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Photometry of open cluster King 21

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Abstract. Photoelectric magnitudes of 26 stars in the field of King 21 have been obtained. The reddening is variable across the cluster. A distance of 1.91 kpc has been estimated for the cluster. It is concluded that the age of the cluster lies between that of the NGC 2362 and of the NGC 457 groups.

Key words : open cluster—photometry—reddening

1. Introduction

The open cluster King 21 has been assigned class III 3m by Ruprecht (1966). Haug (1970) has obtained photometric magnitudes of four stars in the cluster field. The cluster was put on our observing program during the year 1982. Photoelectric magnitudes have been obtained for 26 stars in the cluster field. The identification chart of the cluster obtained by enlargement from POSS chart is shown in figure 1.

2. Observations

The observations of King 21 were carried out during the period 1982 October–December on the 104-cm reflector of the observatory using a thermoelectrically cooled (−20C) EMI 6094S photomultiplier and standard UBV filters. Each star was observed at least on two different nights. Star no. 14 was taken as a comparison star. The differential instrumental magnitudes were determined using nightly extinction coefficients and these were subsequently standardized in the *UBV* system. The magnitudes and colours of the stars thus obtained are listed in table 1. The accuracy of the observations is $\pm$ 0^m.02 in V and $(B - V)$ and $\pm$ 0^m.025 in $(U - B)$ for stars of $V \approx 13^m$. The V, $(B - V)$ and $(U - B)$ magnitudes of the four stars observed by Haug (1970) along with the magnitudes obtained by us are given in table 2 for comparison. The magnitudes of the stars are in reasonably close agreement within the observational errors excepting the V and $(B - V)$ magnitudes of the star no. 15. The difference of 0^m.09 in V and

Table 1. Photoelectric magnitudes and colours of stars in King 21

Star No.	V	$B-V$	$U-B$	$E(B-V)$
1	$12^m.47$	$0^m.63$	$0^m.06$	$0^m.82$
2	14.17	0.87	−0.08	0.95
3	13.43	0.77	−0.02	0.95
4	13.79	0.73	0.14	0.98
5	13.95	0.81	0.05	0.98
6	13.45	0.74	−0.07	0.95
7	13.46	0.65	−0.06	0.82
8	13.74	0.78	−0.01	0.98
9	14.53	0.70	0.09	0.79
10	13.72	0.78	−0.07	1.00
11	13.69	0.75	0.53	0.87
12	13.80	0.64	0.00	0.79
13	14.53	0.60	−0.09	0.79
14	10.95	0.64	−0.20	0.87
15	11.38	0.69	−0.24	0.87
16	13.31	0.73	−0.09	0.94
17	12.37	0.57	−0.25	0.87
18	11.53	0.53	−0.28	0.79
19	13.42	0.67	−0.13	0.87
20	12.86	0.75	0.05	0.92
21	13.68	0.69	−0.04	0.87
22	14.08	0.69	−0.07	0.90
23	14.41	0.81	0.47	0.90
24	14.33	0.70	0.40	0.87
25	14.36	1.18	0.62	0.87
26	14.09	0.74	0.46	0.87

Table 2. Comparison of present observations with that of Haug (1970)

Star No.		Haug (1970)			Present observations		
Present	Haug (1970)	V	$(B-V)$	$(U-B)$	V	$(B-V)$	$(U-B)$
14	62–28	$10^m.95$	$0^m.63$	$-0^m.23$	$10^m.95$	$0^m.64$	$-0^m.20$
15	62–29A	11.47	0.62	−0.23	11.38	0.69	−0.24
17	62–29B	12.35	0.61	−0.29	12.37	0.57	−0.25
18	62–30	11.54	0.55	−0.31	11.53	0.53	−0.28

$0^m.07$ in $(B - V)$ is due to a difference in V magnitude of the star between the two measures. The magnitudes of the star observed by us on two different nights do not differ by more than $0^m.01$ in V, $(B - V)$ and $(U - B)$.

3. Reddening

Reddening across the cluster has been determined using the colour-colour diagram of the cluster shown in figure 2. The slope of the reddening line has been taken to be 0.72 (Johnson & Morgan 1953) and the intrinsic main sequence from Mermilliod (1981). The maximum and minimum values of the reddening estimated by the sliding fit method are $E(B-V)_{max} = 0^m.99$ and $E(B-V)_{min} = 0^m.78$. Thus the differential reddening $\Delta E(B - V)$ comes out to be $0^m.21$. Since the value of $\Delta E(B - V)$ is greater than $0^m.11$, we conclude that the reddening across the cluster is nonuniform (*cf.* Burki 1975). The mean value of $E(B - V) = 0^m.89$ for the cluster is in close agreement with the values of the reddening given by Haug (1970) for the four stars in the cluster field.

For all cluster stars lying on the main sequence, Q method (Johnson & Morgan 1953) has been used for estimating the reddening. For other stars, the reddening

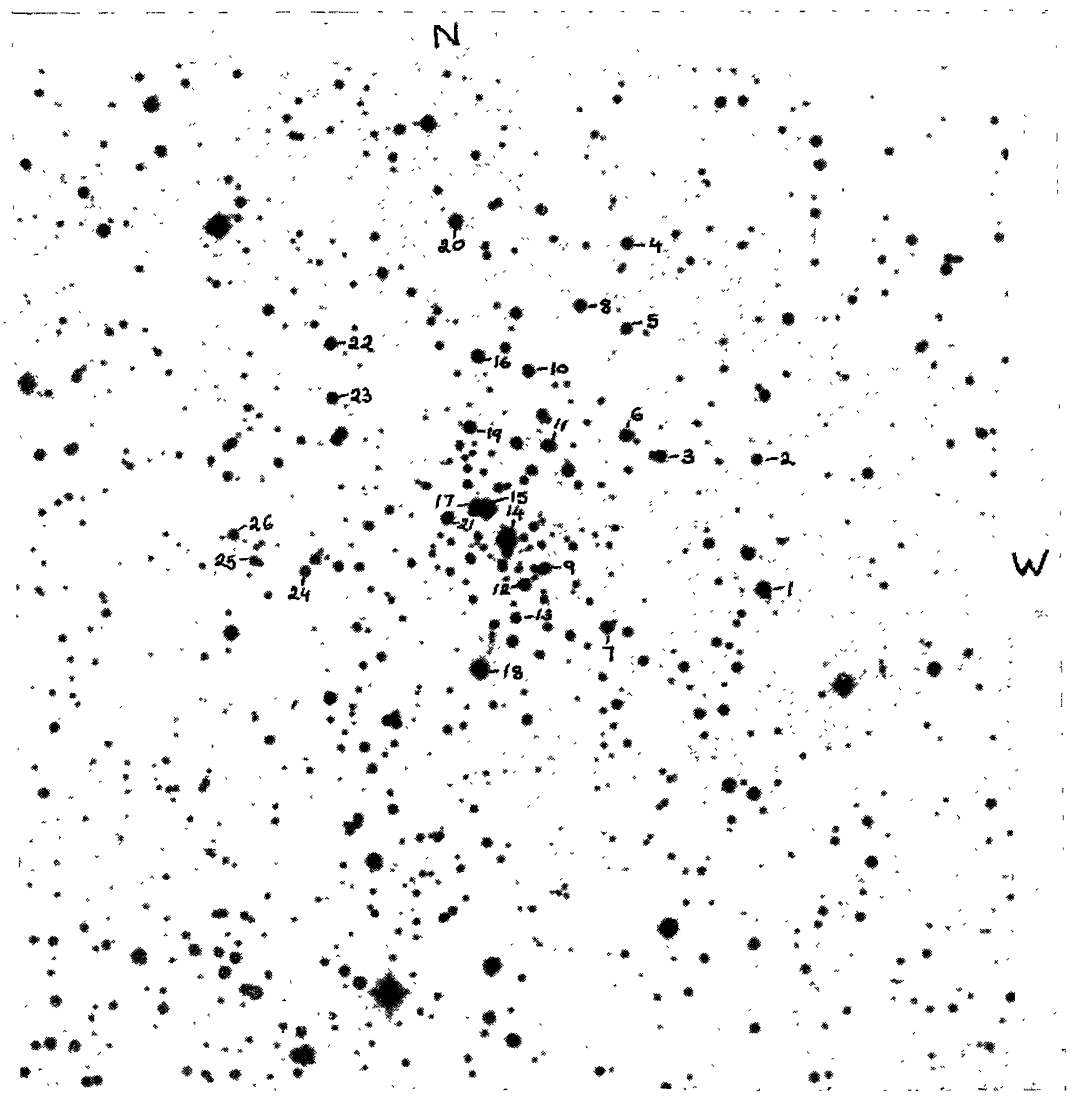

Figure 1. Identification chart for King 21 obtained from POSS chart.

for nearby stars has been applied. The values of reddening for individual stars thus estimated are listed in column 5 of table 1 and have been used in subsequent discussions. The reddening appears to be systematically higher in the northern region of the cluster.

4. Distance

The relation $A_V = 3.25\, E(B - V)$ (Moffat & Schmidt-Kaler 1976) has been used to compute the unreddened magnitudes V_0 of the cluster stars. The distance modulus obtained by fitting the ZAMS given by Mermilliod (1981) to the lower portions of the $[V_0, (B - V)_0]$ and $[V_0, (U - B)_0]$ colour-magnitude diagrams shown in figures 3 and 4 is $11^m.30$ and $11^m.50$ respectively. Thus, the mean value of the distance modulus for the cluster is estimated to be $11^m.40$ which corresponds to a distance of 1.91 kpc.

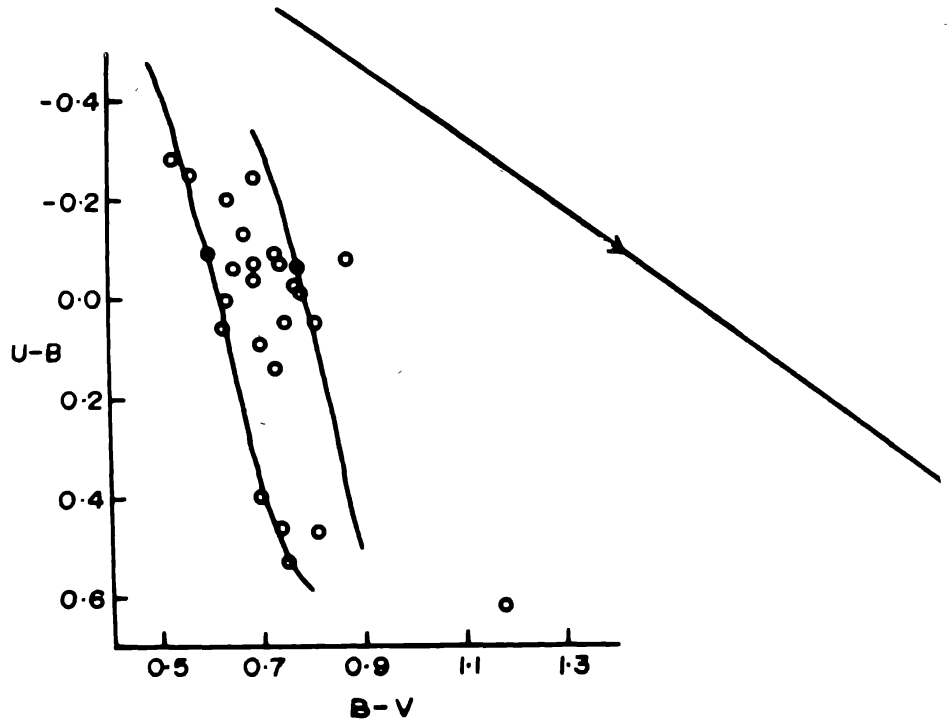

Figure 2. Colour-colour diagram of King 21.

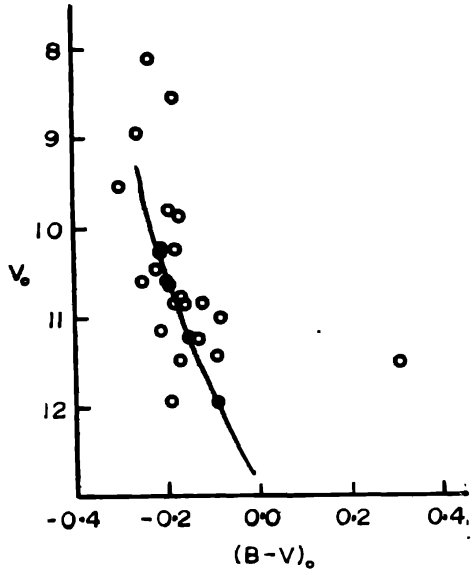

Figure 3. V_0, $(B-V)_0$ diagram of King 21.

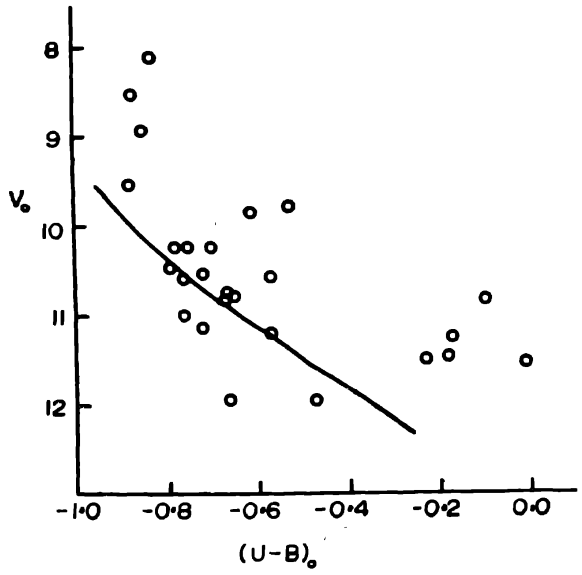

Figure 4. V_0, $(U-B)_0$ diagram of King 21.

5. Membership

The kinemetical data are not available for the cluster. On the basis of the $[V_0, (B-V)_0]$ and $[V_0, (U-B)_0]$ diagrams and the location of stars in the cluster field, the following conclusions are drawn :

(i) The stars numbered 2, 4 and 24 occupy different evolutionary positions in $[V_0, (B-V)_0]$ and $[V_0, (U-B)]$ diagrams. Therefore, these strars are non-members.

(ii) The stars numbered 13 and 22 lie considerably below the main sequence. Therefore, either these are field stars or peculiar cluster star members. (iii) The stars numbered 2, 4, 22 and 24 which are suspected to be nonmembers, lie well outside the crowded region of the cluster. The position of these stars in the cluster field approximately defines the cluster boundary. The stars numbered 1, 20, 23, 25 and 26 lie above the main sequence and are outside the crowded region of the cluster. Therefore, these stars may also be nonmembers.

6. Age

The $[M_V, (B - V)_0]$ and $[M_V, (U - B)_0]$ diagrams have been plotted in figures 5 and 6 respectively.

The age of the post-main sequence cluster stars has been estimated using the composite isochrones given by Mermilliod (1981). From the $[M_V, (B - V)_0]$ and $[M_V, (U - B)_0]$ diagrams the age of the cluster is found to lie between the ages of the NGC 2362 and NGC 457 groups.

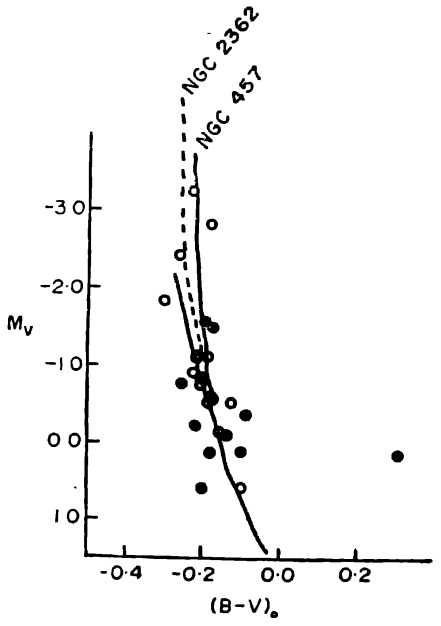

Figure 5. M_V, $(B-V)_0$ diagram of King 21. Filled circles denote suspected nonmembers.

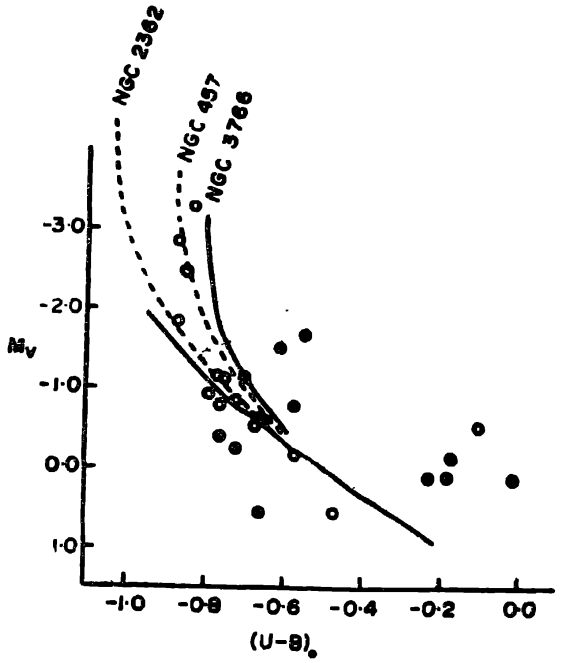

Figure 6. M_V, $(U-B)_0$ diagram of King 21. Filled circles denote suspected nonmembers.

7. Variability

Star no. 19 was observed on four nights. It was found that the brightness of the star varies from night to night. The observed variation in V magnitude is about $0^m.1$. The V, $(B - V)$ and $(U - B)$ magnitudes of the star on the four nights are listed in table 3. We have used the mean magnitudes of the star from table 1.

Table 3. Magnitude and colour of start no. 19

J.D. (Hel)	V	$B-V$	$U-B$
2445257.221	$13^m.38$	$0^m.67$	$-0^m.13$
57.276	13.40	0.69	−0.14
57.291	13.40	0.68	−0.14
57.388	13.44	0.68	−0.12
88.281	13.48	0.60	−0.08
96.129	13.41	0.69	−0.12
96.170	13.42	0.66	−0.15
96.295	13.40	0.70	−0.12
97.292	13.44	0.69	−0.10

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