

The Open Cluster NGC 2236

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A three colour photometry in the *RGU*-system leads to a distance of 3430 pc for the open cluster NGC 2236.

Key words: star cluster — galactic

Up to now there exists no photometry of NGC 2236. This cluster lies on plates of the Anticentre-program of the Basel Observatory taken in *RGU* with the 48 inch Palomar-Schmidt telescope in 1968 by Prof. U. Steinlin and Dr. A. Tammann. The plates are centered near NGC 2251 for which a photoelectric scale is available.

In *R*, *G* and *U* 5, 5 and 7 plates respectively were measured at an Iris-Photometer. Photoelectric and photographic *UBV*-magnitudes for 32 respectively 3 stars of NGC 2251 are used as photometric standards (Hoag *et al.*, 1961). These magnitudes have been transformed to the *RGU*-system by the formulae derived by Steinlin (1968). The faintest photoelectric magnitudes of the stars measured in NGC 2251 are $G = 17.5$, $R = 16.3$ and $U = 17.7$. The characteristic curves taken from NGC 2251 have been extrapolated by approximately 0.5 magnitudes, which is 1 magnitude brighter than the limiting magnitudes of the plates.

A small field error was found on a few plates. The magnitudes taken from these plates were reduced to the magnitudes of the plates not showing field errors by a correction of $\Delta G = +0.06$ and $\Delta U = -0.09$ magnitudes.

The *U*-plates show NGC 2251 as projected on an extended area of a very thin nebular background, which does not exist on the *G*- and the *R*-plates. The iris-measurements of the stars of NGC 2251 are affected by this nebulosity and show an iris reading too large for a star of a given *U*-magnitude. For NGC 2236 this error causes magnitudes which are too faint by a certain amount. The amount can be

found only approximately in a statistical way by comparing the *U*—*G* colour indices of stars in a given interval of the *G*—*R* colour indices in the field of NGC 2251 with those in the field of NGC 2236. The result of the comparison is as follows:

NGC 2251: 16 stars,

$$\overline{G-R} = 0.75 \pm 0.04, \quad \overline{U-G} = 1.45 \pm 0.03,$$

NGC 2236: 9 stars,

$$\overline{G-R} = 0.78 \pm 0.03, \quad \overline{U-G} = 1.62 \pm 0.04.$$

The two values for $\overline{G-R}$ are almost equal but the $\overline{U-G}$ -values show a difference suggesting a correction of -0.17 mag for the *U*-magnitudes of NGC 2236. An error of ± 0.05 mag in this correction causes an error of $\pm 7\%$ in the resulting distance of the cluster.

The mean errors of the magnitudes given in the catalogue are:

$$R: \pm 0.02; \quad G: \pm 0.03; \quad U: \pm 0.03 \text{ mag}.$$

The cluster NGC 2236 has the following co-ordinates:

$$\text{R.A.} = 6^{\text{h}}27^{\text{m}}0 \quad (1950) \quad l'' = 204^{\circ}.4,$$

$$\text{Decl.} = 6^{\circ}52' \quad b'' = -1^{\circ}.7.$$

Trumpler (1930) classified it as I 2m with an estimated apparent diameter of 6' and a distance of 2290 pc. According to Collinder (1931) the distance is 4800 pc.

Figure 1 shows a map of the cluster with the numbers given in the catalogue of Table 1. The cluster seems to have a complicated shape. A concentration exists around the brightest star No. 1,

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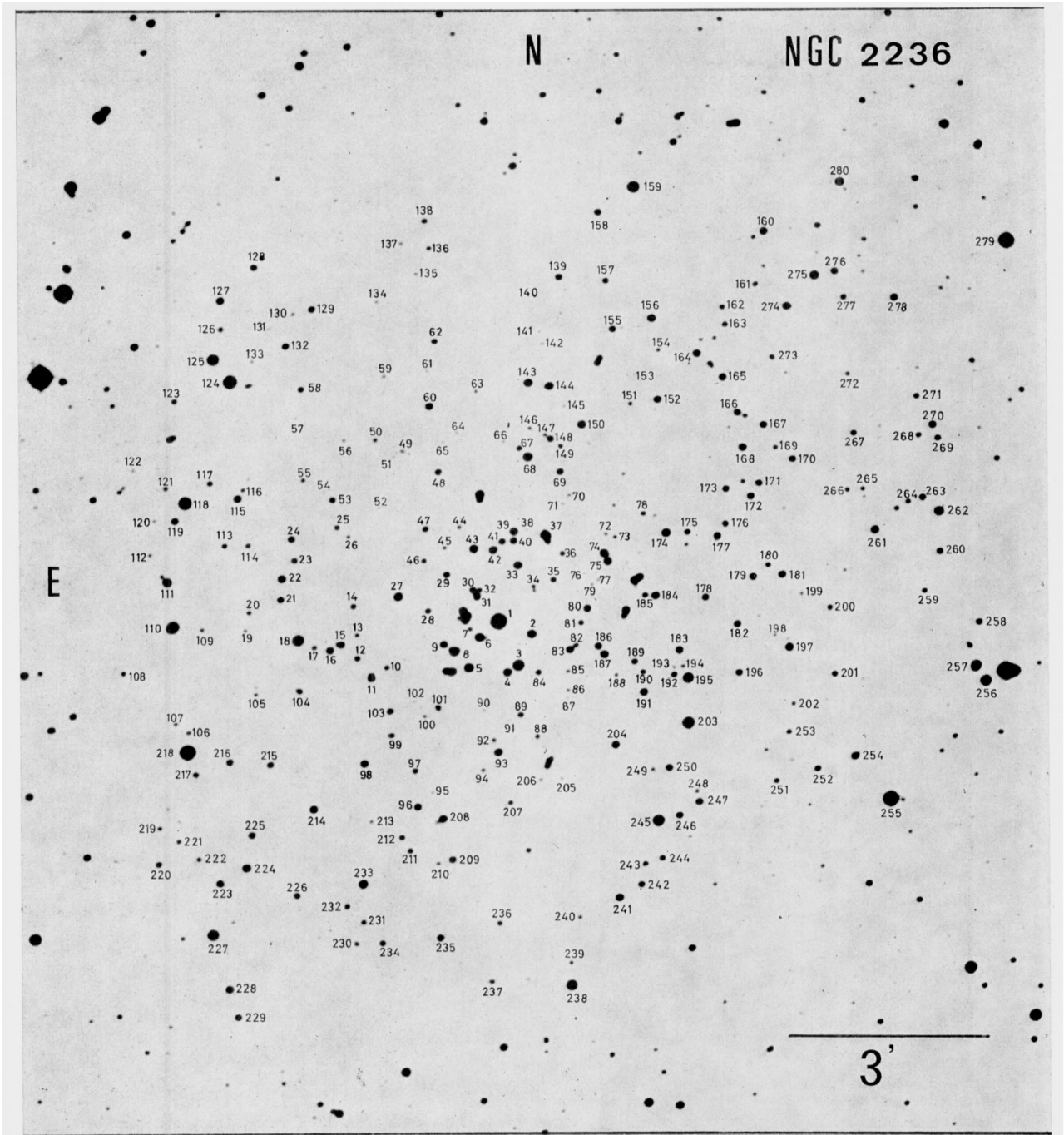


Fig. 1. The open cluster NGC 2236

which is not a physical member. Two star chains extend from there to the NW and to the SW of the central condensation. Both chains consist of physical members and of field stars. The cluster shows a

rather large number of “blend” stars in its central condensation. Therefore some of the brighter stars are missing in the catalogue and for some others the magnitudes are affected more or less by “blend”-

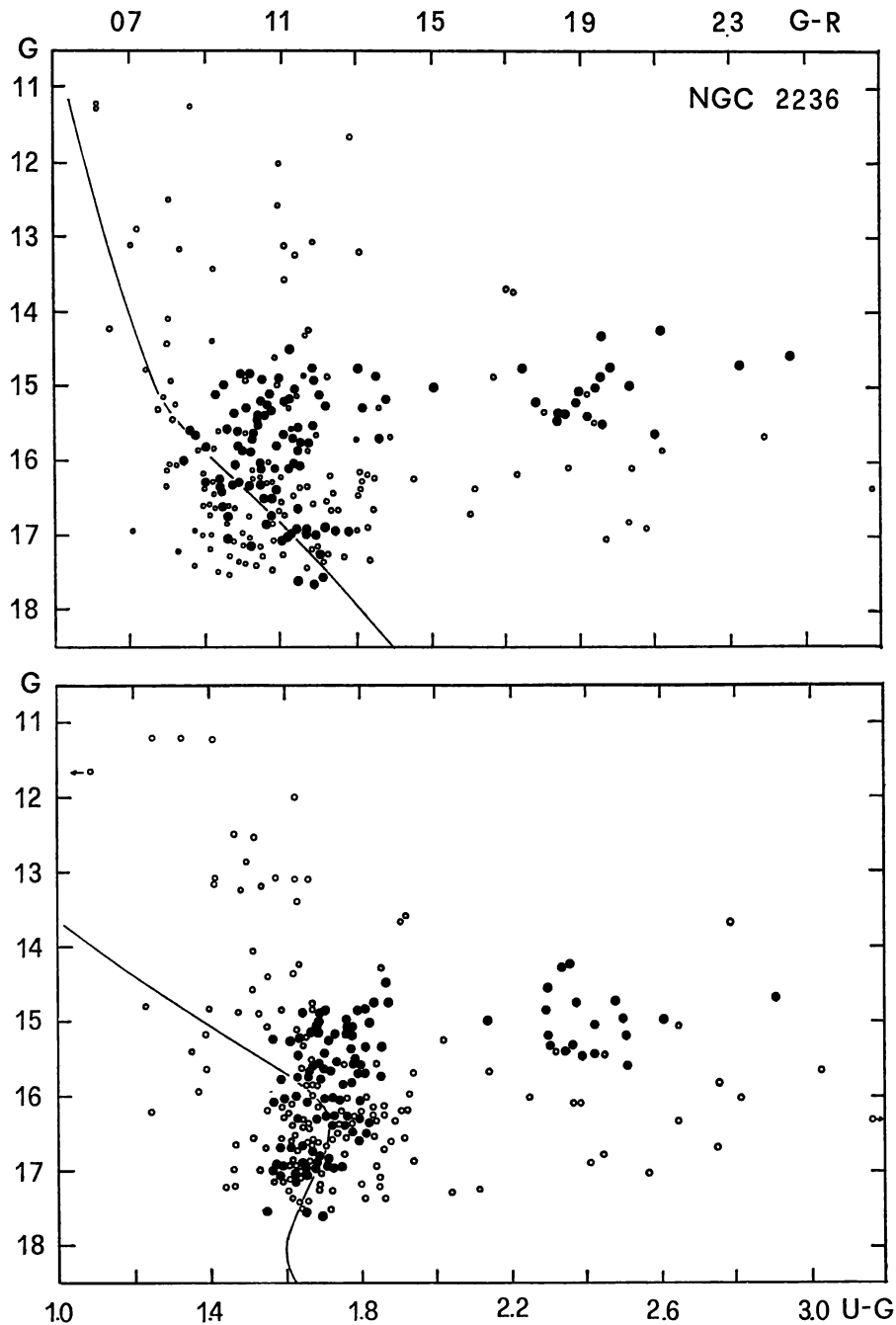


Fig. 2. The two colour-magnitude-diagrams of NGC 2236. Points: physical members, small open circles: field stars

effects. A colon in the catalogue generally expresses this.

The two colour-magnitude-diagrams are given in Fig. 2. A strong evolution effect is evident which causes some doubts, whether the fainter stars of the

cluster are situated exactly on the main sequence, which has to be assumed for the fitting method of distance determination.

Considering the position of a star in the two diagrams and in the area of the cluster 109 stars

Table 1. NGC 2236

No.	<i>G</i>	<i>G</i> − <i>R</i>	<i>U</i> − <i>G</i>
1	11.66	1.29	0.76
2	14.44	0.80	1.56
3	13.21	1.31:	1.54
4*	14.71	2.33	2.91
5*	14.29	1.96	2.34
6*	14.25:	2.12	2.35:
7	16.06	0.82:	2.25
8	13.70	1.70:	1.90
9*	15.20	1.38:	1.74
10*	16.52	1.07	1.82
11*	14.77	1.75	2.38
12*	16.28	0.99	1.77
13	16.75	1.02	1.86
14*	16.33	1.02	1.80
15*	15.16:	—	1.79:
16*	15.20	1.05	1.78
17*	16.72	1.19	1.62
18	13.27	1.14	1.49
19	17.25	1.21	1.45
20*	16.74	0.96	1.59
21*	15.63	0.88	1.68
22*	15.20	1.11	1.77
23*	16.07	1.15	1.75
24*	15.56	1.15	1.74
25*	16.52	1.06	1.78
26*	17.03	1.12	1.57
27	14.89	1.67:	1.41
28	16.18	1.23	1.83
29*	15.62	0.99	1.80
33*	14.76	1.98	2.47
34	16.66:	—	1.88:
35*	16.11:	1.05:	1.80:
36	16.35	1.39	1.84
37	13.62	—	1.92
38	17.54	0.96	1.72
39*	14.87	1.36:	1.71
40*	15.34	1.07:	1.86
41*	15.77	1.16	1.67
42*	14.87	1.96:	2.30
43*	14.50	1.13	1.87
44*	16.95	1.17	1.65
45*	16.98	1.17	1.58
46	16.58	0.91	1.76
47*	16.06	0.98	1.71
48*	15.88	1.02	1.80
50	16.88	1.33	1.94
53*	16.06	0.97	1.73
55	16.80	0.95	1.77
56	17.29	0.96	1.64
58	16.11	2.03	2.37
59	17.18	0.91	1.59
60	15.31	0.77	1.65
62	16.13	1.02	1.69
63	17.13	1.03	1.85
67	16.31	1.02	1.77
68	14.25	1.17	1.64
69*	15.70	1.03	1.81
70	17.24	1.10:	1.88
72*	17.08	1.10	1.59

Table 1 (continued)

No.	<i>G</i>	<i>G</i> − <i>R</i>	<i>U</i> − <i>G</i>
73	16.99	0.89	1.63
78	16.37	0.89	1.69
79	17.36	0.98:	1.62
80*	15.36	0.98	1.82
81*	16.40	0.94	1.76
82	16.50:	—	1.74:
83*	15.03:	—	1.84:
84*	16.31	1.05	1.64
85	16.99	0.91	1.70
86*	17.16	1.02	1.63
87*	17.58	1.21	1.55
88*	16.65	1.15	1.71
89	16.20	0.99	1.91
92*	16.75	1.08	1.67
93*	14.91	1.05	1.65
94	17.14	1.00	1.58
95	17.51	0.93	1.65
96*	15.37	1.86	2.37
97*	16.27	0.94	1.72
98*	15.16	1.12	1.68
99	16.23	1.45	1.78
100*	16.97	1.28	1.74
101	15.99:	—	1.93:
102*	17.67	1.19	1.70
103*	15.75	1.17	1.86
104	16.03:	—	1.80:
105	16.97:	—	1.63:
106	16.68	1.23:	1.68
107	16.94	1.30	1.62
108	16.58	1.18	1.58
109	16.91	2.07	2.40
110	12.56	1.09	1.52
111	14.30:	1.16	1.86:
112	17.09	1.01	1.59
113	16.26	0.92	1.60
114	16.47	1.13	1.69
115	15.24	0.82:	1.66
116	16.82	2.02:	2.45
117	16.21	1.10	1.24
118	12.50	0.80	1.47
119	15.34	1.80	2.30
120	17.28	1.20	2.12
121	16.62	0.93	1.62
122	17.28	1.26	1.61
123	16.33	1.15	1.65
124	12.02	1.09	1.63
125	13.10	1.18	1.63
126	16.45	0.93	1.72
127	15.09	1.91	2.62
128	15.69	2.28	3.03
129	15.80	1.16	1.69
130	17.05	1.96:	2.57
132	15.60	1.12	1.75
133	17.43	1.16	1.64
134	17.37	0.98	1.66
135	17.31	1.33	2.04
136	16.71	1.60	2.75
137	17.21	0.82	1.80
138	16.35	0.79	1.79

Table 1 (continued)

No.	G	$G-R$	$U-G$
139	15.60	1.00	1.84
141*	17.59	1.15	1.75
142	17.40	0.86	1.86
143*	14.85	1.02	1.82
144*	14.91	1.19:	1.70
145	17.46	1.07	1.66
146	16.96	0.99	1.84
147	17.00:	—	1.46:
148	15.72:	—	1.94
149	16.65	1.34	1.67
150	14.83	1.00	1.23
151*	16.87	1.06	1.70
152*	15.28	1.32	1.62
154*	16.98	1.13	1.66
155*	15.72	1.36:	1.81
156*	14.75	1.31	1.84
157	16.03	0.81	1.76
158*	15.42	1.85	2.43
159	13.10	0.70	1.58
160	15.11	1.13	1.55
161	16.36	2.75	3.49
162	16.28	1.16	1.83
163	16.14	1.31	1.86
164*	15.11	0.93	1.77
165	15.18	1.11	1.39
166*	15.42	1.04:	1.71
167*	15.36	1.85	2.31
168*	14.99	0.95	1.77
169*	16.62	0.95	1.80
170*	15.64	1.03	1.71
171*	15.66	1.11	1.72
172*	15.46	1.04	1.64
173*	15.60	0.86	1.69
174*	14.56	1.83	2.30
175*	16.02	0.84	1.63
176*	15.79	0.90	1.63
177*	15.26:	1.06:	1.64:
178*	15.52	1.04	1.67
179*	15.39	1.05	1.78
180*	16.29	0.90:	1.69
181*	15.12	1.07	1.78
182*	15.44	1.84	2.43
183*	15.04:	1.14:	1.69:
184*	15.00	1.51:	2.14
185*	16.08	1.13:	1.66
186*	15.28	1.01	1.72
187*	14.76	1.19	1.88
188*	17.06	0.96	1.66
189*	15.80	1.09	1.70
190*	16.28	0.99	1.73
191*	15.04	1.90	2.43
192*	15.86	1.15	1.77
194*	16.95	1.14	1.73
195	13.56	1.11	1.47
196*	15.56	1.19	1.79
197*	14.86	0.99	1.80
198	17.20	1.18	1.44
199	17.14	1.19	1.61
200*	16.40	1.09:	1.73

Table 1 (continued)

No.	G	$G-R$	$U-G$
201	16.05	1.87	2.81
202	16.94	0.71	1.61
203	12.88	0.72	1.50
204*	15.21	1.89	2.30
205	17.42	1.03	1.81
206	17.28	1.05:	1.72
207	16.61	0.94	1.72
208*	14.98:	2.03:	2.61:
209*	15.64	2.10	2.51
210*	16.98	1.20	1.67
211	16.36	1.61	2.64
212	16.21	1.35	1.55
213	17.04	0.96	1.64
214	14.92	0.81	1.53
215	15.86	0.88	1.66
216	15.69	1.39	1.66
217	16.18	1.32	1.59
218	11.24	0.61	1.33
219	16.73	1.11	1.55
220	16.15	1.73	2.37
221	16.66	1.10	1.68
222	16.60	1.25	1.47
223	15.29	1.36:	2.02
224	14.85	1.16	1.66
225	15.58	0.93	1.69
226	15.82	0.92	1.68
227	13.42	0.92	1.63
228	15.15	0.79	1.63
229	15.64	1.19	1.39
230	16.72	1.08:	1.63
231	16.55	1.10	1.62
232	16.27	1.06	1.60
233	14.39	0.92	1.62
234	16.02	1.05	1.67
235	15.48	1.94	2.44
236	16.63	0.97	1.64
237	16.55:	—	1.83:
238	13.71	1.71	2.79
239	17.01	1.10	1.53
240	16.93	0.87	1.68
241	14.91	1.09	1.47
242*	15.79	0.99	1.59
243	16.37	1.31	1.89
244	16.11	0.80	1.61
245	13.11	1.11	1.41
246*	15.48	1.96	2.39
247*	15.27	1.22	1.57
248*	16.94	1.25	1.71
249*	16.91	1.22	1.69
250*	15.40	1.92	2.35
251	16.40	1.24	1.65
252*	15.86	1.00	1.76
253	16.42	1.31:	1.69
254	14.98:	1.94:	2.50:
255	11.18	0.61:	1.25
256	13.19	0.83	1.42
257	13.12	1.36	1.66
258	15.70	1.30	2.14
259	16.26	1.07	1.86

Table 1 (continued)

No.	<i>G</i>	<i>G</i> − <i>R</i>	<i>U</i> − <i>G</i>
260*	15.69	1.13	1.65
261	14.78	0.74	1.68
262	14.09	0.80	1.52
263*	15.57	0.96	1.79
264*	16.36	0.94	1.82
265	16.59	0.90	1.51
266	16.56	1.22	1.90
267*	16.04	1.05	1.73
268	16.19	1.05	1.91
269	15.86	2.11	2.75
270*	15.11	1.21	1.68
271*	16.04	1.15	1.60
272	16.71	0.91	1.71
273	16.26	1.31	1.81
274	14.86	1.22	1.59
275	14.24	0.64	1.64
276	15.42	0.81	1.35
277*	16.11	1.09	1.57
278*	15.19	1.78	2.51
279	11.24	0.86	1.41
280	14.61	1.08	1.51

Asterisk: probably physical member.
Colon: generally "blend".

were regarded as physical members. But it seems that many stars of the surrounding fit also quite well in the two colour-magnitude-diagrams.

The fitting method for both colour-magnitude-diagrams leads to the following result for

NGC 2236

$m-M = 14.05$ apparent diam. total = 9'
 $E(G-R) = 0.51$ linear diam. total = 9 pc

$E(U-G) = 0.36$ linear diam., core = 3 pc
 $Abs.(G) = 1.37$ earliest type = a 0
 $(m-M)_0 = 12.68$ brightest main
Distance = 3430 pc sequence star $M(G) = 2.0$

The evolved stars of the cluster point in the colour-magnitude-diagrams to 19 red giants separated from them by a pronounced Hertzsprung gap. They define a giant branch with a mean absolute magnitude of $M(G) = 1.0$, which corresponds to the mean absolute magnitude of field stars of the same type. The turn off point in the $U-G$ diagram lies at about $M(G) = 2.0$ and $(U-G)_0 = 1.3$ mag.

The cluster is too old to be an indicator for a spiral arm.

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