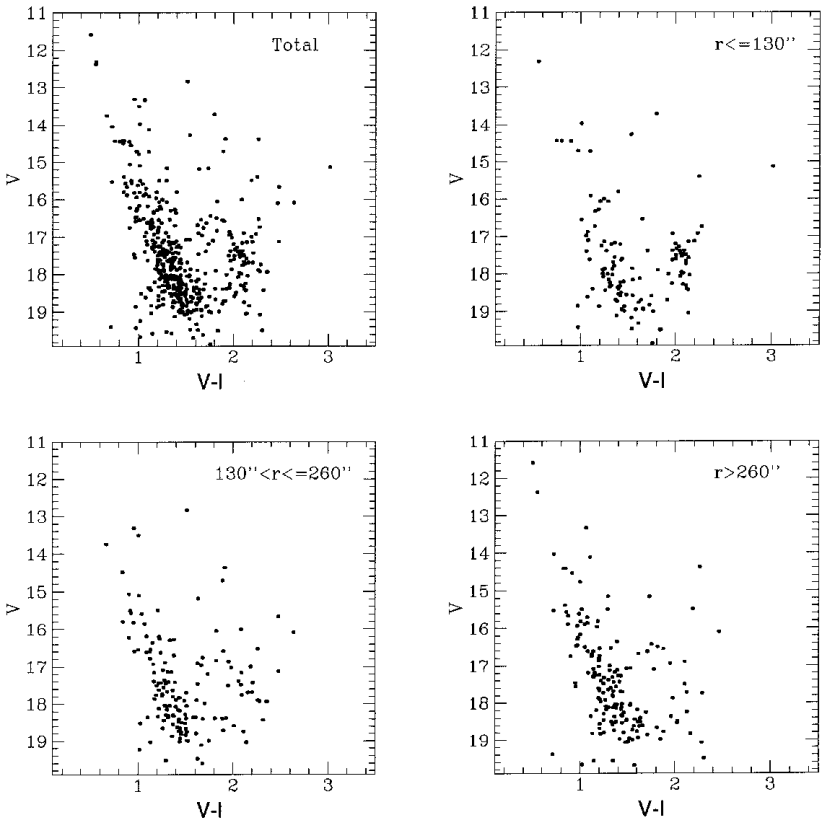

Fig. 2. Radial $(V, V-I)$ CMD of all the stars detected in the field of Berkeley 66. **a)** shows the complete sample centered on the cluster core, whereas **b), c)** and **d)** refers to a subsample inside an annular region of 130 and 260 arcsec, and outside 260 arcsec, respectively

addition we are also limited by the lack of any knowledge of the metal content of the cluster.

Anyhow we have drawn the attention to an unknown cluster till now forgotten, suggesting that it is a member of the old open cluster population. In addition we plan to obtain very soon deeper photometry to better constrain cluster parameters.

Before concluding we must compare our results with Phelps & Janes (1996), who recently studied Berkeley 66. First of all the high field star contamination level prevents any firm conclusions on the cluster parameters. To this fact has to be attributed the differences between the results of the two works. Phelps & Janes (1996), with a significantly deeper photometry, find a greater age (around 3 Gyr) and different colour excess ($E_{V-I} = 1.60$).

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References

Bertelli G., Bressan A., Chiosi C., Fagotto F., Nasi E., 1994, A&AS 106, 275

Carraro G., Patat F., 1994, A&A 289, 397

Neckel Th., Klare G., 1980, A&AS 42, 251

Phelps R.L., Janes K.A., Montgomery K.A., 1994, AJ 107, 1079

Phelps R.L., Janes K.A., 1996, AJ 111, 1604

Setteducati A.F., Weaver, 1962, Newly Found Stellar Clusters, published by Radio Astr. Lab. University of California, Berkeley

Stetson P.B., 1987, PASP 99, 191

Stetson P.B., 1991, DAOPHOT II user manual

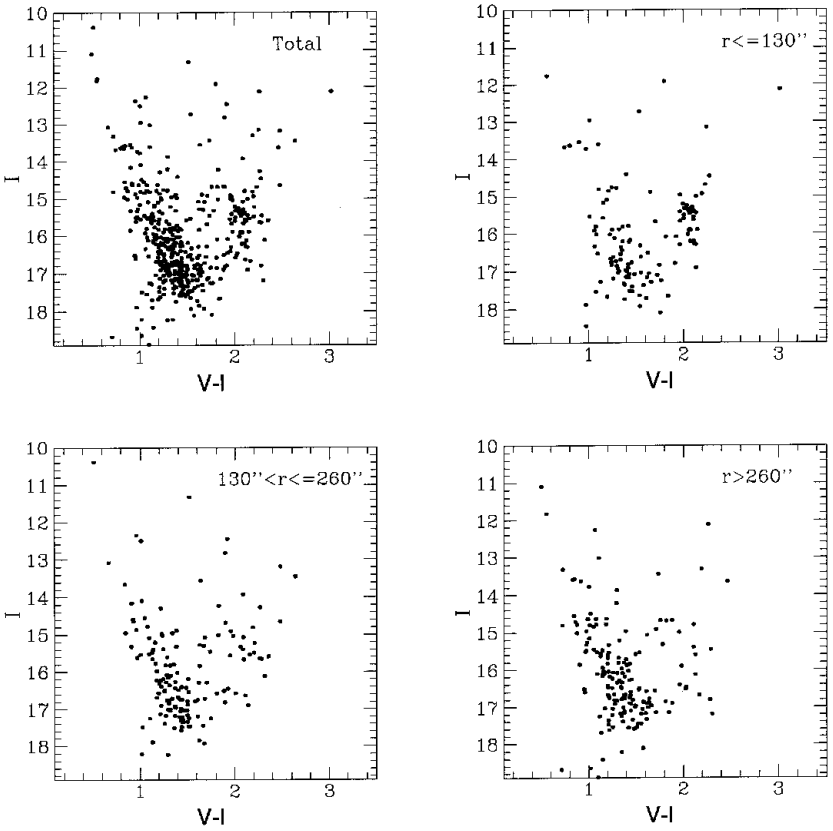

Fig. 3. Radial (I, $V-I$) CMD of all the stars detected in the field of Berkeley 66. Same as above

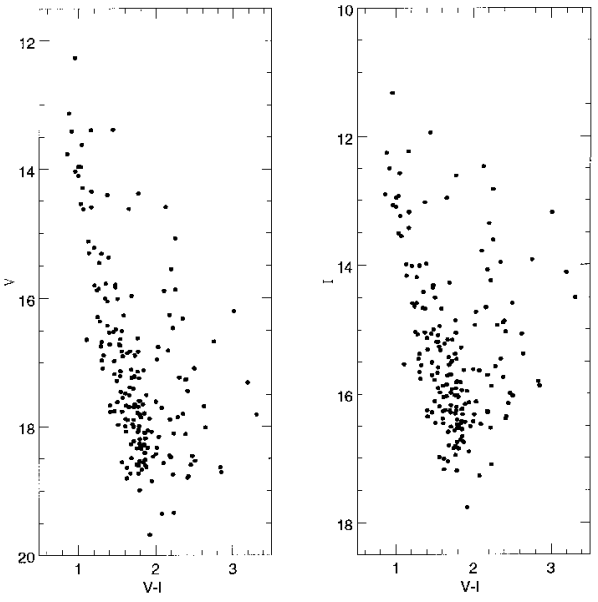

Fig. 4. CMD of the stars detected in the comparaison field. Panel **a)** shows the (V, $V-I$) diagram, while panel **b)** shows the (I, $V-I$) CMD

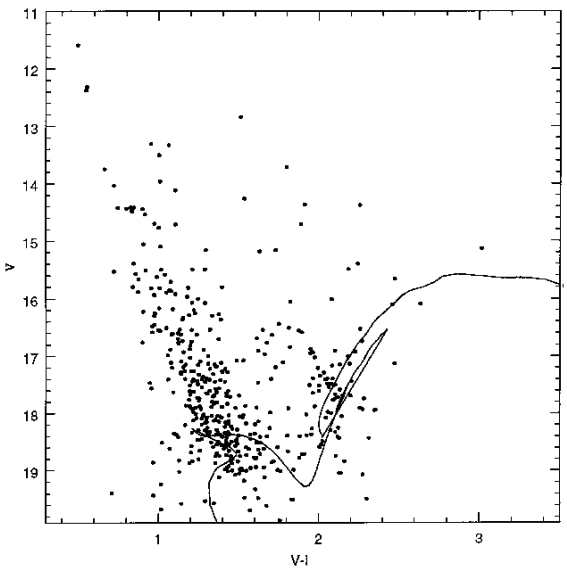

Fig. 5. CMD of Berkeley 66 as in Fig. 2. Overimposed is a solar abundance isochrone for an age of 1.0 Gyr. Colour excess and distance modulus are as in the text