BULLETIN OF THE ASTRONOMICAL INSTITUTES OF THE NETHERLANDS.

COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN.

Variable stars in the globular cluster N.G.C. 6171, by *P. Th. Oosterhoff*.

The present investigation is based upon 18 plates taken by the writer with the 60 inch reflector of the Mount Wilson Observatory. As the number of plates is insufficient for a thorough study of this globular cluster the results obtained should be considered as provisional. They are published, however, since the writer has no opportunity to obtain additional material.

The equatorial and the galactic co-ordinates of N.G.C. 6171 are:

$$\alpha = 16^{h}26^{m}\!\cdot\!9 \atop \delta = -12°50'} \; (1900) \quad \lambda = 332° \atop \beta = +22°$$

The cluster is relatively poor and loose and has been assigned by SHAPLEY[1]) to class X.

Some data about the plates, which were taken at the Newtonian focus, are given in Table 1. The three plates taken with a 40 inch diaphragm were followed by equally long exposures on S.A. 133. The plates of each pair were taken from the same box and were developed together.

The plates have been searched for variable stars at the Mount Wilson Observatory and later by the courtesy of Prof. VAN RHIJN at the Groningen Laboratory, which led to the discovery of 24 variables. With the exception of one variable, which is situated

TABLE 1.

plate	J.D.Hel.M.A.T.Gr.	exposure time	opening of mirror
	$\overline{d}$	min.	$''$
201	2427872·9512	20	60
220	7889·9815	15	60
231	7930·9511	20	60
240	7931·9574	20	60
243	7954·8637	15	60
248	7955·8311	15	60
258	7956·8248	15	60
279	7987·7479	20	60
299	7988·7436	20	60
329	7990·7400	20	60
344	8007·6938	30	40
354	8008·6944	30	40
367	8016·6867	30	40
380	8046·6556	20	60
393	8047·6555	20	60

at a distance from the cluster of nearly 23', they are marked in Figure 1*a*. The rectangular co-ordinates relative to the approximate center of the cluster are given in Table 2. In order to facilitate the identification the co-ordinates of three stars from the A.G.

[1]) "Star clusters", *Harv. Mon.* **2**.

TABLE 2.

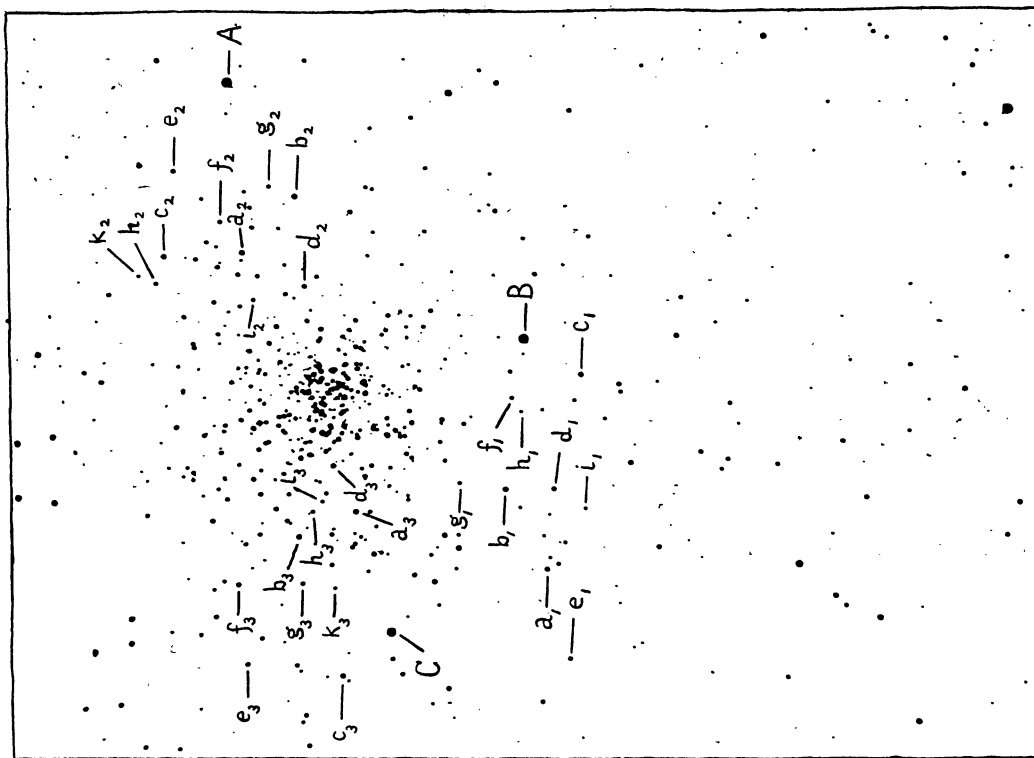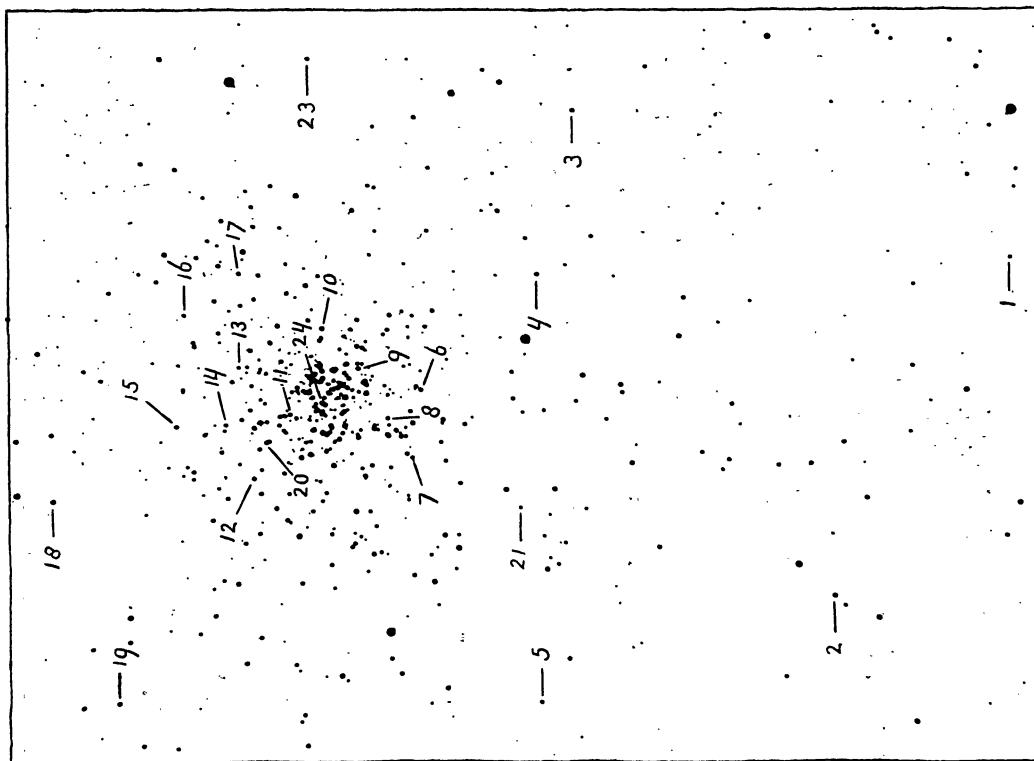| var.	x	y	var.	x	y	*	x	y
	$'$	$'$		$'$	$'$		$'$	$'$
1	− 1·88	− 8·70	13	− ·45	+ 1·20	A.G. Cam. 5712	− 26·87	− 3·36
2	+ 2·48	− 6·48	14	+ ·29	+ 1·37	,, 5714	− 24·85	− 4·46
3	− 3·74	− 3·06	15	+ ·32	+ 2·00	,, 5720	+ 9·97	+ 15·28
4	− 1·66	− 2·61	16	− 1·12	+ 1·89			
5	+ 3·85	− 2·69	17	− 1·65	+ 1·19	A	− 4·08	+ 1·31
6	− ·18	− 1·12	18	+ 1·29	+ 3·59	B	− ·82	− 2·46
7	+ ·70	− 1·02	19	+ 3·88	+ 2·71	C	+ 2·96	− ·75
8	+ ·20	− ·70	20	+ ·52	+ ·85			
9	− ·44	− ·33	21	+ 1·35	− 2·41	22*a*	− 23·41	− 3·41
10	− ·95	+ ·14	22	− 22·57	− 3·05	22*b*	− 22·71	− 3·14
11	+ ·16	+ ·55	23	− 4·39	+ ·32			
12	+ ·98	+ 1·02	24	·00	+ ·14			

273

FIGURE 1b.

FIGURE 1a.

Cam. catalogue and of the three bright stars in the proximity of the cluster are given also.

By means of the three comparisons with S.A. 133 the photographic magnitudes were determined for three sequences of nine or ten stars, which have been marked in Figure 1b. For this purpose the plates were measured in a Hartmann photometer, the wedge being replaced by a scale of graduated exposures. The measures were performed twice in slightly different ways which gave nearly identical results, the mean of which has been adopted. Scale and zero-point were derived from the magnitudes of 50 stars as given in the Mount Wilson Catalogue of Selected Areas. Since the stars which were measured are only a few minutes of arc distant from the center of the plate the correction for coma, which is reduced considerably by the 40 inch diaphragm, has been neglected. The method of measurement proves to be satisfactory. From a comparison between the three measures of the S.A. stars the mean error of a magnitude derived from a single plate is found to be $\pm$ ${}^m\cdot 056$.

The adopted magnitudes of the sequence stars are given in the fourth column of Table 3. The deviations of the individual plates from the mean are shown in the last three columns. These seem to be of a systematic character and indicate differences in scale which probably are due to a difference in seeing between the exposures on the cluster and on the Selected Area.

The magnitudes of the variable stars were determined from estimates made with the aid of an eyepiece. They are listed in Table 4.

Variable 1 probably is a longperiod variable. Its brightness varies gradually over a range of more than three magnitudes during the six months of observation.

TABLE 3.

*	x	y	m_{pg}	344—mean	354—mean	367—mean
a_1	+ 2.15	− 2.76	15.41	+ .12	− .08	− .05
b_1	+ 1.12	− 2.22	15.39	+ .12	− .06	− .05
c_1	− .37	− 3.20	15.50	+ .03	+ .06	− .08
d_1	+ 1.11	− 2.85	15.86	+ .11	− .07	− .04
e_1	+ 3.29	− 3.04	16.13	− .03	+ .03	− .01
f_1	− .06	− 2.30	16.16	− .09	+ .02	+ .07
g_1	+ 1.03	− 1.64	16.42	− .04	+ .03	+ .01
h_1	+ .11	− 2.43	16.66	− .14	− .03	+ .16
i_1	+ 1.36	− 3.25	16.73	− .14	+ .10	+ .04
a_2	− 1.92	+ 1.14	15.21	+ .18	− .07	− .10
b_2	− 2.64	+ .47	15.16	+ .11	+ .03	− .15
c_2	− 1.88	+ 2.14	15.45	+ .01	− .03	+ .01
d_2	− 1.50	+ .34	15.69	+ .06	− .05	− .01
e_2	− 2.97	+ 2.00	15.97	+ .02	+ .11	− .13
f_2	− 2.32	+ 1.41	16.08	− .05	+ .10	− .05
g_2	− 2.76	+ .79	16.23	− .08	+ .02	+ .05
h_2	− 1.54	+ 2.24	16.39	− .09	+ .06	+ .04
i_2	− 1.32	+ 1.01	16.47	− .06	− .02	+ .08
k_2	− 1.64	+ 2.47	16.79	− .12	.00	+ .12
a_3	+ 1.40	− .29	15.20	+ .10	+ .06	− .15
b_3	+ 1.73	+ .44	15.28	+ .02	+ .10	− .12
c_3	+ 3.51	− .13	15.47	+ .03	+ .15	− .19
d_3	+ .81	.00	15.66	− .04	+ .01	+ .02
e_3	+ 3.36	+ 1.10	15.99	− .06	+ .09	− .03
f_3	+ 2.34	+ 1.21	15.98	− .12	+ .13	− .02
g_3	+ 2.33	+ .39	16.17	− .06	+ .08	− .03
h_3	+ 1.40	+ .26	16.38	− .14	+ .09	+ .06
i_3	+ 1.27	+ .14	16.53	− .05	+ .03	+ .02
k_3	+ 2.39	− .03	16.80	− .08	+ .02	+ .07

TABLE 4.

plate	1	2	3	4	5	6	7	8	9	10	11	12
201	< 14.16	16.16	16.00	16.04	16.25	15.68	15.86	——	——	16.58	——	16.26
220	< 14.16	15.95	16.04	16.15	16.16	16.09	15.57	16.42	15.97	16.47	16.47	16.27
231	< 14.16	15.86	16.09	16.09	15.86	16.14	15.89	16.45	15.91	15.48	16.47	16.50
240	< 14.16	16.21	16.00	15.86	16.13	16.16	15.74	16.33	16.02	16.47	16.18	15.27
243	< 15.40	16.25	16.13	16.13	15.74	16.13	16.37	16.29	16.41	16.59	16.06	16.26
248	< 15.40	16.14	16.04	15.68	16.04	16.00	16.54	15.57	16.28	16.34	16.39	16.48
258	< 15.40	15.86	15.91	16.09	15.91	15.81	16.60	16.54	16.31	16.23	16.18	16.46
279	15.95	16.13	15.91	15.64	15.86	15.86	16.61	15.68	15.97	16.31	16.43	15.52
299	15.95	15.90	16.20	16.14	16.06	16.09	16.66	16.54	16.04	15.69	16.02	15.46
329	16.16	16.37	15.79	16.08	15.95	16.13	16.66	16.47	16.18	16.68	16.43	16.18
344	16.54	15.86	15.77	16.14	16.00	16.17	16.42	16.47	15.97	16.41	15.69:	15.73
354	16.66	15.79	15.81	15.91	16.22	16.08	16.50	16.42	16.23	15.69	16.39	16.03
367	16.58	15.62	15.55	16.14	15.81	15.86	16.42	16.37	16.16	16.18	16.18	15.85
380	> 16.75	16.25	15.68	15.72	16.13	16.00	16.42	16.14	16.01	16.44	16.43	16.38
393	> 16.75	16.04	16.09	16.00	15.91	15.77	16.50	15.74	16.01	16.68	16.28	16.42

TABLE 4 (continued).

plate	13	14	15	16	17	18	19	20	21	22	23	24
	m	m	m	m	m	m	m	m	m	s	m	m
201	16·01	16·39	15·64	16·16	16·39	16·44	16·31	15·66	16·61	− 2·1	15·97	15·66:
220	16·53	15·39	15·69	16·43	16·42	16·47	16·21	16·38	16·42	− ·5	15·91	16·46
231	16·16	15·50	15·64	15·91	16·31	16·39	16·24	16·17	16·66	− ·4	15·64	16·21
240	16·53	15·97	16·08	15·69	16·16	16·04	15·88	15·77	16·78	·0	15·64	16·46
243	16·47	16·44	16·06	16·23	16·39	16·42	16·11	16·35	16·66	− 3·6	15·69	16·31
248	16·43	16·47	15·61	16·31	15·97	16·28	16·13	16·13	16·33	− 4·6	15·69	16·46
258	16·44	16·43	16·20	16·39	15·35	16·20	16·08	15·88	16·66	− 4·6	15·61	16·28
279	15·45	15·35	16·08	16·43	15·64	15·75	16·11	16·38	16·73	·0	16·18	16·34
299	15·78	15·57	15·69	16·47	16·47	16·47	16·02	16·24	16·71	− ·5	16·04	16·38
329	16·43	16·01	15·83	16·53	16·23	16·31	15·77	16·28	16·54	·0	15·78	16·08
344	16·53	16·31	15·97	15·88	16·45	16·23	15·99	15·99	16·70	− 2·2	16·04	16·38
354	16·71	16·39	15·92	16·53	16·39	15·91	16·13	16·43	16·73	− 1·3	16·16	16·34
367	15·45	15·53	15·57	15·78	16·42	16·31	15·82	16·21	16·83	− 2·6	15·69	16·21
380	15·91	16·08	15·97	16·39	15·50	16·34	16·17	16·11	16·70	− ·0	15·88	15·66
393	16·16	16·39	15·97	16·23	16·39	16·08	15·77	15·77	16·73	− ·5	15·64	16·04

The character of the lightvariation of variable 22 is unknown. It is situated near the border of the plate and very faint. The estimates could not be reduced to magnitudes. The brightness of the comparison stars 22a and 22b, the positions of which are given in Table 2, is −2^s·6 and ^{s}·0 respectively.

The assumption that the remaining stars are cluster type variables seems to be justified by the fact that the observations at minimum are more frequent than those at maximum brightness and by the small dispersion of the median magnitudes derived below.

The observed maximum and minimum brightness of these variables are given in Table 5. The minimum value is the mean of the three faintest magnitudes. The median magnitudes are shown in the last column. Their mean dispersion and the mean median magnitude are found to be ± ^{m}·15 and 16^m·01. If we omit variable 21 which is exceptionally faint these figures become ± ^{m}·09 and 15^m·99. As the number of plates is small the maxima may be insufficiently covered by observations which will cause the mean median magnitude to be slightly too faint.

The distance modulus derived above must still be corrected for the influence of interstellar absorption. The cluster is situated near the border of HUBBLE's zone of avoidance and according to STEBBINS and WHITFORD[1]) it shows the large color excess $E = ^m$·44 in their color system for the B stars. The total photographic absorption however is unknown. If we assume it to be 10E, following STEBBINS and WHITFORD (l. c.), the resulting distance is 2100 ps. An upper limit of the distance is obtained if we take the photographic absorption to be twice the visual, which yields 8200 ps.

Star counts were made on the plates 354 and 367 for

TABLE 5.

var.	distance from center	max. magn.	min. magn.	median magn.
	'	m	m	m
2	6·9	15·62	16·29	15·96
3	4·8	15·55	16·14	15·84
4	3·1	15·64	16·14	15·89
5	4·7	15·74	16·21	15·98
6	1·1	15·68	16·15	15·92
7	1·2	15·57	16·64	16·10
8	·7	15·57	16·52	16·04
9	·6	15·91	16·33	16·12
10	1·0	15·48	16·65	16·06
11	·6	15·69	16·46	16·08
12	1·4	15·27	16·48	15·88
13	1·3	15·45	16·59	16·02
14	1·4	15·35	16·45	15·90
15	2·0	15·57	16·12	15·84
16	2·2	15·69	16·51	16·10
17	2·0	15·35	16·45	15·90
18	3·8	15·75	16·46	16·10
19	4·7	15·77	16·25	16·01
20	1·0	15·66	16·40	16·03
21	2·8	16·33	16·78	16·56
23	4·4	15·61	16·13	15·87
24	·1	15·66	16·46	16·06

a square area of 121 square minutes of arc around the cluster. The sum of the figures in rows parallel to the x- and to the y-axis are given in Table 6 for different limiting magnitudes. The table indicates a diameter of nearly 10′ which agrees closely with the values derived by REINMUTH[2]) and SHAPLEY[3]) and also

---

[1]) Ap. J. 84, 132; Mt Wilson Contr. No. 547.
[2]) Abh. Heidelberger Akad. Wiss. 13, 1926.
[3]) Proc. Nat. Acad. Sc. 21, No. 11, 593.