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Field star contamination in open star cluster NGC 2301

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Abstract. Photographic photometry of about 900 stars down to $V = 17$ mag has been carried out in the region of the open cluster NGC 2301. The cluster region seems to be severely contaminated by field stars. Statistical criteria yield only 96 ± 17 cluster members. Stars fainter than $V \sim 15$ mag are found to be absent among cluster members. Star counts indicate a diameter of ~ 20 arcmin. The data suggest mass segregation in the cluster.

Key words : open cluster—photographic photometry—star counts

1. Introduction

As open clusters are generally found in the galactic disc, they are projected against rich stellar backgrounds. The separation of cluster members from the field stars is essential for a number of astrophysical investigations and is done using one or more criteria namely kinematical, photometric or spectroscopic, and statistical (cf. Sagar 1985 and references therein). Proper motion data can provide a better method of segregation of cluster stars from the field stars only if the measuring accuracy is good enough to separate their motion; and the extent of their separation depends on the extent of differentiation between their motion (Vasilevskis 1962; Sagar 1987). As the accuracy of the proper motion determination is often low, particularly for the faint stars—and stars exist in the field whose proper motions are more or less identical to those of cluster members—it becomes difficult to get a contamination-free sample of cluster stars.

In the photometric method, stars not falling on the main sequence or among the giants in the colour-magnitude diagrams of the cluster are classified as non-members. Because of the presence of binaries in the cluster and the definition of the main sequence itself for fainter stars, the colour-magnitude diagram becomes cluttered with the non-members and the main sequence becomes poorly defined as is evident in figure 2.

On the other hand, the statistical method can provide a relatively reliable number of members without picking them individually. Such members can be used to study the luminosity function and structure of the cluster. For this purpose, one needs to know the distribution of field stars in the areas located at such a distance from the cluster center that the probability of the presence of cluster stars is negligible but still its distribution can be safely assumed as the distribution of field stars in the cluster region. Recently Mohan *et al.* (1988) (hereafter called paper I), have carried out the star counts in two fields, each of 4 cm $\times$ 4 cm (plate scale = 67 arcsec^{-1} mm), totalling $\sim$ 1 square degree. The fields are located towards east and west side of the NGC 2301 at a distance of $\sim$ 11 arcmin from the cluster centre. This study has provided us an opportunity to estimate the field star contamination in this cluster.

NGC 2301 (C 0649 + 005) classified as I3r by Trumpler (1930) has been photometrically observed in the *UBA* system by Hoag *et al.* (1961), Grubissich & Purgathofer (1962 $\equiv$ GP) and Mostafa *et al.* (1983). There exist two proper motion studies one by Van Schewick *et al.* (1967) and another by Aiad (1986) but these surveys are limited to relatively bright magnitudes. The photometries by Hoag *et al.* and GP barring a few stars are limited to $V \sim 15$ mag. For this cluster a distance of 750 pc, an angular diameter of 15 arc min, $E(B-V) = 0.04$ mag and an age of 1.0 to 1.4 $\times$ 10^8 yr have been reported in the literature (Lynga 1984).

The purpose of this paper is to extend the photometry to fainter magnitudes and to investigate the structure of the cluster using star counts.

2. Observations and reductions

The plates taken with the 90/150 cm CERGA Schmidt (Heudier 1978) have been used to study the cluster NGC 2301. In all we have six plates, two plates in each of the colours *V*, *B*, and *U*. The emulsion and filter combinations are IIaD + GG 495 for *V*, IIaO + GG 385 for *B* and IIaO + UG1 for *U*. The IIaO plates have been hypersensitized by baking with forming gas.

The plates have been digitized using the PDS microdensitometer of Nice observatory with an aperture size of 20 μm $\times$ 20 μm with a step of 20 μm both in X and Y axes. The higher precision and measuring speed of this machine and automatic nature of its operation make it a useful tool for photometric studies of large numbers of stars, like the present one. On each plate, a region of 2 cm $\times$ 2 cm centreed on the cluster has been scanned in the way described in paper I. The image processing has been done using the photometric programs of image processing system STII described in paper I.

2.1. Calibration of the plates

Hoag *et al.* (1961) have given a photoelectric sequence in the open cluster NGC 2301 which is limited to $V = 14$ mag. This sequence was further extended using CCD observations of the cluster obtained with the 3.6 m Canada-France-Hawii telescope. The CCD measures have been processed using the IHAP image

processing package and a stellar profile fitting program developed by C. Motch (Bienayme *et al.* 1987). CCD measures thus obtained and further calibration details are given in paper I. In all we have about 30 stars to calibrate the plates down to $V = 17$ mag. The rms residues of the calibration are 0.08, 0.11 and 0.15 mags for V, B, and U respectively. The precision of measurements estimated from the plate to plate rms deviations varies from 0.06 mag for $V = 11$ mag to 0.08 mag for $V = 17$ mag; from 0.08 mag for $B = 12$ mag to 0.10 mag for $B = 19$ mag; and from 0.07 mag for $U = 12$ mag to 0.15 mag for $U = 19$ mag. The UBV magnitudes and colours of the stars thus obtained (for $V = 11.0$ to 17.0 mag) are given in table 1.

Table 1. *UBV* data for stars in the region of NGC 2301. Stars observed by others have been identified. Numbers prefixed by G, H and A stand for Grubissich & Purgathofer (1962), Hoag *et al.* (1961) and Aiad (1986) respectively.

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
1		9.50	−9.72	14.62	1.32	1.19
2		−1.43	−9.62	15.19	0.71	0.27
3		9.60	−9.64	14.03	0.78	0.10
4		7.72	−9.59	16.51	1.75	1.20
5		5.18	−9.57	16.11	0.74	0.81
6		7.99	−9.56	14.82	0.68	0.35
7		5.06	−9.46	16.85	0.90	0.55
8		8.42	−9.54	15.40	0.67	0.82
9		6.74	−9.52	16.65	0.89	0.58
10		−9.55	−9.47	13.06	0.65	0.13
11		−9.42	−9.49	14.38	0.79	0.29
12		−3.58	−9.48	16.86	1.01	0.63
13		−2.88	−9.47	14.14	0.80	0.63
14		−9.71	−9.46	14.03	0.50	0.20
15		9.53	−9.42	16.22	0.83	0.61
16		−6.46	−9.38	16.63	2.11	
17		5.54	−9.35	14.48	0.63	0 12
18		2.99	−9.35	16.15	1.73	1.20
19		9.48	−9.33	15 37	0.96	0.59
20		−2.46	−9.29	16.76	0.57	0.35
21		−6.87	−9.29	11.07	0.82	0.89
22		6.48	−9.26	15.63	0.50	0.88
23		−8.63	−9.27	16.09	1.65	1.30
24		7.88	−9.26	16.20	0.84	0.64
25		1.33	−9.25	13.76	0.40	0.08
26		−7.08	−9.16	16.93	1.06	
27		−9.29	−9.15	15.76	0.62	0.65
28		−4.32	−9.12	14.87	0.72	0.28
29		5.91	−9.12	15.00	1.40	1.23
30		3.21	−9.08	16.59	0.97	0.61
31		−9.50	−9.07	16.23	1.00	0.63
32		−0.14	−9.07	12.44	0.17	0.32
33		5.53	−9.08	13.19	0.26	0.25
34		8.45	−9.07	14.59	0.66	0.67
35		−6.27	−9.06	16.78	0.81	0.70
36		−2.75	−9.06	16.03	1.34	1.59
37		9.40	−9.06	14.10	1.46	1.40
38		−9.24	−9.00	14.24	1.39	1.07
39		−7.56	−8.99	15.46	0.94	0.57
40		−4.03	−9.00	16.20	1.60	1.40

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
41		3.36	−8.97	14.54	0.58	−0.09
42		5.51	−8.94	14.78	0.48	0.13
43		0.78	−8.93	13.72	0.56	0.30
44		6.33	−8.91	14.65	0.49	0.50
45		−8.26	−8.84	12.47	0.25	0.31
46		−7.52	−8.81	14.31	0.36	0.37
47		−5.55	−8.78	15.79	0.81	0.51
48		6.20	−8.78	13.78	0.60	0.16
49		−5.95	−8.75	16.97	1.97	
50		4.35	−8.75	16.43	0.93	0.63
51		8.83	−8.74	14.70	1.43	1.31
52		−5.19	−8.70	12.30	2.30	2.81
53		−6.90	−8.68	16.22	0.76	0.44
54		0.26	−8.69	16.88	1.18	0.31
55		−8.55	−8.65	15.51	1.56	1.20
56		0.78	−8.63	16.11	1.03	0.82
57		5.92	−8.63	14.53	0.48	0.38
58		3.76	−8.61	14.27	0.47	−0.01
59		−4.07	−8.60	16.12	1.11	0.75
60		−6.08	−8.53	16.77	0.85	0.48
61		−9.09	−8.48	16.53	0.82	0.86
62		−2.42	−8.47	14.98	0.54	0.66
63		−8.18	−8.46	16.67	0.84	0.65
64		−8.45	−8.41	16.43	0.84	0.50
65		5.53	−8.42	15.78	0.78	0.82
66		−3.38	−8.39	16.42	0.64	0.92
67		6.96	−8.37	16.55	0.87	0.47
68		9.33	−8.32	16.51	0.51	0.53
69		1.59	−8.30	15.61	0.68	0.50
70		3.79	−8.31	13.77	0.55	0.02
71		−0.85	−8.23	14.66	0.50	0.38
72		−3.24	−8.21	14.57	0.60	0.18
73		6.73	−8.23	15.27	0.59	0.18
74		−4.78	−8.19	16.05	0.86	0.61
75		4.18	−8.19	16.75	1.09	1.07
76		6.96	−8.14	16.83	1.00	0.60
77		−4.21	−7.97	16.15	0.85	0.75
78		−3.28	−7.95	14.31	0.55	0.34
79		−2.71	−7.87	16.03	0.95	0.87
80		3.91	−7.86	15.58	0.98	0.50
81		8.07	−7.83	13.97	0.47	−0.09
82		6.00	−7.83	15.65	1.66	1.46
83	A202	−1.13	−7.77	13.19	1.41	1.48
84	A199	4.00	−7.74	13.06	0.16	0.19
85		−3.67	−7.70	15.46	1.87	1.80
86		1.68	−7.70	16.86	1.12	1.29
87		−6.31	−7.69	14.69	0.66	0.20
88		−5.08	−7.65	16.26	0.80	0.33
89		−1.63	−7.60	16.08	0.66	0.68
90		0.19	−7.60	16.37	1.08	0.67
91		−4.21	−7.58	13.45	0.36	0.10
92		−3.60	−7.51	12.39	0.66	0.42
93		−8.22	−7.51	14.28	1.48	
94		−5.88	−7.52	12.81	0.30	0.16
95		5.35	−7.53	15.07	0.77	1.22
96		−1.18	−7.48	16.60	1.17	1.21
97		−0.54	−7.47	15.51	0.88	0.69
98		4.34	−7.47	16.11	0.85	0.63
99		6.45	−7.49	16.87	0.94	0.61
100		0.35	−7.46	15.94	0.53	0 29

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	X (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
101		4.99	−7.46	15.36	0.66	
102		−1.77	−7.43	15.91	0.74	0.63
103		3.71	−7.48	11.08	2.24	
104		−7.17	−7.41	15.94	0.88	0.70
105		1.56	−7.43	16.43	1.07	1.26
106		5.19	−7.23	16.63	1.98	0.52
107	A201	1.89	−7.18	14.36	0.67	0.30
108		−5.74	−7.16	16.76	0.72	0.70
109		6.94	−7.14	16.59	0.91	0.57
110		−9.38	−7.14	16.30	0.87	0.55
111		6.66	−7.11	14.64	0.92	0.31
112		7.33	−7.08	16.19	0.77	0,65
113		−1.96	−7.05	14.53	0.53	0.23
114		3.92	−7.07	16.02	1.80	1.46
115		−6.42	−7.02	17.00	0.70	0.40
116		−3.50	−6.99	16.47	0.90	0.67
117		9.63	−6.99	16.63	0.73	0.97
118		−4.10	−6.94	16.81	1.22	1.94
119		−2.37	−6.88	16.69	0.97	0.76
120		0.05	−6.89	16.48	0.99	0.55
121		1.15	−6.91	15.55	0.69	0.63
122		−0.17	−6.84	16.79	0.86	0.94
123		−7.50	−6.82	15.66	1.20	1.15
124		−1.42	−6.79	16.28	0.82	0.47
125		−3.52	−6.76	16.95	1.02	0.33
126		−9.45	−6.74	15.66	1.43	1.30
127		1.88	−6.71	16.77	0.88	0.62
128		2.84	−6.72	14.58	0.70	0.19
129		5.28	−6.73	16.92	0.81	0.57
130		−8.02	−6.71	15.66	1.12	1.36
131	A203	−1.85	−6.67	11.30	0.10	0.15
132		−8.44	−6.69	16.93	0.91	0.35
133		−0.71	−6.69	15.78	0.86	0.56
134		1.43	−6.68	16.52	1.16	0.80
135		−5.75	−6.64	15.16	0.57	0.34
136	A204	−2.62	−6.60	13.22	0.52	0.37
137		−8.04	−6.49	15.27	0.67	0.37
138		−9.54	−6.47	13.53	0.34	0.14
139		−3.48	−6.43	14.78	0.45	0.08
140		7.76	−3.38	14.73	1.38	1.33
141		1.86	−6.32	15.97	0.95	0.81
142		−5.58	−6.30	15.86	0.84	0.60
143		6.93	−6.25	16.35	0.72	0.67
144		−9.26	−6.22	14.86	0.56	0.26
145		0.83	−6.20	15.10	0.44	0.48
146		7.49	−6.19	16.30	1.65	1.18
147		−9.13	−6.14	16.30	0.82	0.54
148		−9.32	−6.09	16.91	1.00	0.35
149		0.22	−6.09	15.27	0.72	0.72
150		−8.09	−6.04	16.92	1.81	
151		1.31	−6.02	15.06	1.43	1.57
152		7.56	−6.01	14.41	1.52	1.47
153		0.78	−5.86	16.94	0.97	0.56
154		−2.83	−5.87	16.70	0.75	0.55
155		−2.50	−5.86	15.25	0.87	0.80
156		−1.25	−5.84	15.57	1.62	1.49
157		−8.26	−5.83	16.98	0.86	0.73
158		−2.23	−5.81	15.64	0.70	0.95
159		−8.45	−5.79	14.47	0.53	0.44
160		−5.67	−5.72	16.41	1.02	1.06

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
161		−0.02	−5.71	16.70	1.00	0.47
162		−7.60	−5.68	16.97	0.93	0.51
163		8.29	−5.66	16.23	0.94	0.72
164		−7.28	−5.58	16.22	0.92	0.51
165		0.59	−5.55	15.88	0.61	0.65
166		7.23	−5.54	15.20	1.80	1.81
167		4.13	−5.52	15.15	0.80	0.55
168		−0.58	−5.50	16.61	0.97	0.81
169		−2.73	−5.48	15.30	0.59	0.74
170		4.24	−5.47	16.22	2.29	
171		−2.29	−5.44	16.42	1.12	0.95
172		−3.71	−5.42	15.95	0.97	1.00
173		−5.34	−5.38	15.31	0.81	0.52
174		1.38	−5.40	16.31	1.02	0.52
175		−3.49	−5.38	16.70	0.91	0.62
176		−5.68	−5.35	16.36	1.67	1.28
177		1.73	−5.31	15.77	0.78	0.50
178		−2.89	−5.28	15.98	1.55	1.16
179		−6.82	−5.27	15.56	1.36	1.27
180		−2.30	−5.24	15.54	0.94	0.55
181	A207	−7.51	−5.21	12.54	0.30	0.21
182	A157	−1.93	−5.20	12.79	0.38	0.20
183		1.57	−5.21	16.67	1.00	0.65
184		2.40	−5.14	15.91	0.88	0.73
185		−6.67	−5.12	16.66	0.68	0.46
186		−6.04	−5.14	16.51	1.64	1.13
187		9.50	−5.11	14.51	0.53	0.30
188		−9.30	−5.11	16.18	0.87	0.52
189		−9.84	−5.11	16.47	0.56	
190		−7.24	−5.05	15.85	0.91	0.48
191		−4.30	−5.06	16.33	0.85	0.40
192		3.84	−5.01	14.88	1.51	1.25
193		−7.02	−4.87	14.10	0.49	0.02
194		−0.91	−4.96	14.86	0.74	0.59
195		7.08	−4.96	16.58	0.83	1.01
196		5.11	−4.93	16.15	0.90	0.66
197		0.80	−4.91	16.82	1.15	0.31
198		−6.50	−4.90	15.26	0.40	0.58
199		−2.23	−4.87	16.57	0.76	0.63
200	A139	3.53	−4.69	13.24	0.28	0.17
201		−1.76	−4.67	16.29	0.92	0.59
202		1.62	−4.69	16.35	0.99	0.80
203		3.69	−4.69	16.71	1.80	
204		−4 81	−4.67	14.65	0.85	0.56
205		−9.87	−4.56	16.97	1.70	0.61
206	A138	3.90	−4.58	13.49	0.45	0.10
207		−0.69	−4.55	14.35	0.61	0.20
208	A198	7.12	−4.56	13.69	0.32	0.41
209		−4.91	−4.53	14.17	0.65	0.38
210		8.18	−4.51	15.73	0.63	0.45
211		−6.82	−4.51	15.19	0.55	0.33
212		−7.96	−4.47	16.28	0.86	0.73
213		0.10	−4.49	16.65	0.83	0.68
214	A114	2.15	−4.46	12.97	0.65	−0.09
215		−3.24	−4.41	16.42	0.83	0.49
216		−7.67	−4.36	15.60	0.75	0.41
217		−3.93	−4.36	15.14	0.54	0.53
218		−1.08	−4.34	15.49	0.66	0.48
219		−8.28	−4.27	14.82	1.16	1.38
220		3.75	−4.29	15.90	0.91	0.24

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (man)	$B-V$ (mag)	$U-B$ (mag)
221		−1.65	−4.17	15.11	0.63	
222	A115	1.15	−4.26	13.90	0.58	−0.31
223		−0.06	−4.21	15.88	1.24	0.86
224		2.43	−4.22	16.26	1.12	0.98
225		9.16	−4.23	15.92	0.84	0.43
226		−8.72	−4.20	16.10	0.95	1.09
227		1.31	−4.18	16.98	1.15	0.43
228		−6.52	−4.16	15.11	0.98	0.89
229		−4.50	−4.10	15.03	0.66	0.26
230		−1.38	−4.13	14.57	1.60	1.78
231		−4.94	−4.08	15.65	1.07	1.08
232		−6.81	−4.06	14.93	0.88	0.57
233		6.34	−4.07	16.51	1.59	1.00
234		0.98	−4.04	16.99	1.91	
235		8.54	−4.07	15.88	0.62	0.75
236		5.09	−4.02	15.77	0.65	0.76
237	A205	−5.87	−3.97	12.59	0.24	0.23
238		−5.08	−3.96	14.30	1.30	1.19
239		−0.62	−3.96	14.66	1.44	1.40
240		4.30	−3.95	15.09	1.46	1.10
241	A197	7.21	−3.97	12.32	0.46	0.21
242		−2.92	−3.94	15.28	0.74	0.32
243		−9.33	−3.88	16.91	0.81	0.92
244		−1.05	−3.81	15.62	0.94	0.61
245	A137	5.42	−3.86	13.27	0.33	0.02
246		0.62	−3.83	15.99	0.86	0.31
247	A194	8.44	−3.84	13.87	0.40	0.11
248		6.37	−3.77	16.55	1.03	0.92
249		−1.88	−3.76	16.70	0.54	0.81
250		−7.27	−3.75	16.28	1.48	1.45
251		5.52	−3.72	15.28	0.71	0.33
252	A136	5.21	−3.69	13.83	0.51	0.11
253		3.61	−3.68	16.35	0.77	0.57
254		−9.38	−3.66	16.17	0.92	0.52
255	A94	1.97	−3.63	13.80	0.57	−0.10
256		3.21	−3.64	16.65	2.05	1.67
257		−7.29	−3.62	14.73	0.75	0.38
258		7.51	−3.62	15.38	0.84	0.85
259	A95	0.22	−3.56	13.95	0.50	0.11
260	A135	5.46	−3.55	14.09	0.73	0.17
261		−6.16	−3.54	15.03	0.57	0.48
262		−0.02	−3.54	15.52	0.88	0.81
263	G114, A113	4.55	−3.54	12.22	0.21	0.28
264	A195	7.72	−3.55	14.07	0.57	0.13
265		9.09	−3.54	15 41	0.78	0.41
266		−6.44	−3.52	15.71	0.71	0.72
267		−5.15	−3.47	15.33	0.59	
268	A117	−2.09	−3.44	13.70	0.44	0.38
269		−4.33	−3.42	16.25	0.65	0.88
270	A116	−1.51	−3.37	13.45	0.33	0.18
271		5.18	−3.38	16.61	1.06	0.98
272	A196	9.34	−3.36	14.31	0.61	0.19
273		−5.85	−3.34	16.59	0.84	0.57
274		−0.88	−3.34	16.05	1.24	1.30
275		8.43	−3.34	16.68	0.83	1.08
276		−9.62	−3.22	13.68	0.36	0.22
277		−9.46	−3.22	16 83	0.46	
278		−6.77	−3.23	16.51	0.64	0.72
279		−2.84	−3.20	16.66	1.02	0.51
280		1.43	−3.20	16.68	0.57	0.68

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	B − V (mag)	U − B (mag)
281		1.70	−3.16	16.61	1.64	0.81
282		4.37	−3.13	16.64	1.17	0.98
283		4.51	−3.12	16.37	1.01	0.85
284		4.79	−3.11	16.90	1.42	1.20
285		7.79	−3.05	15.72	0.77	0.75
286		8.50	−2.98	15.84	0.85	0 89
287	G113, H50, A112	4.86	−2.95	13.40	0.73	0.36
288		9.11	−2.94	15.97	0.84	0.42
289	A206	−5.88	−2.93	12.53	0.48	0.08
290		0.98	−2.92	15.12	0.94	0.27
291	A141	−4.20	−2.88	14.13	0.56	0.10
292		−6.06	−2.86	16.50	1.72	1.12
293		−3.20	−2.84	15.08	0.73	0.43
294		7.13	−2.83	16.70	1.25	0.97
295		−9.01	−2.82	16.26	0.94	0.63
296	A74	0.74	−2.83	14.52	0.45	0.51
297		−1.15	−2.73	16.41	1.35	1.25
298		4.10	−2.74	16.04	0.77	0.63
299		6.17	−2.74	16.10	0.82	0.86
300		9.23	−2.75	15.32	0.48	0.60
301		−1.56	−2.67	16.45	1.18	1.15
302		4.65	−2.64	16.62	1.19	1.57
303		8.88	−2.65	16.19	1.59	1.30
304		−3.81	−2.53	16.37	0.92	0.45
305	G115	3.33	−2.53	14.16	1.65	1.46
306	A193	8.17	−2.54	11.40	0.25	0.17
307	A159	−5.05	−2.48	14.41	0.44	0.40
308		1.28	−2.45	16.23	0.88	0.39
309		−9.82	−2.37	13.41	0.23	0.39
310		−1.44	−2.37	15.99	0.69	0.57
311		7.27	−2.38	15.41	0.78	0.63
312		−5.60	−2.35	15.86	0.49	0.43
313	G116	3.20	−2.37	14.58	0.83	0.49
314		−7.72	−2.32	16.81	1.84	
315	A211	−7.52	−2.30	13.35	0.64	0.32
316		−5.24	−2.23	15.90	0.85	0.51
317		1.33	−2.24	15.32	0.85	0.47
318		−1.44	−2.20	16.19	1.85	
319		3.08	−2.19	16.22	0.99	0.43
320	G121, A75	−0.55	−2.13	13.36	0.41	0.09
321		−8.53	−2.11	15.68	0.85	0.58
322		4.72	−2.05	16.17	0.84	0.57
323		1.99	−2.04	16.68	1.17	0.80
324		−4.94	−2.03	14.74	1.35	1.83
325		−4 60	−2.02	15.94	0.92	0.75
326		−5.82	−1.96	16.86	1.66	1.39
327		−4.21	−1.96	15.57	0.66	0.43
328		9.22	−1.98	16.69	0.66	0.78
329		−9.63	−1.91	16.78	0.78	1.00
330		3.27	−1.90	15.60	0.86	0.62
331	A208	−6.43	−1.85	13.79	0.42	0.09
332		−6.94	−1.84	15.87	2.01	
333		9.29	−1.81	16.17	0.86	0.57
334	G126, A142	−4.59	−1.74	11.07	−0.02	0.10
335		9.16	−1.73	14.65	1.74	1.86
336		−5.72	−1.71	16.24	1.09	1.07
337		−4.86	−1.73	15.66	0.67	0.42
338		0.11	−1.67	15.99	1.07	0.82
339	G117	2.61	−1.68	14.78	0.74	0.35
340	G120, H48, A62	0.79	−1.66	13.34	0.58	0.20

Contd.

Table 1—*Contd.*

Number	Cross identifications	*X* (mm)	*Y* (mm)	*V* (mag)	*B* − *V* (mag)	*U* − *B* (mag)
341	G111, A134	6 88	−1.66	13.56	0.33	0.08
342		3.09	−1.64	15.99	1.11	0.57
343	G112, A92	4.52	−1.64	14.48	0.59	0.08
344		−1.46	−1.61	16.74	0.78	0.53
345		2.02	−1.62	15.84	0.93	0.88
346		9.66	−1.61	16.93	0.48	0.89
347	G127, A118	−4.42	−1.58	12.13	0.18	−0.11
348	G118	2.21	−1.54	14.07	1.71	1.73
349		2.94	−1.54	15.84	1.16	0.43
350		8.69	−1.55	14.74	0.74	0.56
351	A209	−6.63	−1.51	12.25	1.48	1.64
352	A191	9.15	−1.50	12.65	−0.03	0.51
353		−9.06	−1.47	14.40	1.21	1.16
354		−5.31	−1.46	15.24	0.75	0.32
355		5.57	−1.41	16.60	0.93	0.68
356		3.64	−1.38	15.36	0.86	0.38
357		0.07	−1.38	16.69	0.97	0.56
358		4.89	−1.29	16.94	0.95	0.83
359		1.60	−1.22	15.23	0.70	0.24
360	A210	−7.57	−1.21	11.52	0.09	0.03
361	G122, A96	−2.68	−1.03	14.29	0.53	0.18
362		−5.68	−1.02	16.71	1.09	1.24
363		6.78	−1.01	16.90	1.00	0.66
364		8.45	−1.02	14.78	0.48	0.31
365		3.26	−1.00	16.56	1.07	0.34
366		−3.84	−0.98	14.55	0.70	0.09
367		9.12	−0.98	14.82	0.71	0.57
368		−4.72	−0.92	14.97	0.54	0.05
369		9.29	−0.88	15.21	0.84	0.63
370		−0.25	−0.85	15.88	0.97	0.77
371		0.42	−0.85	16.98	1.00	0.88
372	G128, A119	−4.57	−0.82	11.16	0.10	−0.04
373		4.71	−0.81	15.57	0.98	0.91
374	G123	−3.15	−0.79	14.45	0.82	0.60
375		5.50	−0.78	16.86	0.93	0.97
376		−9.33	−0.75	16.87	0.80	0.82
377		−8.95	−0.75	16 58	1.11	1.06
378		−5.60	−0.72	15.44	0.84	0.52
379	A190	8.43	−0.69	14.43	0.65	0.27
380	G31, H60, A45	1.92	−0.66	13.81	0.69	0.02
381	G110, A111	6.78	−0.66	12.88	0.22	0.23
382		−0.62	−0.62	14.70	0.59	0.36
383	G124, A97	−3.34	−0.61	12.86	0.26	0.14
384		8.62	−0.61	15.77	0.75	0.60
385		−8.63	−0.55	13.95	0.54	0.49
386	A188	9.17	−0.55	13.75	0.41	0.04
387		−9.52	−0.53	15.61	0.65	0.41
388		−3.15	−0.53	16.84	1.76	1.15
389	G109, A91	5.63	−0.52	13.82	0.56	0.27
390		7.31	−0.48	16.43	0.86	0.55
391	A160	−6.23	−0.46	14.09	0.51	0.09
392		0.81	−0.45	16.82	1.24	1.02
393		−1.62	−0.42	16.63	1.26	0.94
394		3.20	−0.41	15.16	0.98	0.89
395	G30, H27, A42	2.46	−0.38	11.99	0.44	−0 02
396		4.04	−0.38	15.39	1.71	1.51
397	G32, H69, A44	1.84	−0.36	14.15	0.60	−0.06
398		−4.57	−0.34	16.91	1.49	0.86
399		−6.20	−0.30	15.44	1.96	2.20
400		4.52	−0.33	16.55	1.04	0.62

Contd.

Table 1—*Contd.*

Number	Cross identifications	*X* (mm)	*Y* (mm)	*V* (mag)	*B* — *V* (mag)	*U* — *B* (mag)
401	G43	0.93	−0.31	14.86	0.70	0.01
402	G129, A120	−4.88	−0.26	11.04	−0.03	0.05
403	G29, H51, A60	3.02	−0.27	13.61	0.57	−0.09
404		−7.87	−0.20	15.62	0.48	0.64
405		6.98	−0.13	16.98	0.72	0.74
406		−4.59	−0.10	14.73	0.65	0.27
407		−2.95	−0.11	15.60	0.81	0.72
408		−1.58	−0.09	15.80	0.73	0.70
409	G44, H41, A16	0.54	−0.08	12.68	1.00	0.60
410	G42, H52, A15	1.17	−0.08	13.55	0.53	−0.01
411	G33, H63, A43	1.79	−0.09	13.90	0.54	0.02
412		4.62	−0.07	14.16	2.12	2.44
413		4.40	−0.04	16.31	1.15	0.99
414		6.51	−0.03	16.06	0.80	0.66
415		−2.69	−0.02	15.88	0.75	0.54
416		8.00	−0.02	16.87	0.89	0.26
417		3.35	0.03	15.75	0.89	0.56
418		6.20	0.03	14.68	0.78	0.90
419	G46, H22, A47	−0.88	0.05	11.69	0.14	0.16
420		0.24	0.08	16.35	1.30	1.25
421		2.35	0.05	16.47	1.02	0.51
422		1.40	0.10	16.63	0.93	0.70
423		9.59	0.08	15.44	0.83	0.53
424	A121	−5.44	0.14	15.69	0.68	0.65
425		−8.71	0.16	14.35	0.55	0.35
426		−1.59	0.18	16.53	0.92	0.81
427	G47, H66, A48	−0.90	0.20	14.10	0.65	−0.17
428		1.32	0.20	16.46	1.29	0.97
429		2.03	0.19	15.99	1.00	
430		−3.44	0.25	14.49	1.89	2.07
431		6.57	0.23	15.11	0.81	0.92
432		−1.70	0.26	16.27	1.35	1.43
433		0.43	0.29	16.83	1.14	1.74
434		3.49	0.28	15.05	0.86	0.35
435		3.95	0.28	16.26	1.44	1.09
436		−3.77	0.31	14.76	0.52	−0.07
437		−3.01	0.36	16.17	0.95	0.98
438		5.25	0.37	17.00	1.35	
439	G131, A143	−6.57	0.41	13.20	0.38	0.05
440		−3.95	0.41	16.86	0.75	0.59
441	G48, H35, A19	−0.36	0.39	12.34	0.53	0.00
442		1.76	0.44	14.71	0.72	0.18
443		6.91	0.44	16.32	1.02	1.26
444		−8.13	0.46	16.22	0.63	0.58
445	G35, H15, A40	2.71	0.52	11.30	0.35	−0.22
446		9.25	0.56	15.21	0.82	0.55
447		−3.25	0.56	16.23	1.00	0 58
448		−2.30	0.59	15.98	0.86	0.79
449		−0.24	0.57	14.94	0.77	0.31
450	G36, H55, A41	2.57	0.60	13.70	0.58	−0.21
451		9.16	0.59	15.78	0.75	0.38
452		−4.42	0.65	16.96	1.03	0.75
453	A133	7.89	0.67	14.56	0.45	0.44
454		8.97	0.65	14.51	0.43	0.44
455		−0.96	0.68	15.20	1.53	1.36
456		3.74	0.69	15.19	0.83	0 44
457		−0.57	0.70	16.11	0.97	0.34
458		1.17	0.69	16.27	1.24	0.91
459		6.62	0.70	15.79	1.03	0.61
460		−4.00	0.70	15.69	1.52	1.27

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
461		3.12	0.73	16.74	1.00	0.72
462		7.68	0.71	15.87	1.68	1.20
463		1.70	0.73	15.44	1.04	0.34
464		−2.59	0.76	14.54	2.87	
465	G51, H44, A17	0.60	0.76	12.98	0.35	0.14
466		−6.95	0.81	15.00	0.69	0.47
467		3.38	0.81	15.60	0.94	0.64
468		4.32	0.79	16.46	1.21	1.27
469		−6.51	0.82	16.98	0.89	0.58
470	G66, H68, A51	−1.80	0.87	14.08	0.49	
471		−3.95	0.87	15.53	0.64	0.56
472		3.92	0.86	15.65	0.82	0·59
473		4.99	0.87	16.94	1.73	
474		−9.01	0.88	15.36	0.65	0.35
475		−5.81	0.88	16.53	1.25	1.10
476	G71, A76	−4.16	0.93	11.26	0.48	0.07
477	G49. H47, A20	−0.54	0.92	13.15	0.39	0.04
478	G50, H37, A18	0.37	0.94	12.61	0.36	0.07
479		0.05	0.94	16.16	0.91	0.94
480	G37, H24, A39	3.04	0.96	11.91	0.62	0.29
481		−6.09	0.99	16.67	1.26	1.52
482		1.07	1.03	16.57	1.09	
483		2.78	1.03	16.59	1.32	0.50
484		0.98	1.05	16.59	1.52	
485	G65, A50	−1.34	1.10	14.51	0.56	0.20
486	G38, H14, A11	2.37	1.09	11.06	0.21	−0.27
487	G52	0.77	1.11	14.86	0.78	0.13
488		4.03	1.10	12.45	0.34	0.13
489		−8.10	1.11	16.40	1.02	0.54
490	G106, A132	7.31	1.12	12.03	0.48	−0.31
491	G67	−2.15	1.14	14.65	0.57	0.17
492		−6.29	1.18	16.95	1.14	0.43
493	A187	9.26	1.20	15.33	0.77	0.66
494	G53, H74	0.44	1.24	14.52	0.80	0·15
495	G107, A90	6.12	1.25	11.50	0.13	0.32
496		−8.80	1.30	14.61	0.57	0.09
497	G69, H40, A52	−2.48	1.31	12.66	1.00	0.66
498		3.83	1.34	11.27	0.35	−0.06
499		−2.35	1.38	16.61	0.84	
500		9.35	1.37	15.12	0.89	0.78
501		−8.44	1.42	16.21	1.86	
502		1.64	1.43	16.81	1.00	0.59
503		2.23	1,41	15.81	1.01	0.38
504		5.44	1.41	15.49	1.09	0.51
505	A161	−7,88	1.45	13.91	0.42	0.08
506		7.12	1.47	16.75	1.16	1.09
507		9.50	1.46	14.94	0.95	0.72
508		1.01	1.50	11.09	1.67	
509	A4	1.54	1.74	11.33	0.63	
510		−8.13	1.57	16.56	0.84	0.90
511	G24, H23, A38	3.33	1.59	11.65	0 14	0.11
512	G68	−1.85	1.60	14.65	0.53	0.48
513		1.34	1.59	16.44	1.51	
514		1.21	1.65	15.13	1.11	0.02
515	G5, A10	2.03	1.65	12.41	1.45	0.82
516	A162	−7.36	1.66	14.22	0.51	0.09
517	G72, H19, A98	−4 85	1.66	11.27	0.16	0.45
518	G74, A77	−4.00	1.75	11.01	0.26	−0.09
519		−2.41	1.75	16.31	0.85	0.55
520		−1.07	1.75	16.33	0.82	0.72

Contd.

Table 1—*Contd.*

Number	Cross identifications	*X* (mm)	*Y* (mm)	*V* (mag)	*B* — *V* (mag)	*U* — *B* (mag)
521		8.58	1.77	15.53	1.68	1.23
522	G54	0.10	1.80	14.75	0.77	0.13
523		4.35	1.81	16.91	1.02	0 87
524		3.86	1.89	15.49	0.80	0.56
525		7.98	1.90	16.60	0.93	0.58
526		6.71	1.93	15.90	1.06	0.73
527		8.58	1.91	15.93	0.75	0.25
528		−6.37	1.94	11.33	−0.21	
529	G55, H32, A21	0.23	1.96	12.41	0.51	−0.10
530		−1.56	1.98	16.12	0.98	0.68
531		−1.40	1.98	16.56	0.88	0.61
532	G63, H46, A24	−0.71	2.04	13.10	0.45	−0.06
533		1.23	2.09	15.58	1.07	0.48
534		−1.80	2.11	15.46	0.90	0.69
535	G6, A9	1.86	2.13	12.74	2.05	1.86
536		−6.79	2.16	15.64	1.55	1.07
537		−4.63	2.17	17.00	0.93	
538		7.43	2.17	16.03	1.07	0.93
539		−3.94	2.18	14.20	1.77	1.09
540		3.43	2.18	16.55	0.93	0.59
541	G56, H39, A22	0.12	2.23	12.74	0.41	−0.06
542		9.41	2.26	15.23	0.79	0.49
543		−0.34	2.30	16.99	1.09	0.74
544		5.20	2.30	16.52	0.91	0.44
545		9.32	2.29	15.51	0.79	0.43
546	G76	−3.99	2.32	13.86	0.66	−0.05
547	G62, H34, A23	−0.64	2.38	12.41	0.36	0.09
548	G7, H30, A8	1.96	2.37	12.58	0.38	0.04
549		−6.99	2.39	15.03	1.19	1.24
550		9.64	2.45	16.01	1.80	1.68
551		0.60	2.46	16.35	0.94	0.55
552	G23, H42, A37	3.04	2.46	12.84	0.41	−0.02
553		4.44	2.51	16.16	0.86	0.53
554	G8, A7	1.64	2.55	13.13	0.63	−0.23
555	G61, H26, A25	−0.93	2.60	11.78	0.05	0.20
556		1.53	2.63	16.35	0.73	
557		−0.45	2.64	15.86	0.86	0.88
558	G105, A110	6.30	2.68	13.86	0.41	0.06
559		8.92	2.69	15.05	0.74	0.66
560		−7.11	2.69	16.08	1.09	1.20
561		−6.41	2.69	16.54	0.90	0.91
562		−3.32	2.71	16.83	0.74	0.88
563		9.74	2.72	15.13	0.68	0.38
564		6.71	2.76	15.38	1.81	1.89
565	G77	−1.69	2.75	14.61	0.66	0.17
566		2.87	2.76	15.03	0.63	0.09
567		4.23	2.76	15.66	0.96	0.67
568		−1.54	2.79	16.34	0.91	0.53
569		1.13	2.82	11.21	0.26	
570		3.38	2.80	15.97	0.85	0.46
571		3.68	2.84	16.32	0.95	0.74
572	G79, H71, A64	−2.44	2.88	14.22	0.49	0.12
573		0.95	2.88	16.25	1.18	−0 06
574		4.04	2.89	16.33	0.99	0.54
575		−7.58	2.89	16.80	0.91	0.65
576	G78, H33, A53	−2.10	2.92	12.43	0.23	0.27
577		−3.32	2.94	16.85	1.56	
578		−1.40	2.95	15.69	0.88	0.47
579	G22, H65, A36	3.19	2.96	14.08	0.64	0.17
580		5.16	2.95	16.98	0.93	0.75

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
581		—1.52	2.98	16.11	0.89	0.64
582	G21	2.32	3.01	15.61	0.95	0.52
583		6.30	3.00	14.80	0.64	0.27
584	G104, A109	6.83	3.00	13.97	0.42	0.15
585	G10, H59, A6	0.79	3.06	13.82	0.66	—0.06
586	G60,H18, A26	—0.80	3.10	11.36	0.07	0.01
587		4.85	3.09	16.91	1.28	0.69
588		3.83	3.14	15.54	0.77	0.44
589	A131	7.90	3.15	14.39	0.51	0.25
590		—5.98	3.17	16.41	0.75	0.44
591		6.43	3.15	14.29	0.71	0.51
592	G101, A89	5.55	3.21	13.95	0.46	0.02
593	A163	—7.02	3.24	13.76	0.65	0.16
594		—1.16	3.30	15.36	1.47	1.07
595		4.97	3.31	15.57	1.64	1.35
596	G102, A88	5.82	3.33	14.06	0.52	0.03
597	G80, A80	—3.27	3.33	14.03	0.60	—0.02
598	G16, H54, A33	1.59	3.34	13.70	0.55	—0.07
599		5.47	3.40	16.69	1.59	
600	G59, H56, A27	—0.88	3.44	13.62	0.49	0.01
601	G19, H25, A34	2.60	3.48	11.72	0.28	0.20
602	G57, H38, A28	—0.51	3.56	12.71	0.40	0.05
603	G15, H73, A32	1.61	3.57	14.41	0.51	0.13
604		6.45	3.57	16.34	1.21	0.65
605		—6.72	3.60	16.78	1.06	0.54
606		—1.67	3.59	16.88	0.93	0.78
607		—4.02	3.63	15.49	0.86	0.83
608		5.03	3.64	15.27	0.80	0.56
609		4.73	3.71	16.97	0.96	0.66
610	G84, A82	—3.00	3.84	14.05	0.45	0.13
611		—0.11	3.75	16.30	1.04	0.69
612		3.97	3.74	15.06	0.67	0.51
613		—5.20	3.79	14.08	0.74	0.67
614		—8.17	3.81	15.38	0.74	0.80
615		9.06	3.83	14.53	0.74	0.45
616		3.53	3.85	15.42	1.00	0.95
617		8.30	3.85	15.90	0.71	0.30
618		—3.35	3.86	16.51	1.91	
619	G81	—3.70	3.86	14.24	0.64	0.11
620		—1.84	3.88	16.73	0.69	1.03
621		—1.00	3.89	16.85	0.74	0.66
622	G12, H28, A29	1.15	3.91	12.01	0.27	0.22
623	G11, H70	0.69	4.00	14.19	1.20	0.90
624		—6.49	4.03	16.98	1.02	0.91
625	G58, H61 A54	—0.78	4.01	13.71	0.50	0.19
626		4.11	4.02	15.27	0.60	
627		4.56	4.01	16.12	0.86	0.61
628		3.00	4.03	15.95	1.46	
629	G18, H62, A56	3.12	4.06	13.87	0.62	0.12
630		6.44	4.09	16.36	1.75	
631	G82, A100	—4.35	4.10	13.65	0.84	0.64
632		—0.29	4.13	16.83	0.90	0.73
633	G17, H49, A55	3.06	4.16	13.39	0.39	0.18
634		2.84	4.17	16.56	1.63	1.85
635		—8.56	4.20	16.79	0.79	0.64
636		—5.33	4.20	15.85	1.91	1.90
637		5.85	4.23	16.01	0.95	0.89
638		7.97	4.21	16.06	0.86	0.63
639	A164	—7.25	4.23	13.60	0.41	—0.04
640		4.16	4.28	16.83	0.96	0.41

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	B — V (mag)	U — B (mag)
641		8.31	4.29	14.70	0.47	0.27
642		—3.74	4.29	14.79	0.71	0.39
643		8.06	4.30	16.05	1.30	0.82
644		4.97	4.33	16.78	0.86	0.57
645		2.56	4.36	16.38	0.95	0.58
646		—1.92	4.39	16.07	1.05	0.74
647		—8.98	4.41	13.93	0.55	0.09
648		4.58	4.40	16.04	0.65	0.82
649		9.29	4.43	14.72	1.03	1.10
650	A107	6.11	4.49	13.94	0.50	0.03
651		8.08	4.51	11.79	0.06	0.29
652		—6.95	4.51	15.05	1.26	1.63
653		1.86	4.52	15.39	0.72	0.47
654		2.76	4.54	16.98	0.90	0.50
655		7.25	4.58	15.94	0.80	0.88
656		—0.47	4.60	15.86	0.82	0.55
657		—7.88	4.68	16.52	1.07	1.03
658	G83, A101	—3.61	4.68	12.32	0.40	0.24
659		5.28	4.70	14.39	0.57	0.35
660		—9.60	4.74	15.81	0.46	0.87
661		7.81	4.76	15.94	0.90	0.57
662	A66	—0.95	4.89	11.59	0.10	
663	G93	0.47	4.88	14.63	0.69	0.33
664	A165	—7.45	4.91	12.69	1.32	1.47
665		1.14	4.92	15.47	1.13	0.59
666	A154	7.45	4.92	13.78	0.51	0.25
667		—7.08	4.95	15.39	0.71	0.33
668		1.70	4.94	15.96	1.25	1.06
669		6.32	4.96	15.66	0.92	0.69
670		—4.30	4.99	16.34	1.62	1.41
671	A106	5.39	4.99	11.69	0.42	0.25
672		4.29	5.00	16.92	0.84	0.65
673		—0.29	5.02	16.09	0.91	1.03
674		—9.50	5.02	15.61	0.82	0.68
675		—7.28	5.07	15.30	0.68	0.24
676		1.81	5.11	15.58	0.92	0.97
677		5.92	5.11	14.90	1.28	1.06
678		—6.07	5.15	16.95	1.45	0 85
679	G92, H31, A67	0.14	5.16	12.14	0.12	0.30
680	G94, H45, A68	0.57	5.15	13.30	0.61	0.10
681		1.64	5.16	14.87	0.65	0.30
682		6.90	5.14	16.86	1.13	0.65
683		—3.93	5.29	16.17	1.06	1.22
684		—0.57	5.29	14.95	0.80	0.31
685		8.39	5.28	16.58	0.93	
686		4.13	5.29	14.90	0.56	0.59
687		—1.94	5.36	14.51	1.88	2.11
688		7.28	5.36	14.63	0.65	0.54
689		2.58	5.37	16.02	0.96	0.83
690	A153	7.73	5.39	13.51	0.63	0.23
691		—6.33	5.40	16.76	1.97	
692	A105	4.98	5.42	12.95	0.38	0.55
693		—4.76	5.46	14.82	0.83	0.24
694	A87	3.71	5.50	14.12	—0.29	
695		6.57	5.49	16.20	0.69	0.55
696	G100, H57, A72	3.05	5.51	13.63	0.43	0.05
697	A185	9.12	5.51	14.39	0.51	0.27
698	A186	9.27	5.61	13.54	0.90	—0.30
699		4.35	5.65	15.14	0.67	0.41
700		—5.97	5.66	15.56	0.77	0.30

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
701		3.66	5.69	15.61	1.64	1.15
702		5.95	5.69	16.53	1.02	0.31
703		—2.96	5.75	16.19	0.78	0.54
704	A152	7.77	5.76	12.13	0.33	
705		—5.99	5.78	15.50	0.83	0.68
706		—3.61	5.82	16.84	1.36	1.51
707	A130	6.63	5.81	11.43	0.10	0.22
708		—9.76	5.83	15.41	0.71	0.76
709	G99, H67, A86	2.76	5.84	13.97	0·53	0.13
710		6.40	5.86	15.07	0.72	0.34
711	G96, A70	1.24	5.92	11.72	0.49	0.02
712		—9.11	5.99	15.59	0.87	0.47
713		8.32	6.00	16.73	1.30	1.18
714		8.95	6.05	15.30	0.70	0.67
715	G90	—1.53	6.05	14.32	0.62	0.09
716		—7.95	6.10	15.05	0.61	0.50
717		—0.70	6.12	15.84	0.83	0.56
718	G86, A102	—2.93	6.14	12.30	0.56	0.13
719		—7.58	6.17	16.70	0.88	0.91
720		7.44	6.18	14.65	0.56	0.27
721		5.76	6.20	14.97	0.74	0.16
722		—6.62	6.23	15.73	0.81	0.89
723	G91, A84	—0.60	6.26	14.30	0.55	0.14
724		5.86	6.27	15.13	1.03	0.52
725	G89, A83	—1.71	6.32	11.53	0.01	0.33
726		6.31	6.35	16.17	1.13	0.83
727		—1.15	6.38	15.82	0.69	0.53
728		—0.59	6.39	16.49	0.91	0.30
629		4.41	6.41	16.24	1.05	0.93
730		0.06	6.41	15.98	1.01	0.67
731	A151	6.52	6.42	14.02	0.38	0.44
732		8.96	6.41	16.88	0.83	0.99
733		—3.77	6.46	14.44	0.72	—0.01
734		—2.60	6.45	15.45	0.90	0.58
735		8.37	6.47	16.07	0.89	0.76
736		6.80	6.47	15.65	0.66	0.27
737	G88, A103	—2.42	6.50	13.61	0.41	—0.02
738	A184	8.07	6.51	14.13	0.22	0.32
739		—6.16	6.53	16.89	0.77	0.74
740		—3.49	6.56	16.36	0.77	0.38
741		—5.10	6.57	16.69	0.90	0.43
742		6.15	6.57	15.57	1.80	1.48
743	A125	—3.78	6.60	12.87	0.34	0.03
744	G87, A104	—2.55	6.61	13.62	0.36	0.04
745		5.46	6.66	14.70	0.70	0.30
746		—3.18	6.71	14.74	1.66	1.79
747		5.75	6.71	15.60	0.60	0.68
748		9.49	6.82	12.63	—0.09	
749	A183	7.99	6.72	13.02	0.35	0.21
750		—6.01	6.77	16.44	1.00	0.60
751		8.54	6.83	14.75	0.63	0.38
752		—2.75	6.83	15.83	0.61	0.59
753	A182	8.32	6.85	14.32	0.57	0.37
754		8.79	6.88	15.26	0.94	0.84
755		—9.48	6.90	14.56	0.41	0.32
756		—5.71	6.89	16.46	0.94	0.62
757		5.77	6.89	16.35	1.73	
758		3.62	6.93	16.61	0.94	0.57
759		—1.40	6.94	14.95	0.66	0.41
760		—6.06	6.95	16.84	1.73	1.44

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	B — V (mag)	U — B (mag)
761	A150	6.21	6.99	13.46	0.34	0.57
762		—4.19	6.99	14.32	0.51	0.13
763		0.31	6.99	14.77	0.69	0.28
764		—7.23	7.03	13.77	0.49	—0.01
765		6.54	7.04	14.97	1.48	1.50
766	A181	8.44	7.05	11.76	0.02	0.32
767		—4.53	7.14	14.52	0.64	0.15
768		8.71	7.14	15.85	1.29	1.19
769		—6.19	7.15	14.90	0.60	0.28
770		3.61	7.16	15.95	0.90	0.54
771		7.72	7.16	16.98	1.21	0.52
772		—7.18	7.18	15.03	0.58	0.22
773		4.51	7.23	16.85	1.02	0.63
774		6.06	7.27	16.72	0.77	0.71
775		6 69	7.27	15.94	0.95	0.74
776		—3.48	7.30	17.00	0.89	0.69
777		1.64	7.32	17.00	1.01	0.45
778	A129	5.03	7.36	12.99	0.37	0.26
779		—7.66	7.38	14.03	0.49	0.28
780		—5.09	7.41	16.33	2.16	
781		—0.26	7.40	15.78	0.31	0.23
782		2.82	7.42	15.72	1.02	0.45
783		9.55	7.45	16.41	0.97	0.53
784		—5.59	7.46	16.86	0.76	0.70
785		0.34	7.46	15.02	0.85	0.75
786	A180	6.63	7.47	13.66	0.25	0.51
787		—7.29	7.51	14.24	0.83	0.66
788		—4.03	7.53	15.72	0.80	0.38
789		0.09	7.53	15.91	0.67	0.62
790		2.99	7.51	16.42	0.61	0.31
791		6.28	7.50	15.49	1.16	1.10
792		—3.66	7.54	16.17	0.76	0.43
793		1.22	7.57	16.32	2.59	
794		5.27	7.59	16.44	0.89	0.53
795		—9.55	7.60	16.78	0.85	0.75
796		—3.52	7.63	16.55	0.70	0.96
797		5.99	7.65	16.19	0.94	0.44
798		—0.47	7.67	15.47	0 91	0.40
799		7.76	7.66	16.63	0.97	0.36
800		—7.86	7.67	14.98	0.74	0.42
801		—9.67	7.70	16.05	0.73	0.60
802		6.44	7.70	16.98	1.11	0.50
803		7.56	7.75	16.06	0.98	0.71
804		—0.65	7.81	15.07	0.65	0.63
805		6.07	7.79	16.09	0.85	0.70
806		7.65	7.80	16.10	0.97	0.77
807		—4.30	7.87	15.72	0.98	1.09
808		—9.03	7.95	17.00	0.89	0.76
809		—2.37	7.93	14.78	0.76	0.33
810		3.94	7.93	14.91	0.61	0.40
811		—4.95	7.97	16.60	0.89	0.49
812		7.08	7.97	16.83	1.19	1.00
813		8.82	7.95	16.74	0.94	1.21
814	A149	5.26	8.01	13.18	0.40	—0.01
815		—4.10	8.03	16 58	0.90	0.54
816	A168	—4.44	8.05	13.12	0.36	0.03
817		—8.15	8.09	14.97	0.70	0.26
818		—8.49	8.10	16.01	0.99	0.30
819		—2.42	8.10	14.57	1.12	1.27
820	A128	2.87	8.11	14.25	0.52	0.10

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	Y (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
821	A179	7.34	8.13	13.69	0.59	0.24
822		—4.22	8.14	13.19	1.16	0.86
823		—1.96	8.15	16.93	1.06	0.75
824		3 23	8.15	16.62	1.10	0.34
825		6.89	8.14	15.61	0.80	0.31
826		9.40	8.18	16.99	1.15	1.48
827		1.95	8.20	15.68	0.98	0.75
828		8.76	8.27	14.21	0.64	0.48
829		—6.26	8.31	16.98	0.82	0.80
830		—0.58	8.30	15.12	0.94	0.24
831		—0.72	8.34	16.78	1.24	0.68
832	A127	2.58	8.34	13.05	0.36	0.46
833		4.81	8.37	15.11	0.69	0.31
834		5.31	8.40	15.68	0.64	0.12
835		6.06	8.39	16.97	1.12	0.69
836		—6.73	8.43	16.88	0.93	0.68
837		—4.20	8.51	15.89	0.85	0.45
838		—9.39	8.52	11.09	0.32	0.33
839		6.24	8.55	16.77	1.49	0.84
840	A146	—2.65	8.59	14.44	0.59	0.10
841		—3.08	8.63	16.52	1.96	
842		—7.44	8.65	15.69	0.74	0.24
843		—8 04	8.67	16.58	1.00	0.61
844		—5.22	8.68	14.30	0.64	0.33
845	A177	5.12	8.71	12.83	0.23	0.23
846		—5.59	8 74	14.31	1.03	1.14
847		—0.01	8.74	14.75	1.69	1.86
848		—3.77	8.76	16.78	1.05	0.71
849		—8.83	8.78	15.33	0.78	0.57
850		—7.46	8.79	13.58	1.32	1.07
851		7.56	8.78	16.68	0.93	0.63
852		—9.63	8.80	15.72	1.04	1.20
853	A147	—2.24	8.81	11.11	—0.04	0.19
854	A148	—0.20	8.84	13.43	0.59	0.44
855		6.05	8.85	16.62	1.33	1.63
856		2.47	8.86	15.37	0.70	0.49
857		—2.69	8.89	16.58	1.84	
858		6.44	8.90	16.33	0.79	0.81
859		—8.27	8.93	15.85	1.82	0.83
860		4.01	9.05	16.60	0.77	0.64
861		8.57	9.06	16.87	0.81	0.45
862		0.10	9.08	15.60	0.66	0.38
863		7.08	9.14	16.46	0.91	0.53
864		—1.59	9.15	16.56	0.94	0.47
865		9.11	9.16	15.99	0.88	0.66
866		7.71	9.25	15.57	0.84	0.47
867	A170	—2.34	9.27	11.90	1.47	1.95
868		3.31	9.29	15.41	0.95	0.38
869		8.53	9.32	16.45	0.60	0.86
870		—6.24	9.34	15.87	0.92	0.73
871		—0.76	9.32	15.44	0.67	0.74
872		7.17	9.35	16.72	1.14	0.45
873		1.54	9.36	16.32	0.77	0.56
874		5.03	9.41	16.69	1.30	0.91
875		—7.73	9.41	16.72	1.17	0.99
876		—7.43	9.41	12.89	0.35	0.47
877		7.87	9.48	13.18	0.32	0.59
878		—1.72	9.50	16.28	1.85	2.12
879		—8.02	9.52	16.28	1.17	1.33
880		—4.39	9.52	15.88	0.86	0.78

Contd.

Table 1—*Contd.*

Number	Cross identifications	X (mm)	X (mm)	V (mag)	$B-V$ (mag)	$U-B$ (mag)
881		—8.23	9.55	14.34	0.55	0.15
882		7.26	9.58	12.97	0.41	
883		3.46	9.61	16.40	0.87	
884		—2.77	9.63	14.81	1.53	1.84
885		—1.03	9.64	16.78	1.19	1.46
886		5.42	9.65	16.51	1.24	
887		—2.38	9.67	14.91	0.65	
888		0.67	9.69	15.59	0.86	
889		—2.63	9.73	14.78	0.48	
890		—5.72	9.73	16.81	0.67	
891	A172	—1.48	9.75	14.32	0.61	
892		—4.58	9.77	16.30	1.65	
893	A171	—2.11	9.77	14.00	0.39	
894		—0.68	9.76	15.77	0.82	
895		—7.00	9.77	11.55	1.48	
896	A169	—3.70	9.80	11.64	0.61	

2.2. Comparison with existing photometries

The present photometry has been compared with the photometries of Hoag *et al.* (1961) and GP. In table 1, the cross-identifications of common stars in different photometries are listed. Figure 1 compares V and $(B-V)$ magnitudes of Hoag *et al.* and GP with our magnitudes. The statistical results of these comparisons are listed in table 2 and indicate that mean values of the differences are not too different from zero with standard deviations expected from the errors in the photometric observations. All these indicate a good agreement between the various existing photometries of the cluster.

2.3. Completeness of the data

The data are complete down to 17.0 mag in V and 18.5 mag in B. The limiting magnitude for the sake of completeness has been studied by determining the magnitude up to which the number of stars detected on the plates in V and B colours was the same. Visual inspection of the stars in NGC 2301 on the plates revealed that there are about 10 per cent of the stars which have been lost in the final catalogue. However, all of them have been detected on at least one plate. The possible reason for elimination of the stars in the final catalogue appears to be crowding and unresolved pairs of stars.

3. Membership of the stars

Statistical criterion has been used to estimate the number of member stars in the cluster. The basic assumption of this method is that the distribution of field stars is uniform in the vicinity of the cluster. In order to verify this, star counts in the equal areas but located on the east and the west side of the NGC 2301 are made. To ensure that cluster members have not been included at all in this analyses, only outer 2 cm $\times$ 4 cm area of the zones studied in paper I which are situated $\sim$ 33 arcmin away from the cluster centre are considered. A comparison

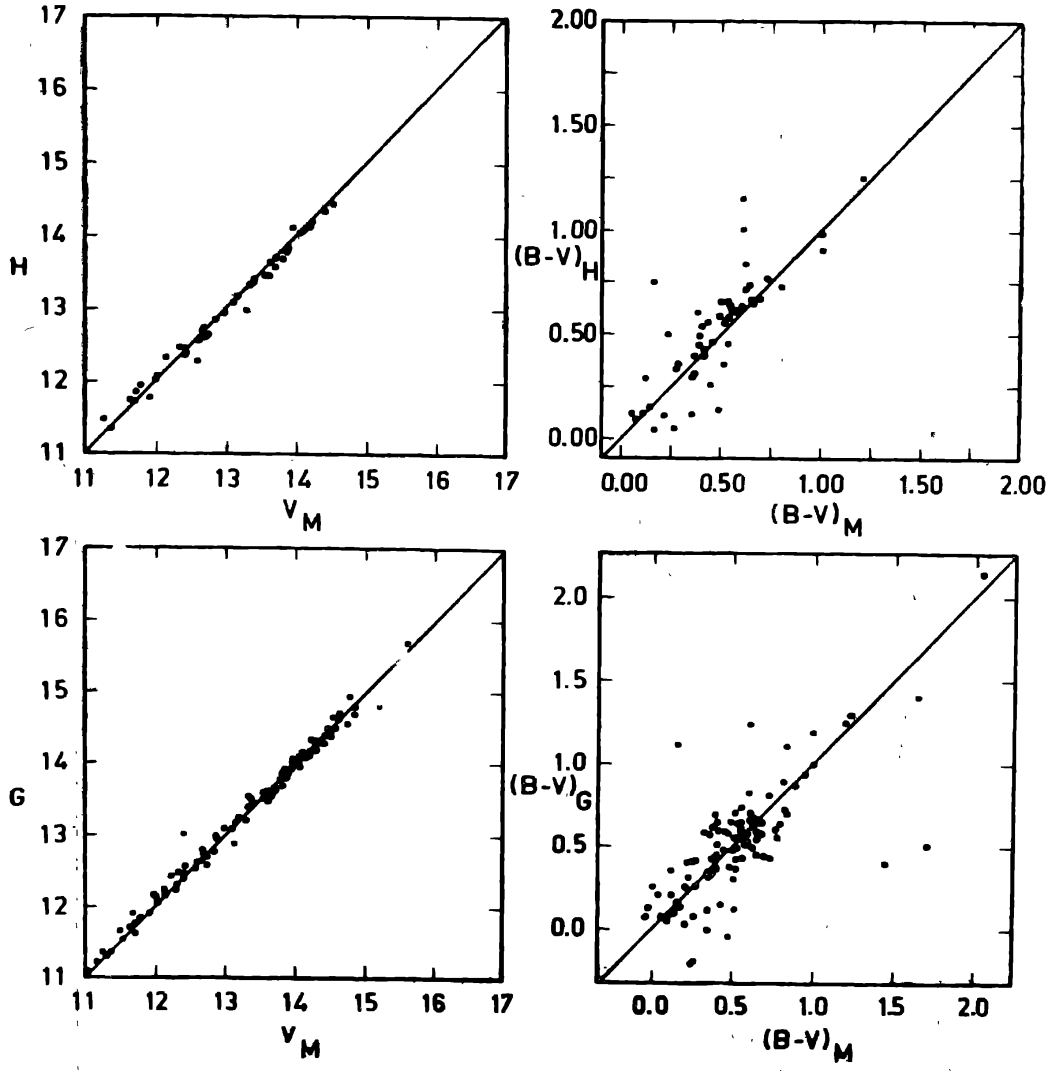

Figure 1. Comparison of present photometry with those of Grubissich & Purgathofer (1962) and Hoag *et al.* (1961).

Table 2. Comparison of various photometries. G : Grubissich & Purgathofer; H : Hoag *et al.* M : Present work

	G–H			G–M			H–M		
	V	*B*	*U*	*V*	*B*	*U*	*V*	*B*	*U*
No. of common stars	56	56	46	97	97	60	45	45	44
Mean (mag)	0.04 ±.01	−0.04 ±.01	−0.06 ±.02	0.01 ±.01	0.01 ±.01	−0.06 ±.02	−0.03 ±.01	0.04 ±.02	0.03 ±.02
S.D.	0.09	0.09	0.11	0.09	0.14	0.16	0.11	0.11	0.12

of the star counts of both zones indicates that their differences in all *V* magnitude bins are rejected at the significance level of 2.5 σ or less. Consequently, we believe that the differences in star counts of the above mentioned two areas are statistically insignificant and the assumption of uniformity of the distribution of

field stars is valid in the vicinity of the cluster. The average of star counts of the two areas has been considered as the representative of that distribution.

In table 3, we have listed the star counts in the cluster region as a function of V magnitude. Field star counts normalized to the cluster area have also been listed. The number of cluster members has been determined by subtracting the field counts from counts in the cluster region. The statistical errors estimated using the procedures given by van den Bergh & Sher (1960) are also given in the table.

Table 3. Stars counts in the cluster region and in field

Range in V magnitude	Cluster	Field	Number of members
11 to 12	38	16	22 ± 4
12 to 13	47	31	16 ± 6
13 to 14	80	57	23 ± 8
14 to 15	159	124	35 ± 13
15 to 16	231	222	9 ± 17
16 to 17	341	345	—

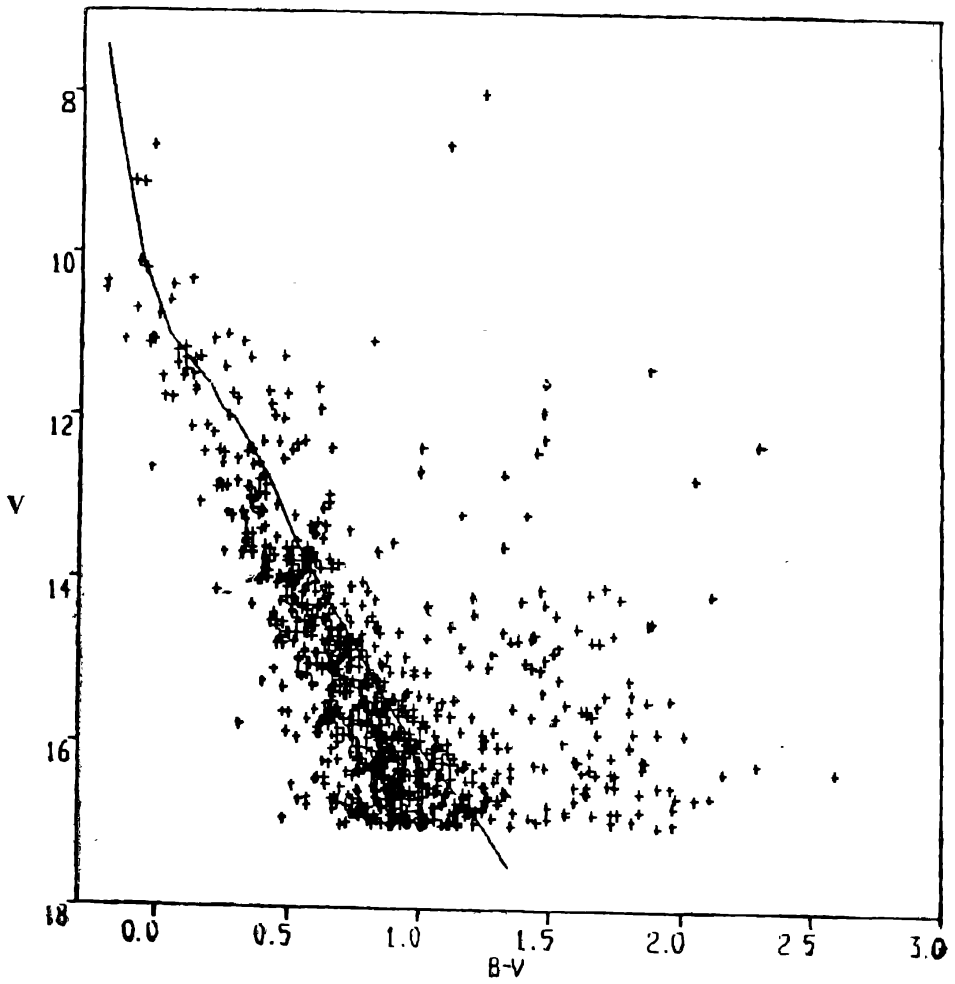

Figure 2. V, $(B - V)$ diagram of stars in the cluster region.

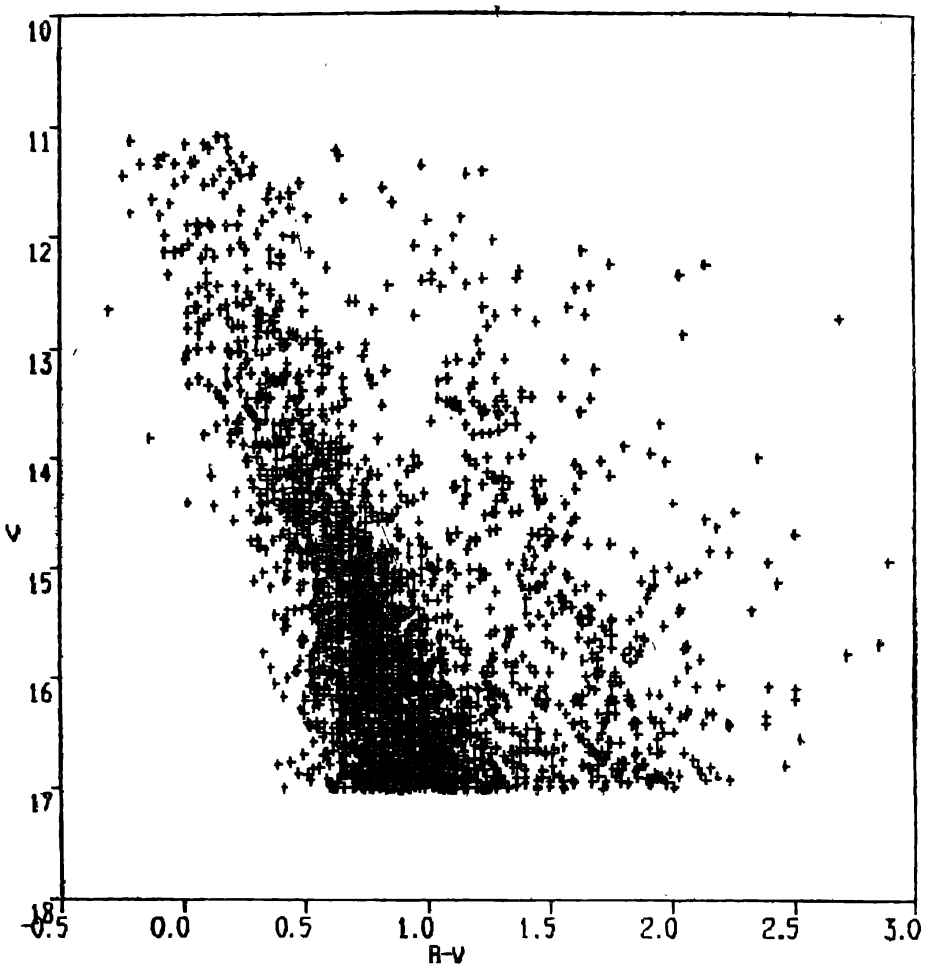

Figure 3. V, $(B - V)$ diagram of field stars.

We have plotted the V, $(B - V)$ colour-magnitude diagram for the stars in the cluster region in figure 2 and for the field stars in figure 3. In figure 2, ZAMS (Schmidt-Kaler 1982) shifted by $E(B - V) = 0.04$ mag and $(m_v - M_v) = 9.5$ mag has also been plotted. A comparison of the two diagrams shows that there is a difference in the upper part but the lower part looks similar. This indicates the lack of faint stars in the cluster which cannot be due to the possibility that low mass cluster member stars fainter than $V = 15$ mag have been lost in our observations. The reasons for this assertion are as follows :

(i) Considering the fact that reddening in the direction of the cluster is low amounting to only $E(B - V) = 0.04$ mag, apparent B magnitude of a main sequence cluster member star with $V = 17$ mag (i.e. $M_v = 7.5$ mag) will be 18.24 mag because its $(B - V)_0$ is only 1.2 mag (Schmidt-Kaler 1982). It means that all the main sequence cluster member stars up to $V = 17$ may have been detected because the limiting magnitude of our observation in B is 18.5 mag.

(ii) Iben's (1965) theoretical calculations of stars' pre-main sequence evolutionary phase indicate that time taken by a star of $\sim 0.6\ M_\odot$ to reach the main sequence

is $\sim$ 1 to 1.4 $\times$ 10^8 yr which is equal to the age of the cluster (see section 1). This indicates that mass of the faintest cluster main sequence member star is $\sim 0.6\,M_\odot$. Such a star will have $M_V = 7.7$ mag and $V = 17.2$ mag. This evidently indicates the absence of pre-main sequence stars brighter than $V = 17$ mag in the cluster NGC 2301.

These discusions indicate that if one accepts Iben's (1965) theoretical calculations then only main sequence and giant members brighter than $V = 17$ mag are present in the cluster and all of them have probably been detected in the present observations.

If we use only photometric criteria for membership determination then it is evident that majority of the stars in figure 2 will be classified as members. However, table 3 indicates that the number of cluster members in the magnitude range $V = 11$ to 15 mag is only 96 ± 17. This indicates that the membership determination based on photometric criteria can be some times misleading.

From his proper motion survey, Aiad (1986) has estimated 56 stars as cluster members. His survey is complete essentially up to $V = 14.0$ mag. From statistical criteria, we find that the number of cluster members up to $V = 14$ mag is 61 ± 11, which is in excellant agreement with the results of Aiad.

4. Discussion

The extent of the cluster has been estimated by dividing the cluster in concentric rings of $\sim$ 2 arcmin width (2 mm on the plate), the innermost ring being of a radius of $\sim$ 3 arcmin. We have taken star no. 1 of GP as cluster centre. Total number of stars were counted in each ring and the stellar surface density as a function of distance from the cluster centre has been plotted in figure 4 alongwith the error bars. We have also indicated the field star surface density found from the field counts. From figure 4 it appears that the cluster extends to a radius of 10 arcmin. Lynga's (1984) catalogue lists 7.5 arcmin as the angular radius of the cluster.

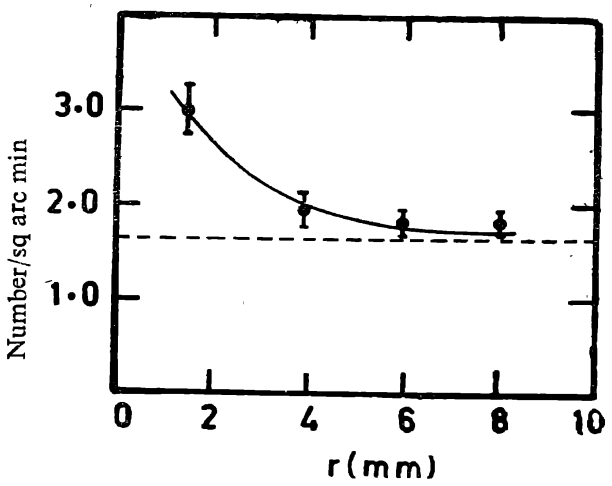

Figure 4. Plot of total stellar surface density ($V = 11$ to 17 mag) versus distance from cluster centre in the cluster region. Dotted line indicates field star density.

Table 3 indicates that there are no cluster members fainter than $V = 15$ mag ($M_V \sim 5.5$ mag). As the data are complete down to $V = 17$ mag (see last section), this finding cannot be due to incompleteness of the data. It is difficult to explain such observations in this cluster with existing theories of star formation. Accurate proper motion studies down to $V = 17$ mag are needed to confirm this finding.

We have also studied the radial surface distribution of cluster members as a function of mass. We have divided the stars in two mass groups namely high mass 1.3-2.2 $M_\odot$ (V =11-13 mag) and low mass 0.9-1.3 $M_\odot$ (V = 13-15 mag). The surface stellar densities of cluster members (D) in the two mass bins as a function of cluster radius (r in mm) are given in table 4. In figure 5, log D has been plotted against log r. The slopes estimated by least square linear regression are -1.6 ± 0.5 and -1.0 ± 0.2 and the correlation coefficients are -0.83 and -0.95 for high mass and low mass bins respectively. Similar linear relations have been observed in some other open star clusters also (cf. Sagar

Table 4. Radial stellar surface density of cluster members in the two mass bins

Radius in mm	Stellar surface density	
	11 mag < V < 13 man (2.2-1.3 $M_\odot$)	13 mag < V ≤ 15 mag (1.3-0.9 $M_\odot$)
3	0.64 ± 0.01	0.39 ± 0.01
5	0.03 ± 0.01	0.15 ± 0.01
7	0.08 ± 0.004	0.14 ± 0.003
9	0.04 ± 0.004	0.06 ± 0.003

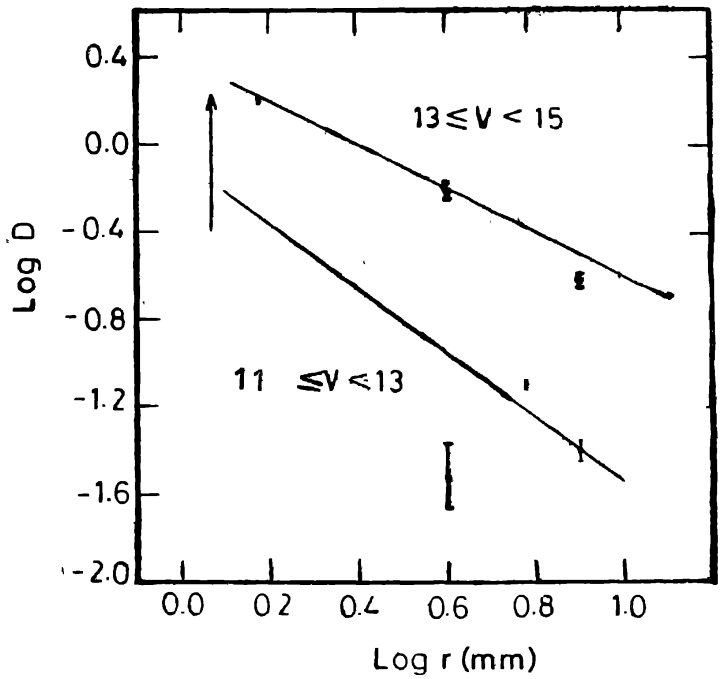

Figure 5. Radial stellar surface density of cluster members in the two mass bins. The vertical length of arrow denotes the amount in log by which low-mass stars are offset in surface density from the high-mass stars.

et al. 1988). A comparison of the above slopes indicates that massive stars are more concentrated towards the cluster centre relative to the low mass stars. As the cluster is older than 10^8 yr, this observed fact could be due to dynamical evolution of the cluster. However, the possibility that it could be due to a combination of both initial star formation conditions and dynamical evolutionary processes cannot be completely ruled out because in open star clusters younger than some million years mass segregation has been observed (cf. Sagar *et al.* 1988).

Acknowledgements

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