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UBVRI CCD photometry of the two southern galactic star clusters Berkeley 79 and Trumpler 11

Ram Sagar[1] and R. D. Cannon[2]
[1]*Indian Institute of Astrophysics, Bangalore 560 034, India*
[2]*Anglo-Australian Observatory, Epping, NSW, Australia*

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Abstract. CCD observations in *U, B, V, R* and *I* passbands have been made down to $V = 18.5$ mag for the southern galactic star clusters Berkeley 79 and Trumpler 11. The sample consists of 60 and 358 stars respectively. Berkeley 79 seems to have non-uniform extinction over the observed region with a median value of $E(B-V) = 1.19$ (±0.05) mag while a uniform reddening with $E(B-V) = 0.21$ (±0.02) mag appears to be present over the face of Trumpler 11. The distances to the clusters Berkeley 79 and Trumpler 11 have been estimated as 2.3 ± 0.2 kpc and 3.1 ± 0.3 kpc respectively. Based on the isochrones fitting to the bright stars, an age of ~ 65 Myr has been assigned to Berkeley 79 while age of Trumpler 11 has been estimated to be in the range of 100 to 250 Myr.

Key words : photometry—star clusters—stellar evolution

1. Introduction

The galactic (open) star clusters are good tools to analyse the large scale properties of the disc of our Galaxy and to test the theories of stellar and galactic evolution (see Janes *et al.* 1990) as they have been forming and dissolving rather continuously since the formation of galactic disc which took place about 10 Gyr ago. For such studies, a knowledge of cluster's distance, age and stellar content of star clusters are mandatory which can be derived from the colour-magnitude (CM) and colour-colour diagrams of star clusters. Such diagrams are lacking for most of the distant open star clusters. As the introduction of modern detectors like charge coupled devices (CCDs) make now possible to have observations of these unstudied objects with a moderate size (~ 1 metre class) telescope, we observed two such clusters in 1989 on the 1-metre Australian National University (ANU) telescope at Siding Spring Observatory and the present work reports the results of these observations.

The Berkeley 79 (C1842 – 012 ≡ OCL 86; $l = 31.°14$, $b = 0.°84$) and Trumpler 11 (C1003 – 613 ≡ OCL 808; $l = 284.°66$, $b = -4.°85$) are small southern galactic open star clusters of angular diameters ~ 6-7 arcmin. They have been classified as Trumpler class II 1r and II 3m respectively (Lyngå 1987).

In this paper we describe the new *UBVRI* CCD photometric observations of the stars in the field of Berkeley 79 and Trumpler 11. These observations have been used to study the interstellar extinction across the cluster regions and to determine age, distance and other parameters of the clusters.

2. Observations

The observations for the clusters were made on 30/31 March 1989 and 25/26 June 1989 in the *U, B, V, R* and *I* photometric passbands using a blue coated GEC P8603 Astromed Comp detector at the *f*/8 Cassegrain focus of the ANU 1.0 metre telescope located at Siding Spring Observatory. Each pixel (which is 22 micron square) of the 385 × 578 size CCD corresponds to 0.56 arcsec on the sky. Figures 1 and 2 show regions imaged with the CCD for Berkeley 79 and Trumpler 11 respectively. Two graded exposures (see table 1) ranging from 30 to 600 seconds in each passbands were taken. For Berkeley 79, observations in *R* passband could not be done. As the present observations were carried out during another main observing programme, further details of the instrument and observing procedure have been described there (Sagar & Cannon 1994).

3. Reductions

The data were reduced mainly at the Anglo-Australian Observatory, Epping and partly at the Vainu Bappu Observatory, Kavalur and Indian Institute of Astrophysics, Bangalore using

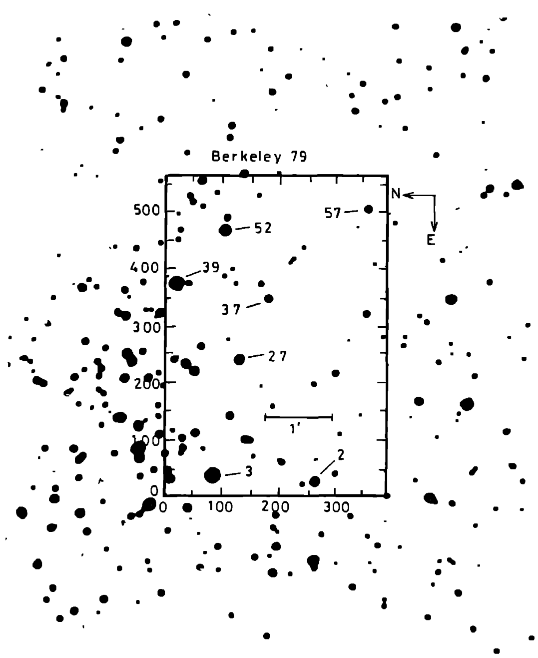

Figure 1. Identification map for the imaged region of Berkeley 79. It is reproduced from the B film copy of the Palomar Observatory Sky Survey. The size of a CCD frame is 3.5 × 5.4 arcmin^2 and the coordinates are in pixel units. A few stars from table 3 are identified.

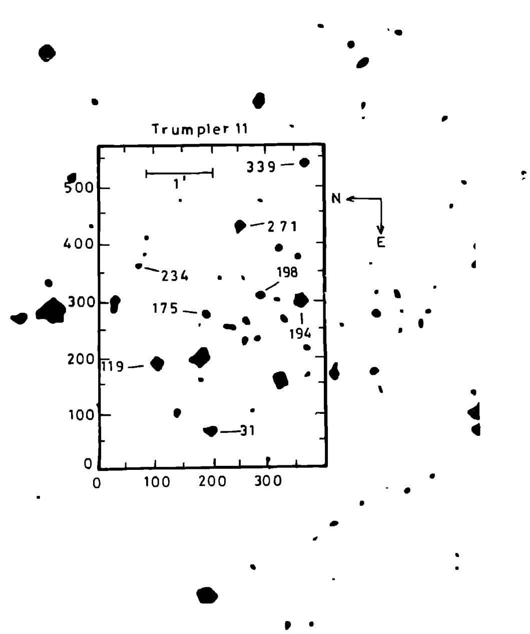

Figure 2. Identification map for the imaged region of Trumpler 11 It is reproduced from the B film copy of the ESO Sky Survey. Other informations are the same as in figure 1. A few stars from table 4 are identified.

Table 1. Log of CCD observations

Cluster	Filter	Exposure time (seconds)	Date
Berkeley 79	*U*	300, 600	25/26 June 1989
	B	200, 600	"
	V	60, 300	"
	I	60, 200	"
Trumpler 11	*U*	100, 400	30/31 March 1989
	B	60, 300	"
	V	30, 300	"
	R	30, 300	"
	I	30, 300	"

VAX 11/780, μ Vax computers and SPARC Sun 4/350 Workstations. Initial processing of the data frames was done in the usual manner using the FIGARO data reduction package. The uniformity of flat fields is better than a few per cent in all the filters. The averaged flat-fields were used in flat-fielding the CCD data frames.

Although the cluster fields are not exceptionally crowded, the magnitude estimation of a star on each of the frames has been done using the DAOPHOT profile-fitting software (Stetson 1987) so that it can be determine reliably to faint levels. The stellar point spread function (PSF) used by the DAOPHOT was evaluated from the sum of more than 10 uncontaminated stars present on each frame.

Further processing and conversion of these raw instrumental magnitudes into standard photometric system have been done using the procedure outlined by Stetson (1992). The image parameters and errors provided by DAOPHOT were used to reject poor measurements. A few per cent stars were rejected in this process. DAOMASTER programme was used for cross identifying the stars measured on different frames of a cluster region.

The colour equations for the CCD system given earlier by us (Sagar & Cannon 1994) in the study of the NGC 4755 have been used in this work, as both observations were carried out during the same observing runs. For establishing the local standards, we selected about 20 isolated stars in both clusters and used DAOGROW programme for the construction of aperture growth curve required for determining the difference between aperture and profile fitting magnitudes. These differences and the difference in exposure times and atmospheric extinctions are used in evaluating zero-points for the reference cluster frames. For this, we have used the mean values of atmospheric extinctions for the site. The zero-points are uncertain by ~ 0.05 mag in *U* and *B* and by ~ 0.03 mag in *V, R* and *I*. The internal errors estimated from the scatter in the individual measures of different exposures are listed in table 2 as a function of magnitude for all filters. The errors are large (more than 0.10 mag) for stars fainter than V = 17 mag.

The X and Y pixel coordinates as well as V, $(U-B)$, $(B-V)$, $(V-R)$ and $(V-I)$ magnitudes of the stars observed in Berkeley 79 and Trumpler 11 cluster regions are listed in tables 3 and 4 respectively along with the number of observations in each filter. A few bright stars are identified in figures 1 and 2.

Table 2. Internal photometric errors as a function of brightness σ is the standard deviation per observation in magnitude

Magnitude range	σ_U	σ_B	σ_V	σ_R	σ_I
≤ 12 0	0.006	0.003	0 006	0 006	0.006
12 0-13.0	0.009	0.004	0.013	0 008	0.007
13 0-14 0	0.015	0.007	0.014	0 012	0 013
14.0-15.0	0.022	0 016	0.028	0.029	0.023
15 0-16.0	0.057	0 033	0.043	0.036	0.032
16 0-17.0	0.101	0 063	0.072	0.050	0.045
17.0-18 0	—	0.098	0.120	0.085	0 078

Table 3. Relative positions and CCD *UBVI* magnitudes of stars measured in the field of Berkeley 79 The number of observations in the *U, B, V* and *I* filters are denoted by N_u, N_b, N_v and N_I respectively. Photometric members, probable members and non-members are denoted by m, pm and nm respectively in the last column

Star	*X* (pixel)	*Y* (pixel)	*V* (mag)	*(U − B)* (mag)	*(B − V)* (mag)	*(V − I)* (mag)	N_u	N_b	N_v	N_I	Remarks
1	242 31	28 75	16 76		1.15	1.55		2	2	2	m
2	264.65	35.10	13.82	0 03	0.91	1 30	2	2	2	2	m
3	84.00	40.22	12.10	0 03	0.67	0.87	2	2	2	2	m
4	203.37	67 90	15 71	0 54	1.23	1 64	1	2	2	2	pm
5	22 56	74 51	17 08		1 37	1.65		2	2	2	m
6	153.25	75.21	16.56		1.34	1.44	1	2	2	2	m
7	26.46	85.66	15.98	0.43	1.05	1.67		2	2	2	m
8	62.92	86 48	16 71		1.37	1.74		2	2	2	m
9	301 02	98 34	15 63	0.45	1.70	2 38	1	2	1	1	nm
10	25.22	104.44	15 94	0.39	1.11	1.51	2	2	1	2	m
11	147.69	105.13	16.73		1.14	1.63		2	1	2	m
12	136.83	106.37	14.94	0.36	1.24	1.59	2	2	2	2	nm
13	48.29	114.25	15.08	0.31	0.94	1.31	2	2	2	2	m
14	7 87	116 87	16.98			1 79			2	2	m
15	305 86	123.70	16.74		1 41	1 76		2	2	2	m
16	108.66	148.89	15.43	0 37	0.99	1 37	2	2	2	2	m
17	341.74	160.76	16.49		1.98	2.52		2	2	2	nm
18	303.32	168.87	17 85		1.35	1.79		2	1	2	m
19	184.56	169.03	16.47		1.16	1.53		2	2	2	m
20	162.13	205.50	17 19		1.33	1.74		2	2	2	m
21	256.18	213.80	16.49		1.25	1 66		2	1	2	m
22	41.85	226.98	14.75	0 13	0.91	1.29	2	2	2	2	m
23	187.89	228.38	17.92			1.99			2	2	m
24	294.35	234.87	15.41	0.56	1.36	1.70	1	2	2	2	nm
25	26.29	239.81	14.64	0.14	0.90	1.21	2	2	2	2	m
26	5.22	246.98	15.94			1 49			2	2	m

(*Continued*)

Table 3. (Contınued)

Star	X (pixel)	Y (pıxel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_I	Remarks
27	121.45	251 99	14.33	0.08	0.94	1.27	2	2	2	2	m
28	52.14	273.33	15.90	0 39	1.00	1.34	1	2	2	2	m
29	336.85	281 36	17.85		1.70	2 21		2	2	2	m
30	206.73	285.54	17.84		1.46	1 77		2	2	2	m
31	100.60	288.32	17.40		1 30	1.64		2	1	2	m
32	315.74	295.89	17.88		1.21	1.78		2	2	2	m
33	251.62	296.34	17.57		1 61	1.90		2	2	2	m
34	322.25	332 51	17.76			2.06			2	2	m
35	345 27	345.86	15.54	0.32	1.06	1 43	1	2	2	2	m
36	204.03	359 71	17.88			1 78			2	2	m
37	169.03	366.11	15 28	0 17	0.98	1.30	2	2	2	2	m
38	211.33	378.38	17.69		1.59	1.79		2	2	1	m
39	3.32	385.47	12.45			1 22			2	2	m
40	26.28	387.99	16.47		1.37	1.81		2	2	2	m
41	109.77	391.45	17.11		1 55	1.82		2	2	2	m
42	155.46	392 18	16.16	0.50	1.24	1 62	1	2	2	2	m
43	90.00	404.73	16.65		1 41	1.75		2	2	2	m
44	312.71	407.69	17 32		1 14	1.69		2	1	2	m
45	131.52	410 84	17.97			1.88			1	2	m
46	102.82	418.67	17.38		1.41	1.85		2	2	2	m
47	205.90	432.93	17.30		1.38	1.81		2	2	2	m
48	356.67	438.53	17.10		1.18	1.62		2	2	2	m
49	212.15	441.16	16.91		1 32	1.73		2	2	2	m
50	229.26	462.56	17.16		1.40	1.78		2	1	2	m
51	6.57	484.49	16.72			1.54			2	2	m
52	87.01	486.78	13.36	0.32	0.81	1.06	2	2	2	2	m
53	323.67	504.51	17.52			1.95		.	1	2	m
54	89.63	511 79	15.49		1.61	2.00	1	2	2	2	nm
55	46.34	529.93	16.59		1.42	1.79	1	2	2	2	m
56	27.89	536.31	15.41		2.08	2.46		2	2	2	nm
57	341.49	538.15	15.36	0.51	1.08	1.51	2	2	2	2	m
58	21.95	548 71	16.27		1.44	1.90		2	2	2	pm
59	145.89	553.77	17.16		1.27	1.77		2	2	2	m
60	69.88	556.00	16.87		1.39	1.84		2	2	2	m

4. Interstellar extinction in the direction of clusters

In order to estimate interstellar extinction to the clusters, we have plotted $(U-B)$ versus $(B-V)$ diagrams for Berkeley 79 and Trumpler 11 in figures 3 and 4 respectively. Adopting the slope of reddening line $E(U-B)/E(B-V)$ as 0.72, we fitted the intrinsic zero-age main-sequence (ZAMS) given by Schmidt-Kaler (1982) to the MS stars of spectral type earlier

Table 4. Relative positıons and CCD *UBVRI* magnıtudes of stars measured in the field of Trumler 11. The number of observations ın the *U, B, V, R* and *I* filters are denoted by N_u, N_b, N_v, N_r and N_i respectively. Photometrıc cluster members, probable members and non-members are denoted by m, pm and nm respectively in the last column

Star	*X* (pixel)	*Y* (pixel)	*V* (mag)	(*U* – *B*) (mag)	(*B* – *V*) (mag)	(*V* – *R*) (mag)	(*V* – *I*) (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
1	302 22	1.17	13.09			0.49	1.26			2	1	1	nm
2	108.11	2 61	16.86				0 67			2		1	pm
3	344.30	4 78	17.23				0 88			2		2	pm
4	321.92	4 90	17.84			0.47	0.99			2	1	2	m
5	373.26	4.91	17 72				0.95			2		2	pm
6	271.94	6.85	15.16			0.38	0 75			2	2	2	nm
7	124 51	7 17	17 57			0.77	1.43			2	2	2	nm
8	11.42	8 96	17 62			0 44	0.93			2	2	2	pm
9	328.27	13.21	17.12			0.45	0.81			2	2	2	m
10	264.54	14 24	16 12	0 10	0.76	0.44	0.86	2	2	2	2	2	pm
11	193.68	16 64	17.94		0.86	0.48	0.92		1	2	2	2	m
12	375.43	19.58	15.66	0.05	0.62	0.34	0 72	2	2	2	2	2	m
13	344.84	20 63	15.05	0.03	0 54	0.36	0.69	2	2	2	2	2	nm
14	110.54	21.70	16 83			0 71	1 33			2	2	2	nm
15	13.20	24.31	18 07			0.79	1.45			2	2	2	nm
16	98.83	26 08	16.07	0 76	1.15	0 64	1.25	2	2	2	2	2	nm
17	117 43	30.52	18.45		0 96	0.44	0.92		2	1	2	2	m
18	237.42	31.03	18 27		1 00	0 45	0.85		1	2	2	1	pm
19	222.04	31.48	17.29			0 49	0.97			2	2	2	m
20	85.31	31.88	17 41		1 02	0.62	1 16		1	2	2	2	pm
21	79 32	33.19	16.84		0.87	0.47	0.91		2	2	2	2	m
22	88 47	34 89	16.53			0 68	1 36			2	2	2	nm
23	43.46	40.42	17.60		1 06	0 59	1 15		2	2	2	2	pm
24	268.24	40 46	18.05		0.99	0.35	0.78		1	2	2	2	pm
25	21 18	43.43	16.57			0.45	0.91			2	2	2	m
26	78.14	46.01	17.25		0.94	0.48	0.97		2	2	2	2	m
27	180 93	46.16	17.21			0 72	1 42			2	2	2	nm
28	295.54	46.22	17.39		1 21	0 77	1.45		2	2	2	2	nm
29	38.40	46.84	17 69		0 76	0.43	0.87		1	2	2	2	m
30	239.43	48.25	17 78		0.79	0 47	1 07		1	2	1	2	m
31	199.43	48.38	12 31	–0.25	0.06	0.08	0.18	2	2	2	2	2	m
32	359.62	49 28	17.28		0 86	0.46	0.94		2	2	2	2	m
33	140.27	49.71	17 58			0 51	1 02			2	2	2	m
34	41.99	52.92	17 78		0 94	0.60	1.06		1	2	2	2	m
35	13.35	54.42	14.69			0 48	0 94			2	2	2	nm
36	187.43	54.45	17.35		0.57	0 36	0.74		1	2	2	2	pm
37	323.61	56.68	18.40		0.49	0 23	0.58		1	2	2	1	nm
38	290.42	58.68	17.98			0.63	1.33			2	2	2	pm

(*Contınued*)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-R)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
39	233.85	58.77	17.75			0.43	0.95			2	2	2	pm
40	8 54	58.94	16.50			0.74	1.37			2	1	1	nm
41	209.44	59.11	16.21		1 43	0.86	1.64		2	2	2	2	nm
42	79 01	60 02	18.00		0.85	0.40	0.85		1	2	2	2	m
43	178.21	63.77	14.36	0.00	0.55	0.35	0 68	2	2	2	2	2	nm
44	371.49	64 75	17.85		0.70	0 40	0 83		1	2	2	2	pm
45	138.16	64.95	16 53	0 40	0.95	0 58	1 06	1	2	2	2	2	nm
46	178 13	78.33	15 72	0.45	1.09	0.62	1.21	2	2	2	2	2	nm
47	297.31	79 18	17.87		0.71	0 36	0.81		2	2	2	2	pm
48	379.72	80.33	18 38			0.78	1.47			2	2	2	nm
49	247 66	80.36	18 32		0.49	0.52	0 89		1	1	2	2	pm
50	136 98	80.64	13 33	0.69	1.02	0 60	1.13	2	2	2	2	2	nm
51	288.22	80.67	16 99			0.67	1 29			2	2	2	nm
52	227 63	82.75	16.86		0.78	0 34	0.74		2	2	2	2	m
53	83 91	84.62	17.17			0.59	1.06			1	2	1	pm
54	252.49	84.75	16 66		0.67	0 40	0 78		2	2	2	2	m
55	32.84	85.38	17.31		1 09	0 53	1 13		1	2	2	2	pm
56	136.21	87.60	14.17	0.02	0 61	0.40	0.75	2	2	2	2	2	nm
57	338 33	87.91	17.96		0.94	0.51	1 01		1	2	2	2	m
58	272.26	88.87	14.27	0.08	0.19	0 12	0 26	2	2	2	2	2	m
59	328.85	91 81	15 50	0 00	0.56	0.36	0.70	2	2	2	2	2	m
60	94.24	92.01	17.61		0 91	0.47	0.92		2	2	2	2	m
61	298.39	92 26	16.72		0.93	0.55	1.02		2	2	2	2	nm
62	308.33	95.82	17 53			0.81	1.40			2	2	2	nm
63	19 48	95.93	15.95	0 07	0.49	0 34	0.63	2	2	2	2	2	m
64	150.30	96 20	18 30		1 18	0 58	1.04		1	1	2	2	m
65	251 78	96.76	16.35	−0.02	0.65	0.37	0.73	2	2	2	2	2	m
66	258 82	103.06	17.24			0.41	0.82			2	2	2	m
67	375.39	103.59	17.54		0.76	0.50	0.94		2	2	2	2	m
68	76.58	107 91	18.28		1.07	0.52	1 07		1	2	2	2	pm
69	246 82	109 05	15.49	−0.01	0.52	0.32	0.63	2	2	2	2	2	m
70	282 03	109 86	15.17	0.12	0.33	0.20	0.40	2	2	2	2	2	m
71	232.89	112.02	17.60			0 64	1.08			2	2	2	m
72	127.84	113 26	18.48			0.62	1 12			2	2	2	m
73	181.53	114.44	17 48		0 99	0.52	0.99		2	2	2	2	m
74	168.32	117 18	16.54	0.01	0.74	0.40	0.83	2	2	2	2	2	m
75	369 63	119.13	17.64		0 79	0.48	0.90		1	2	2	2	m
76	81 18	120 90	17.40		1.06	0.51	1 01		2	2	2	2	m
77	361.08	121.22	15 46	0.01	0.56	0 32	0.64	2	2	2	2	2	m
78	245 99	123 77	16.75			0.47	0.92			2	2	2	m

(*Continued*)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-R)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
79	27 94	125 38	17.77		0.95	0.42	0.96		1	2	2	2	m
80	210.83	125.85	15.81	0 43	1.05	0.64	1.23	2	2	2	2	2	nm
81	13.87	126 75	18 49			0 58	0 98			2	2	2	m
82	317.46	127.74	17.01		0.79	0.49	0.91		2	2	2	2	m
83	224.53	130.75	15 70		1.03	0.62	1.21		2	2	2	2	nm
84	342.88	131 18	15.78	0 03	0 59	0 34	0 69	2	2	2	2	2	m
85	180.70	135.21	16 99			0.51	0.97			2	2	2	m
86	139.78	135.38	15.91	0.04	0.78	0.47	0.90	2	2	2	2	2	nm
87	253.38	135.56	17.69		0 43	0.19	0 40		2	2	2	2	nm
88	66.34	139.98	16.46		1.22	0.67	1.25		2	2	2	2	nm
89	173 15	140.71	18.24		0.73	0.51	0.95		1	2	2	2	pm
90	322.85	142.62	11 98	−0 36	0 05	0.07	0.15	2	2	2	2	1	m
91	187.55	145.24	15.98	0.11	0 60	0.39	0 76	2	2	2	2	2	m
92	169.59	146 74	17.49		0.69	0.45	0.81		2	2	2	2	m
93	238.38	146 83	15.19	0 12	0.31	0.19	0.38	2	2	2	2	2	m
94	113.25	147.27	17.74			0.41	0 87			2	2	2	pm
95	75 55	147.99	17 54		0.90	0 59	1 26		1	2	2	2	m
96	127.86	148.40	14 76	0 08	0 27	0.13	0.29	2	2	2	2	2	m
97	52 47	148 41	16 42	−0.05	0.75	0.38	0 83	2	2	2	2	2	m
98	222.95	149.40	17 90		0.82	0.45	0.97		1	2	2	2	m
99	231.60	151.88	17.60		1.01	0 64	1.16		1	2	2	2	pm
100	353.17	152.02	17 30		0.84	0.54	0.94		2	2	2	2	m
101	298.99	152.52	18.05		0.53	0.44	1.02		1	1	2	2	pm
102	312.22	152 82	15.25	0.86	1.15	0 68	1 26	2	2	2	2	2	nm
103	174.81	153.26	17.71			0 42	0.83			2	2	2	pm
104	365 65	153.38	15.69	0 79	1 12	0.71	1.33	1	2	2	2	2	nm
105	325.08	156.18	14.24	0 04	0 18	0.10	0 24	2	2	2	2	2	m
106	373.51	157.35	14.06	1.40	1.32	0.75	1.38	2	2	2	2	2	nm
107	105.51	159.48	16 25	0.12	0.55	0.63	1 08	2	2	2	1	1	pm
108	131.13	160 66	17.84		1 01	0.40	0.85		2	2	2	2	pm
109	245 37	162.82	18.23		0 57	0.49	0.84		1	2	2	2	nm
110	217.20	164 27	17.56			0.50	0 98			2	2	2	m
111	351.26	164.55	16 60		0 93	0.42	0 82		2	2	2	2	m
112	172.40	165.11	17.58		0 53	0.43	0.75		2	2	2	2	pm
113	20.92	167.21	15.39	1.21	1.34	0 76	1.40	1	2	2	2	2	nm
114	371 30	167.53	17.96			0 38	0.99			2	2	1	pm
115	74 61	168.29	18 01		0 41	0 36	0.85		1	2	2	1	pm
116	149 58	169.29	18.13		0 88	0.34	0.86		1	2	2	2	m
117	338 18	171.27	16.05	0 13	0 60	0.35	0 72	2	2	2	2	2	m
118	66.26	171.52	17 22			0 47	0 97			2	2	2	m

(*Continued*)

Table 4. (Continued)

Star	*X* (pixel)	*Y* (pixel)	*V* (mag)	(*U* – *B*) (mag)	(*B* – *V*) (mag)	(*V* – *R*) (mag)	(*V* – *I*) (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
119	98.71	171.81	10.97	1.07	1.26	0.69	1.29	2	2	1	1	1	m
120	312.58	172.40	17.04		0.63	0.44	0.83		2	2	2	2	m
121	368 47	172.72	17 84		1.26	0.91	1 58		1	2	2	2	nm
122	127.32	174.57	18.49			0.67	1.27			1	2	2	m
123	75.61	177.07	17 14		0.84	0.49	0.98		2	2	2	2	m
124	159.37	177.27	15.67			0 63	1 22			2	2	2	nm
125	280.22	180.67	16.32	0.07	0.66	0.37	0.73	2	2	2	2	2	m
126	179.25	183.58	10.92	–0.25	0.08	0.10	0.21	2	2	1	1	1	m
127	245.77	187.58	17.95		0.60	0.46	1.00		1	2	2	2	pm
128	69.66	188.45	14 76	0.72	1.16	0.66	1.29	2	2	2	2	2	nm
129	271.46	190.65	17.62			0 61	1 10			2	2	2	m
130	319.26	191.23	15 23	0.08	0.58	0.37	0.70	2	2	2	2	2	nm
131	95.11	193.06	16.91			0.53	1.09			2	2	2	pm
132	49.63	197.90	15.10	0.09	0.65	0.41	0 82	2	2	2	2	2	nm
133	187.72	199.13	15.50	0.12	0 71	0.43	0.83	2	2	2	2	2	nm
134	252.79	199.82	17.72		1.04	0.55	1.06		1	2	2	2	m
135	136.78	203 32	16 92		0 65	0 31	0.67		2	2	2	1	m
136	240.03	203 74	17.53		0.40	0 06	0.20		2	2	2	2	nm
137	346.88	204.58	17.42		0.91	0.63	1.11		2	2	2	2	pm
138	370.89	205.06	13.85	–0.02	0.16	0.10	0.23	2	2	2	2	2	m
139	163.18	207 58	18.06		0 77	0.58	1 23		1	2	2	2	pm
140	128.43	207 79	17 97		0.96	0.48	0 87		1	2	2	2	m
141	28 87	207.93	15.49	0.51	1 05	0.61	1.21	2	2	2	2	2	nm
142	67.23	209.33	18.23			0.64	1.17			2	2	2	m
143	21.98	210.92	16 65		0 84	0 48	0.94		2	2	2	2	pm
144	362.88	210 95	17.18		0.72	0.41	0.80		2	2	2	2	m
145	300.14	211 62	15 56	0.16	0.40	0.26	0.50	2	2	2	2	2	m
146	60.32	217.89	18 25			0.47	1.07			2	2	2	pm
147	257 46	219.58	14.02	0.13	0.25	0.14	0.29	2	2	2	2	2	m
148	300.08	220 10	18.10		0.73	0.59	1.02		2	1	2	2	m
149	279.27	221.01	14.04	0.02	0.17	0.10	0.22	2	2	2	2	2	m
150	80.39	221.27	17.68		0.87	0.48	0 98		2	2	2	2	m
151	359.53	224.44	17.93		0.77	0.37	0.90		1	2	2	2	m
152	221.83	225.59	17.81		1.40	0.86	1.61		1	2	2	2	nm
153	287.31	228.51	17.80			0.50	0.88			2	2	2	m
154	353.13	230.35	16.35		0.54	0 37	0.75		2	2	2	2	m
155	310.00	234.82	17 34			0.63	1.15			2	2	2	nm
156	120.94	236 56	18.15		1.01	0.40	1.00		1	2	2	2	m
157	260.84	237.62	17.62			0.33	0.76			2	2	2	pm
158	296 82	238 18	17.27			0 60	1.12			2	2	2	pm

(*Continued*)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-R)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
159	100.84	238.93	18.05		0.81	0.44	0.89		1	2	2	2	m
160	236.76	239.90	13 73	0.03	0.70	0 43	0.85	2	2	2	2	2	nm
161	79.06	241.20	15.87	−0 04	0 61	0.38	0.76	2	2	2	2	2	m
162	223.51	242.11	14.20	0.05	0.46	0.28	0.56	2	2	2	2	2	nm
163	318.00	242.82	17 47		0.82	0 34	0.74		2	2	2	2	m
164	280.68	242 92	16.08		0 92	0.49	0.92		2	2	2	2	nm
165	174.57	244.42	14.55	0.10	0 23	0.11	0.27	2	2	2	2	2	m
166	268.93	246.86	17.02			0 40	0 80			2	2	2	m
167	343 01	247.56	17.79		0 85	0.57	0.98		1	2	2	2	m
168	15.17	251.41	15.92			0 41	0.82			2	2	2	pm
169	33.45	255.46	17.18		0 70	0.46	0 88		2	2	2	2	m
170	257.23	255.46	13 89	−0 04	0.16	0.05	0.14	2	2	2	2	2	m
171	327 11	256.00	14.49	0.10	0.19	0.11	0.23	2	2	2	2	2	m
172	282.57	258.74	16.68		0.82	0.46	0.86		2	2	2	2	m
173	28.68	259.01	17.92			0 93	1.87			2	2	2	nm
174	323.80	263.21	15.05	0 82	1.16	0.68	1.26	2	2	2	2	2	nm
175	186 65	264 61	13.18	0 09	0.58	0.36	0 70	2	2	2	2	2	nm
176	209.09	265.62	17.55		0 66	0.50	0.92		1	2	2	2	m
177	277.07	267.28	18.17		1.05	0 41	0 66		1	2	2	2	nm
178	18.67	267.90	13.88	0 00	0.60	0.38	0.75	2	2	2	2	2	nm
179	125.42	269.20	15.51	0 17	0.81	0.47	0 91	2	2	2	2	2	nm
180	61 81	269 50	18.08		0.60	0 60	0 96		1	1	2	2	m
181	300.01	271.18	16.87		0.78	0.46	0.87		2	2	2	2	m
182	44.26	272.27	14.51	0.12	0.25	0.10	0 36	2	2	2	2	2	m
183	278 74	275.51	15.99	0 90	1.21	0.66	1.23	1	2	2	2	2	nm
184	104.03	277.21	17.51			0.40	0 81			2	2	2	pm
185	302.70	279.79	16 66			0.72	1 33			2	2	2	nm
186	54.97	280.79	16.95			0.61	1.21			2	2	2	nm
187	299 78	286.65	17.33		0.91	0.54	1 09		2	2	2	2	pm
188	23.78	286 67	12 14	−0.03	0.55	0.35	0 71	2	2	2	1	1	m
189	146.49	287 58	17 53		0.81	0.45	0 88		2	2	2	2	m
190	269 28	288 13	18.14			0.45	0.67			2	2	1	nm
191	92.82	288.20	17.27		0.67	0.45	0 96		2	2	2	2	m
192	152.66	290 57	18.05		0.75	0.52	0 96		2	2	2	2	m
193	318 38	290.76	15.11	0.15	0.31	0 19	0.38	2	2	2	2	2	m
194	359.03	291.13	11.97	−0 32	0 07	0 06	0.13	2	2	2	2	2	m
195	81.10	292.28	16.88		0.66	0.45	0.89		2	2	2	2	m
196	309.66	293.94	15.87	0.86	1.17	0 66	1 22	1	2	2	2	2	nm
197	205 49	299.52	17.75		0.83	0 54	0.96		1	2	2	2	m
198	284.61	300.23	13.01	−0 19	0 11	0.07	0.14	2	2	2	2	2	m

(*Continued*)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-R)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
199	194.52	303.52	18.32		1.19	0.61	1 15		2	2	2	2	m
200	280.70	303.62	16 04			0.72	1.35			2	2	2	nm
201	343.66	304.79	16 44			0 48	0.93			2	2	2	pm
202	78.73	305.57	16.71			0.65	1.27			2	2	2	nm
203	208.12	305 63	16 29	0.41	1.00	0 58	1 11	2	1	2	2	2	nm
204	116.04	308.42	16.40	0.06	0 74	0 40	0.86	2	2	2	2	2	m
205	22.65	308.64	17.69			0.46	0 91			2	2	2	m
206	97 72	309.07	16.37			0 72	1.37			2	2	2	nm
207	62.43	310.17	18.37		0 46	0.49	0 93		1	1	2	1	pm
208	361.80	314.63	15 48	0.09	0.63	0 38	0.77	2	2	2	2	2	pm
209	252.36	316.47	18.52		0.49	0.39	0.64		1	1	2	2	nm
210	293.25	317 04	18.31		1.00	0.43	0.75		1	2	2	2	pm
211	337.46	318 82	16.85			0 40	0 87			2	2	2	m
212	75.17	320.13	17 63			0 37	0.83			2	2	2	pm
213	24 50	323 26	17.21		0 57	0.32	0.69		1	2	1	1	pm
214	309 94	324.46	16 19	0.01	0 66	0.41	0.83	2	2	2	2	2	m
215	254 75	325 74	15.63	0 12	0.62	0.44	0 80	2	2	2	2	2	nm
216	34 96	327.43	17.04		0 89	0.55	1.08		2	2	2	2	pm
217	138 39	327.44	16 99		1.06	0 61	1.08		2	2	2	2	nm
218	211.23	328 37	14 49	0.15	0 46	0 30	0 56	2	2	2	2	2	nm
219	156.03	329 92	18 41			0.64	0.97			2	2	2	m
220	56.25	332.19	16.78			0.76	1.45			2	2	2	nm
221	377.59	332.49	17.68		1.44	0 65	1 19		2	2	2	2	pm
222	43 71	332.56	17.64		0.82	0.55	1 08		1	2	2	1	m
223	370.85	335 42	18.20		1.07	0.52	1.01		2	2	2	2	pm
224	293.89	335.84	17.82		0.84	0.42	0 88		2	2	2	2	m
225	231.47	336.49	16.38			0 74	1 43			2	2	2	nm
226	41.04	337 59	17.86		0 98	0.67	1.10		2	1	2	1	m
227	66.15	338.28	16.69		1 20	0.67	1.29		2	2	2	2	nm
228	203 24	340.22	17 37		0 87	0.53	0.91		2	2	2	2	m
229	247.68	341.17	16.57		0.53	0.43	0 77		2	2	2	2	m
230	287.55	342 10	16.50	0.37	0 88	0 54	0.95	1	2	2	2	2	nm
231	211.68	345.16	16.65		0.64	0 45	0 86		2	2	2	2	m
232	246.35	348 15	17.11			0.47	0 84			2	2	2	m
233	73.62	349 95	16.08	−0.07	0 68	0.38	0 79	2	2	2	2	2	m
234	61.81	350 55	13.36	0.22	0.75	0.45	0.86	2	2	2	2	2	nm
235	94.23	352.50	17 03			0 49	0.95			2	2	2	m
236	334 51	355.69	18 35		0.74	0.54	0.79		1	1	2	2	pm
237	267.66	364.45	17.99		0.57	0.35	0 79		1	2	2	1	nm
238	131.43	367 84	18.03			0.57	1.10			1	2	2	m

(*Continued*)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-R)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
239	264.39	368.17	17.31		0 81	0.44	0 84		1	2	2	2	m
240	124.93	368.31	16.34	0 27	0.75	0.47	1.01	1	2	2	2	2	pm
241	195.49	368.56	17.93		0.89	0.52	1.02		2	2	2	2	m
242	75.32	371.27	13.55	0.16	0.63	0 39	0.75	2	2	2	2	2	nm
243	350.44	372.14	13.47	−0.12	0.11	0 07	0.16	2	2	2	2	2	m
244	164.37	372.15	17.64		0 54	0.28	0.66		1	2	2	1	nm
245	281.26	372.95	17.96		0.83	0.56	1 01		1	2	2	2	m
246	148.07	376.15	15.43	−0.01	0.65	0.43	0.84	2	2	2	2	2	nm
247	171.57	381.96	15.94	0.13	0.53	0.34	0 66	2	2	2	2	2	m
248	226.93	383.45	17.58			0 43	0.80			2	2	2	pm
249	18.12	384.33	18.12			0 65	1 35			2	2	2	pm
250	316.76	387 44	12.28	1.26	1.29	0.72	1.31	2	2	2	2	1	m
251	120.05	390.87	15 32	0.49	0 95	0.53	0.99	1	2	2	2	2	nm
252	164.58	392.05	17 16		0 79	0 46	0.91		2	2	2	2	m
253	345.41	397.13	16.84			0 49	0.91			1	1	2	m
254	77.04	401.53	14.94	0.11	0 34	0.18	0.43	2	2	2	2	2	m
255	168 51	403.08	17 60		0.94	0 48	0.98		2	2	2	2	m
256	94.90	405 39	17.67			0.50	1.04			2	2	2	m
257	211.08	405.67	17.54		1.13	0.60	1.16		2	2	2	2	pm
258	175.54	405 79	15.59	0.15	0 79	0.46	0.88	2	2	2	2	2	nm
259	79.33	406.21	14.29	1.54	1 53	0 89	1.66	1	2	2	2	2	nm
260	106.08	407.71	17 36			0 43	0.82			2	2	2	m
261	346.25	407.92	18.25		0 94	0 71	1.26		1	1	2	2	m
262	238.92	408 23	15.40	1.10	1.36	0 80	1.51	1	2	2	2	2	nm
263	26.59	412 24	16 76		0.83	0.52	0.98		2	2	2	2	pm
264	119.30	412.53	16 52			0.70	1.36			2	2	2	nm
265	323.24	416.34	15.99	0.09	0 51	0.32	0 60	2	2	2	2	2	m
266	367.01	417.39	16.92		0.82	0.45	0.85		2	2	2	2	m
267	21.61	421.22	17.72		1.02	0.62	1.16		1	2	2	2	pm
268	130.43	421.82	16.41		1.37	0.78	1.45		2	2	2	2	nm
269	375.67	423.48	16 36	0 08	0.56	0.33	0.66	2	2	2	2	2	m
270	349 01	424.06	15.28	0.62	1.01	0 58	1 08	2	2	2	2	2	nm
271	246.32	426.52	11.73	0.17	0.73	0.44	0 82	2	2	1	1	1	m
272	261.53	427.26	17.77			0.56	1.30			1	2	2	pm
273	32.71	432.24	16 62			0 43	0.81			2	2	2	m
274	379.59	433.07	18.31			0 67	1 22			2	2	2	m
275	294.78	435.28	18.39		0.90	0.49	0 99		1	1	2	2	m
276	284.07	435.61	17.94			0.40	0 79			1	2	2	nm
277	122.08	437.13	17 52		0.75	0 54	1 11		1	2	2	2	m
278	10 07	440 70	17 24			0 61	1.32			2	2	1	pm

(*Continued*)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	(U – B) (mag)	(B – V) (mag)	(V – R) (mag)	(V – I) (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
279	339 86	442.82	17.06		0.69	0.41	0.80		2	2	2	2	m
280	274.92	444.77	14.74	0.12	0.26	0.15	0.31	2	2	2	2	2	m
281	81.16	445,32	15.77	0.05	0 67	0.38	0.76	2	2	2	2	2	pm
282	290.78	449.11	17.72			0.37	0.65			2	2	2	nm
283	26.21	449.50	17.18		0.88	0 44	0.85		2	2	2	2	m
284	259.55	454.10	18.18		1.01	0.52	1.08		1	1	2	2	m
285	120.63	456.71	17 22		0.97	0.34	0.83		2	1	2	1	pm
286	235.07	457.16	17 80		0.98	0.46	0.91		2	2	2	2	pm
287	217.06	460.70	16 86		0 89	0.51	0 95		2	2	2	2	m
288	257.67	463.40	17.49		0.85	0.44	0.91		2	1	2	2	m
289	69.07	464.16	15.45	0.03	0 64	0.41	0.77	2	2	2	2	2	nm
290	137.30	468.02	14 70	0.14	0.27	0.12	0.28	2	2	2	2	2	m
291	35.20	468.37	17.18		0 78	0.43	0.86		2	2	2	2	m
292	176.37	470.54	15.93	0.12	0 73	0.46	0.88	2	2	2	2	2	nm
293	285.25	472.07	14.99	0.10	0.34	0.14	0.42	2	2	2	2	2	m
294	136.71	472.48	14.84	0.00	0.61	0.38	0.73	2	2	2	2	2	nm
295	270.19	473.09	16.84		0 73	0.47	0.85		2	2	2	2	m
296	240.60	473.21	17.03		0.80	0.52	0.99		2	2	2	2	m
297	258.76	474.56	16.42		0.66	0 39	0.79		2	2	2	2	m
298	320.63	475.20	16.38		0.73	0.42	0 83		2	2	2	2	m
299	229.10	475.39	17.84		0.62	0.40	0.84		2	2	2	2	pm
300	115 66	477.29	18.17			0.36	0.89			2	2	2	pm
301	277.71	477.58	17.64		0.74	0.46	1.01		1	1	2	2	m
302	57.29	478.99	18 49			0.68	1.34			2	2	2	pm
303	148.84	479.65	16.61		0 81	0.43	0 86		2	2	2	2	m
304	41 05	480.57	17.54		0.96	0.52	0.94		1	2	2	2	m
305	209.95	482.03	18.32			0.52	1.04			2	2	2	pm
306	7.20	487.36	13.57			0.59	1.13			2	2	2	nm
307	229.98	487.54	16.19	0.07	0 79	0 38	0.79	2	2	2	2	2	m
308	282.90	489.79	16.66		1.30	0.63	1.27		2	2	2	2	nm
309	336.73	491.68	17 58		1 04	0 63	1.18		1	2	2	2	pm
310	60 73	493.09	14 79	0.35	0 97	0.55	1.04	2	2	2	2	2	nm
311	135.38	498.00	17 83		1.06	0.35	0.86		1	2	2	2	pm
312	335.12	499 68	16 24	0.05	0 59	0.33	0.67	2	2	2	2	2	m
313	286 90	499.87	16.81			0 44	0 87			2	2	2	nm
314	32 14	502 23	17.71		0 80	0 56	1.04		1	2	2	2	m
315	67 06	507.24	18 27		0.87	0.48	0 97		1	2	2	1	m
316	320.98	509 00	15.65	0 09	0.43	0.26	0 52	2	2	2	2	2	m
317	57 05	511.50	18 34			0.94	1.90			2	2	2	nm
318	186 41	512 32	17 97		0 91	0 44	1 04		1	2	2	2	m

(Continued)

Table 4. (Continued)

Star	X (pixel)	Y (pixel)	V (mag)	$(U-B)$ (mag)	$(B-V)$ (mag)	$(V-R)$ (mag)	$(V-I)$ (mag)	N_u	N_b	N_v	N_r	N_i	Remarks
319	305.46	512.43	16.23	0.65	1.21	0 68	1.29	1	2	2	2	2	nm
320	142 43	513.34	17.18		1 51	0 67	1.28		2	2	2	2	nm
321	94 71	514.08	17.02		1.16	0.57	1.18		2	2	2	2	pm
322	259 96	515.53	17 09		0.78	0.45	0.85		2	2	2	2	m
323	315.15	516.22	17 00		0.80	0 41	0 82		2	2	2	2	m
324	32.62	520.84	18 04		0 94	0 48	0 89		1	2	2	2	m
325	215.88	520.86	15.07	0.07	0.70	0.42	0.81	2	2	2	2	2	nm
326	150.43	522 09	16.62		0.84	0.47	0 93		2	2	2	2	pm
327	169.99	526.95	17.29		0.83	0 46	0.82		2	2	2	2	m
328	275.24	528.11	16 46	0.68	1.04	0.60	1.19	1	2	2	2	2	nm
329	94 51	528 25	17 03		0.75	0.41	0 86		2	2	2	2	m
330	189 86	531 38	13.96	0 43	0.89	0 50	0.92	2	2	2	2	2	nm
331	107.12	534 71	18.42		1.23	0.44	0.90		2	2	1	2	pm
332	13 83	535.17	17 15			0 14	0.37			2	2	2	nm
333	207 62	536.05	16.85		0.55	0 44	0.75		2	2	2	2	m
334	161.01	536.68	17 97		1.03	0 57	1 06		1	2	2	2	m
335	256.17	540 57	18 26		0.93	0 42	0 89		1	2	2	2	m
336	245 61	541 38	18.00			0.50	1.12			2	2	2	m
337	43.31	542.78	17.97		0.97	0.63	1 10		1	2	2	2	m
338	84 18	543 17	17.02		0.86	0.47	0.95		2	2	2	2	m
339	361.11	544 22	12 12	0.25	0.76	0.44	0 84	2	2	2	1	1	m
340	302.18	545.18	17 04		1.09	0 54	1 05		2	2	2	2	pm
341	309.21	547.76	15.82	0.10	0.75	0 43	0 81	2	2	2	2	2	pm
342	61.31	549.23	18 15		0 88	0.54	0.95		1	2	2	2	m
343	278.35	550.07	17 07		0.99	0 54	1.03		2	2	2	2	pm
344	116.40	552 75	17.94		0.63	0 31	0.60		2	2	2	2	nm
345	208.48	552.87	17.65		0 94	0.38	0.73		2	2	2	2	nm
346	306.73	553.84	17 09		0.49	0.22	0 50		2	2	2	2	nm
347	326.28	555.31	16.68		1.15	0 70	1.20		2	2	2	2	nm
348	15.88	557.85	15.54	0.23	0.86	0 53	1 00	2	1	2	2	2	nm
349	280.54	558.53	17 57		0.80	0.37	0 77		2	2	2	2	m
350	110 06	559.16	18.54		0.86	0 42	0.96		1	1	2	2	pm
351	193.88	560.50	16.56		1.26	0.64	1.16		2	2	2	2	nm
352	160.64	561.94	17.36		0.83	0.35	0 77		2	2	2	2	m
353	22.38	563.47	17.55		0.81	0 44	0.78		1	2	2	2	m
354	38.82	566.93	18 25		0.95	0.69	1.10		1	1	2	2	m
355	142.49	568.07	18.36			0.43	0.90			2	2	1	pm
356	78.47	569 79	13 43	−0.20	0 08	0.10	0.16	2	2	2	2	2	m
357	156.70	573.92	15 84	0.10	0.48	0 26	0.51	2	2	2	2	2	m
358	260.62	574 41	16.43		0.85	0.44	0 90		2	2	2	2	m

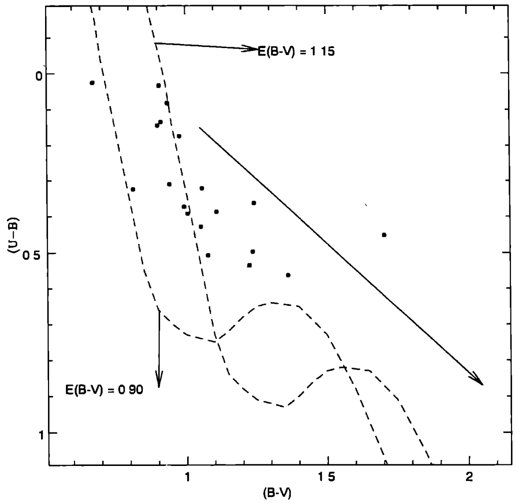

Figure 3. The $(U-B)$ versus $(B-V)$ diagram for Berkeley 79. The slope of the reddening line is 0.72 and is shown by continuous straight line. Arrow of this line indicates the direction of reddening. The two dotted curves represent the locus of Schmidt-Kaler (1982) ZAMS shifted in the direction of reddening for the values of $E(B-V)$ indicated in the diagram.

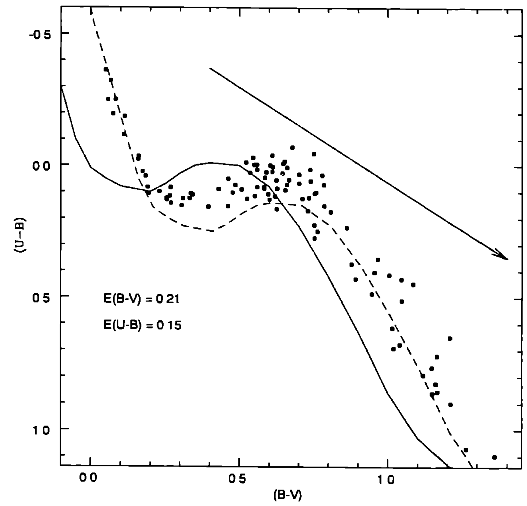

Figure 4. The $(U-B)$ versus $(B-V)$ diagram for Trumpler 11. The continuous curve represents the locus of Schmidt-Kaler (1982) ZAMS while the dotted curve is the same but reddened for a value of $E(B-V) = 0.21$ mag. Other explanations are the same as in figure 3

than A0. This yields a mean value of $E(B-V) = 0.21$ (±0.02) mag for Trumpler 11 while for Berkeley 79, the value of $E(B-V)$ varies from 0.9 to 1.2 mag. Most of the stars in Berkeley 79 have $E(B-V)$ close to 1.15 mag. It is interesting to note that the interstellar extinction values derived here for the clusters under study agree fairly well with the visual extinction values derived by Neckel & Klare (1980) at the cluster distances in the direction of their locations.

For determining the nature of interstellar extinction law in the direction of clusters we performed the following simple analysis. Inspection of the $(U-B)$ versus $(B-V)$ and apparent CM diagrams (figures 5 and 6) reveals that bright stars ($V < 15$ mag) with $(B-V) < 1.4$ mag in Berkeley 79 and with $(B-V) < 0.23$ mag in Trumpler 11 have spectral type earlier than A0. There are 14 such stars in Berkeley 79 and 13 in Trumpler 11. For these stars, the $(B-V)_0$, $E(B-V)$ and $E(U-B)$ values have been determined using the UBV photometric Q method (cf. Johnson & Morgan 1953; Sagar & Joshi 1979) and the calibration given by Schmidt-Kaler (1982). For calculating $E(V-R)$ value, we used the present $(V-R)$ measurement and $(V-R)_0$ value derived from Johnson's (1966) calibration between $(B-V)_0$ and $(V-R)_0$ after converting the $(V-R)_0$ values to the present photometric system using relations given by Bessel (1979, 1983). The $E(V-I)$ value has been calculated using Walker's (1985) calibration between $(B-V)_0$ and $(V-I)_0$, and the present $(V-I)$ value. The mean values of the colour excess ratios derived in this way are listed in table 5 for both the clusters. They are in good agreement with the normal values. This indicates that the law of interstellar extinction in the direction of both the clusters is normal.

5. Colour-magnitude diagrams and field star contamination

The apparent CM diagrams for Berkeley 79 and Trumpler 11 are shown in figures 5 and 6 respectively. A well defined cluster sequence is clearly visible in stars brighter than $V \sim 16$

Table 5. A comparison of the colour excess ratios with $E(B-V)$ for both star clusters with the corresponding values for the normal interstellar extinction law given by Schmidt-Kaler (1982) for $E(U-B)/E(B-V)$; by Alcala & Ferro (1988) for $E(V-R)/E(B-V)$ and by Dean *et al.* (1978) for $E(V-I)/E(B-V)$

Object	$E(U-B)/E(B-V)$	$E(V-R)/E(B-V)$	$E(V-I)/E(B-V)$
Normal interstellar	0.72	0.65	1.25
Berkeley 79	0.72 ± 0.01	—	1.31 ± 0 04
Trumpler 11	0.68 ± 0.02	0.59 ± 0.07	1.20 ± 0.10

mag. In fainter stars, width of the cluster sequence is large. This can be mainly due to large observational error ($\sigma \geq 0.15$ mag in $(B-V)$ at a given V; see table 2). Clearly, at fainter magnitudes, the luminosity functions of the clusters do not rise steeply enough to dominate the field star contamination and at cluster distances field and cluster stars will also occupy the same area in the CM diagrams. It is, therefore, difficult to separate field stars from the cluster members only on the basis of their closeness to the main populated area of the CM diagrams. However, the possibility of cluster membership is small for the stars located well away from the MS and we consider them as non-members (see tables 3 and 4). Other stars have been identified as probable members or members of the cluster depending upon their closeness to the MS in one or more apparent CM diagrams of the cluster. In this process scatter produced due to photometric errors, binaries, differential extinction etc. have been accounted properly. As present observations are unable to decide about the cluster membership of a few stars brighter than $V \sim 13$ mag, we consider them as cluster members in our further discussions. The membership status of each star decided in this way is listed in tables 3 and 4 for Berkeley 79 and Trumpler 11 respectively. To know the actual members from them, their precise proper motion and/or radial velocity measurements are required.

6. Distance to the clusters

In order to determine the distance modulus of the clusters, we have plotted intrinsic CM diagrams for Berkeley 79 and Trumpler 11 in figures 7 and 8 respectively. For plotting these figures, we have converted apparent V magnitude and $(B-V)$, $(U-B)$, $(V-R)$ and $(V-I)$ colours into intrinsic ones using the values of $E(B-V)$ and following relations for $E(U-B)$ (cf. Kamp 1974; Sagar & Joshi 1979); $E(V-R)$ (cf. Alcala & Ferro 1988); A_V and $E(V-I)$ (Walker 1987)

$$E(U-B) = [X + 0.05E(B-V)]E(B-V)$$

where $X = 0.62 - 0.3(B-V)_0$ for $(B-V)_0 < -0.09$ and $X = 0.66 + 0.08(B-V)_0$ for $(B-V)_0 > -0.09$;

$$E(V-R) = [E1 + E2 \times E(B-V)]E(B-V)$$

where $E1 = 0.6316 + 0.0713(B-V)_0$ and $E2 = 0.0362 + 0.0078(B-V)_0$;

$$A_V = [3.06 + 0.25(B-V)_0 + 0.05E(B-V)]E(B-V)$$

and

$$E(V-I) = 1.25[1 + 0.06(B-V)_0 + 0.014E(B-V)]E(B-V).$$

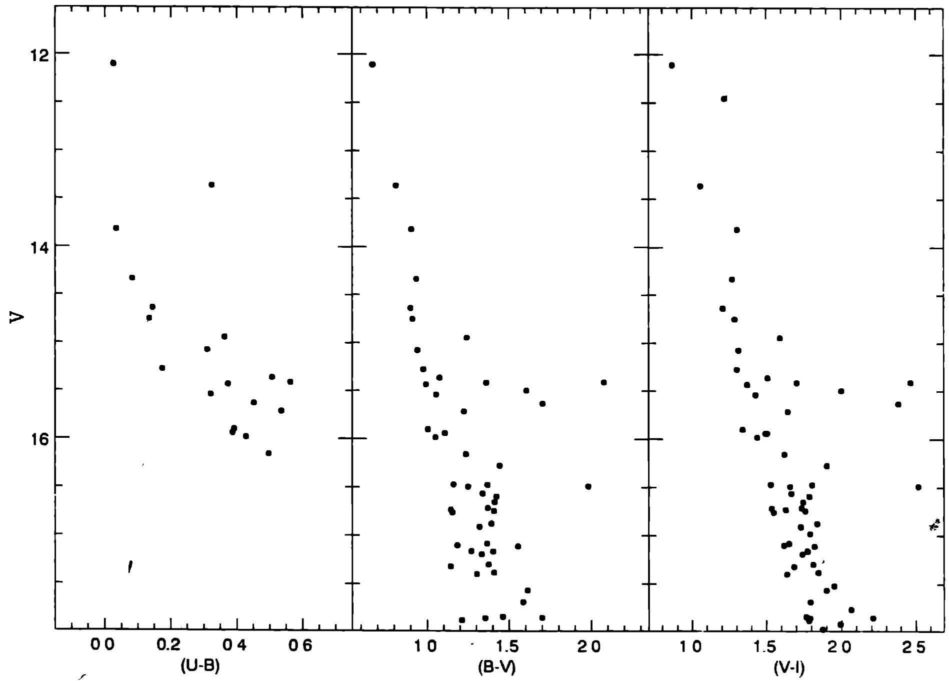

Figure 5. The V, $(U - B)$; V, $(B - V)$ and V, $(V - I)$ diagrams for Berkeley 79.

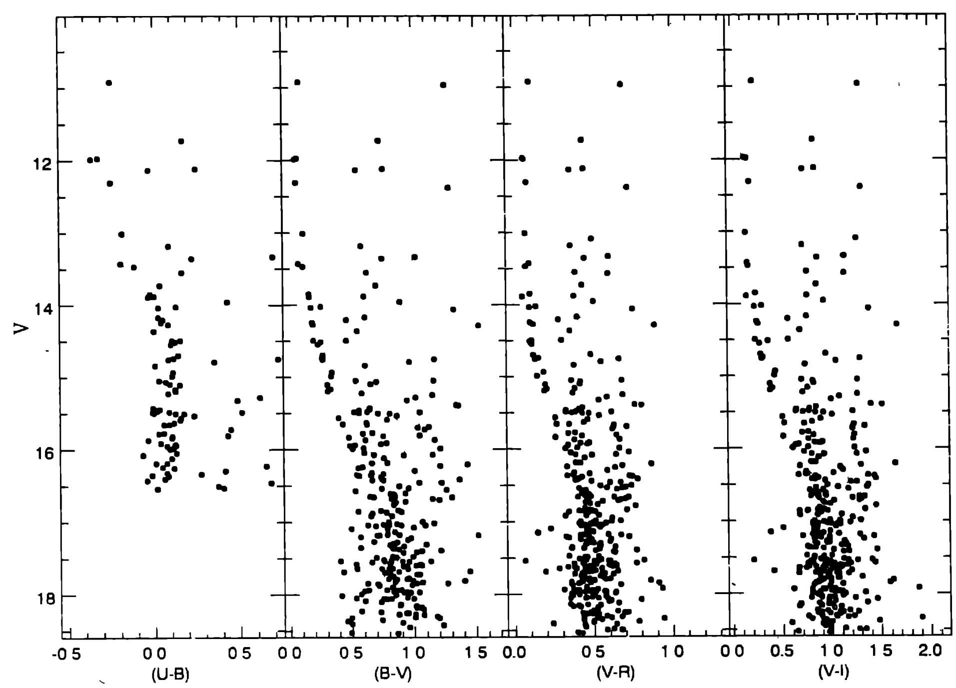

Figure 6. The V, $(U - B)$; V, $(B - V)$ V, $(V - R)$ and V, $(V - I)$ diagrams for Trumpler 11

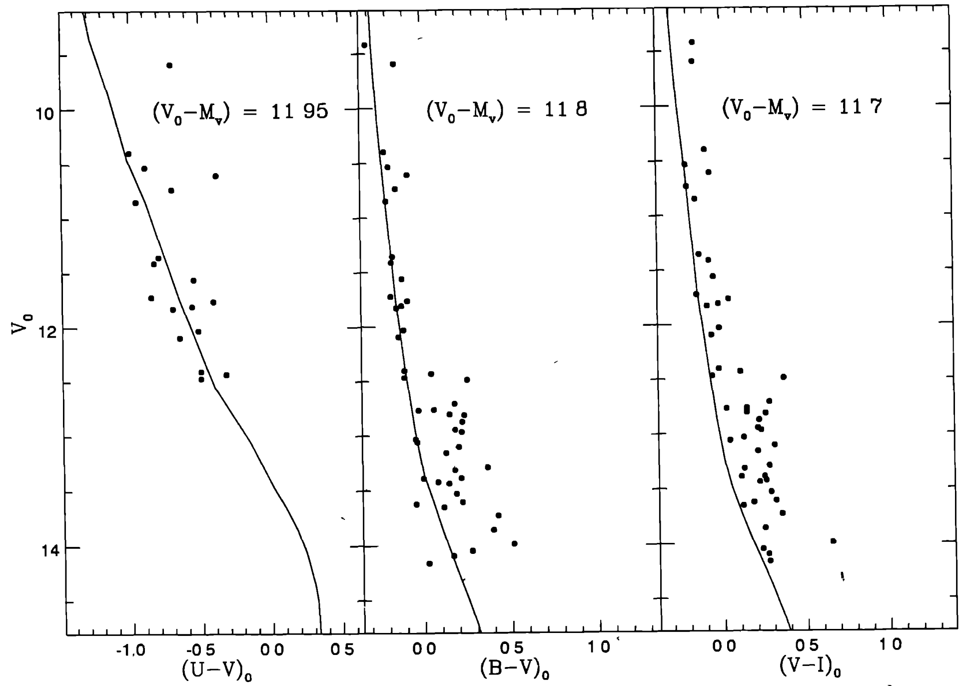

Figure 7. The V_0, $(U-V)_0$; V_0, $(B-V)_0$ and V_0, $(V-I)_0$ diagrams for the probable members of Berkeley 79. Continuous curves are the ZAMS fitted to the unevolved part of the cluster MS for the values indicated in the diagram The mean distance modulus $(m-M)_0$ to the cluster is 11 8 mag.

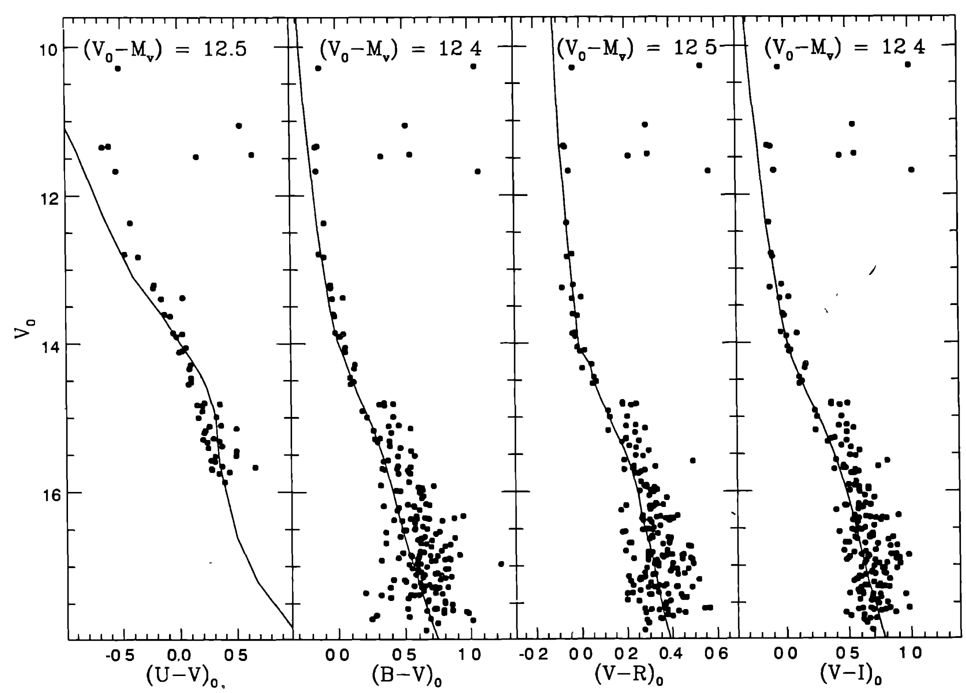

Figure 8. The V_0, $(U-V)_0$; V_0, $(B-V)_0$; V_0, $(V-R)_0$ and V_0, $(V-I)_0$ diagrams for the probable members of Trumpler 11. Continuous curves are the ZAMS fitted to the unevolved part of the cluster MS for the values indicated in the diagram The mean distance modulus $(m-M)_0$ to the cluster is 12.45 mag.

The individual values of $E(B-V)$ have been used for stars earlier than spectral type A0 (generally $V < 15$ mag) since they are known (see Section 4). For fainter stars, individual values are not known. So for them, we have used the median $E(B-V)$ value for the clusters i.e. $E(B-V) = 0.21$ for Trumpler 11 stars and 1.19 for Berkeley 79 stars.

In V_0, $(U-V)_0$ and V_0, $(B-V)_0$ diagrams, we fitted the ZAMS given by Schmidt-Kaler (1982) while the ZAMS given by Walker (1985) was fitted in the V_0, $(V-R)_0$ and V_0, $(V-I)_0$ diagrams. The $(V-R)_0$ colour for the ZAMS on the present photometric system was derived by converting Johnson (1966) $(V-R)_0$ colours using the relations given by Bessell (1979, 1983). After accounting for the colour dispersion expected from the error in observations, the visual fit of the ZAMS to the bluest envelope of the CM diagrams gives $(m-M)_0$ value indicated in figures 7 and 8. The mean values of $(m-M)_0$ are 11.8 ± 0.2 mag and 12.45 ± 0.2 for Berkeley 79 and Trumpler 11 respectively. The uncertainty is estimated from the errors in R, $E(B-V)$ and the errors in fitting the ZAMS. The distances to the clusters should be considered reliable because they have been derived by fitting the ZAMS over a wide range of the cluster MS. The distance modulus determined above yields a distance of 2.3 ± 0.2 kpc to Berkeley 79 and 3.1 ± 0.3 kpc to Trumpler 11.

7. Ages of the clusters

The M_v, $(B-V)_0$ diagrams for the probable cluster members of Berkeley 79 and Trumpler 11 have been plotted in figures 9 and 10 respectively. For this, extinction corrections have been applied as described in section 4 and the values used for true distance modulus of the clusters are 11.8 mag and 12.45 mag for Berkeley 79 and Trumpler 11 respectively. We have estimated the ages of the clusters by fitting the stellar evolutionary isochrones derived from

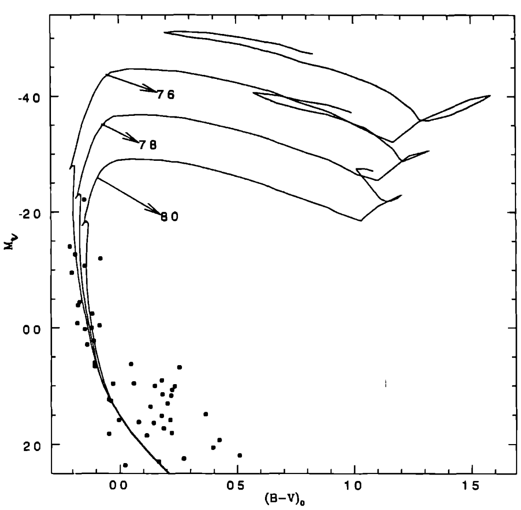

Figure 9. The M_v, $(B-V)_0$ diagram for the probable cluster members of the Berkeley 79. Isochrones from Schaller *et al.* (1992) which include the effect of connective core overshooting for Pop I stars have been fitted to the bright cluster members They indicate that the age of the cluster is ~ 65 Myr.

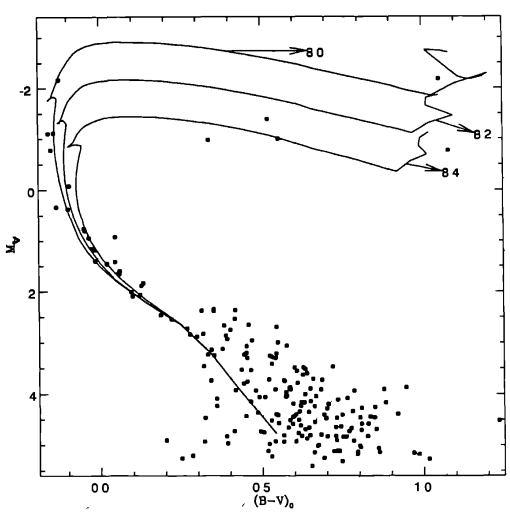

Figure 10. The M_v, $(B-V)_0$ diagram for the probable cluster members of Trumpler 11. Isochrones from Schaller *et al* (1992) for Pop I stars have been fitted to the bright cluster members They indicate that the age of the cluster is between ~ 100 to 250 Myr

Schaller *et al.* (1992) in the corresponding M_V, $(B-V)_0$ diagram. The isochrones are for Pop I stars and include the effects of convective core overshooting in the theoretical calculations. From the diagrams, the following inferences can be drawn.

As stellar evolutionary effects are not clearly visible in the diagram of Berkeley 79, we have determined the cluster age by fitting the isochrones to the bright MS stars. This gives an age of ~ 65 ± 30 Myr to Berkeley 79.

In Trumpler 11, stars brighter than $M_V = -0.5$ mag show evolutionary effects. As present observations are unable to decide their cluster membership status, an accurate estimation of the age of Trumpler 11 is not possible. The isochrone fitting to the bright MS stars and the brightest red giant indicates that the Trumpler 11 is ~ 100 Myr old while the isochrone fitting to those 4 stars which have $-1.5 \le M_V \le 0.5$ and $0.3 \le (B-V)_0 \le 1.1$ gives an age of 250 Myr to Trumpler 11. This may indicate that Trumpler 11 stars have age between 100 to 250 Myr.

Some of the fainter cluster members ($M_V \ge 4.5$ in Trumpler 11 and $M_V \ge 1.5$ in Berkeley 79) might be still in pre-MS stage of their evolution, if star formation process is coeval in the clusters under study. In order to ascertain this, further photometric, spectroscopic and H_α observations are needed.

8. Conclusions

The *U, B, V, R* and *I* CCD photometry down to $V \sim 18$ mag is presented for 60 and 358 stars in the regions of the star clusters Berkeley 79 and Trumpler 11 respectively. These observations enable us to determine cluster parameters accurately for the first time. The present work leads to the following conclusions :

(i) Visual fittings of the ZAMS to the cluster sequence in the intrinsic CM diagrams over a broad range of brightness give a distance of 2.3 ± 0.2 kpc to Berkeley 79 and 3.1 ± 0.3 to Trumpler 11.

(ii) Variable reddening seems to be present across the cluster Berkeley 79 with a median value of $E(B-V) = 1.19 \pm 0.05$ mag. The Trumpler 11 has uniform reddening across its face with a mean value of $E(B-V) = 0.21 \pm 0.03$ mag. This may mean that bright stars in Berkeley 79 have not yet been able to blow off the matter left over after star formation while those of Trumpler 11 have been able to do so. For this age difference between the two clusters might be responsible. The law of interstellar extinction in the direction of both the clusters is normal.

(iii) The Schaller *et al.* (1992) isochrones fitted to the bright stars in the M_V, $(B-V)_0$ diagram of probable members of the clusters indicate that age of Berkeley 79 is ~ 65 Myr while that of Trumpler 11 is between 100 to 250 Myr.

(iv) In the absence of kinematical data, it is difficult to separate unambiguously cluster members from the field stars only on the basis of present observations.

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