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Photographic photometry of two variable stars in the globular cluster ω Centauri,

by *C. J. Kooreman.*

The two stars which form the subject of this publication are the variable No. 164 according to W. Chr. Martin [1]) and a new variable, indicated as No. 168, found on old Cape plates of the ω Centauri cluster by Prof. E. Hertzsprung during his stay at the Cape Observatory in 1939 (*B.A.N.* No. 331).

The plate material is the same as discussed by Dr. Martin in the above mentioned publication.

The co-ordinates of the variables and the comparison stars in the system of Martin are:

	x	y		x	y
164	$+152''80$	$+478''50$	168	$-543''66$	$-201''42$
164*a*	$+163''21$	$+557''09$	168*a*	$-531''48$	$-190''64$

For the determination of the zeropoint of the magnitudes two stars have been used, viz. for the variable No. 168 the star No. 64a and for No. 164 the star l_2, the magnitudes of which are $14^{m}{\cdot}792$ and $13^{m}{\cdot}728$ respectively, as taken from Table 2 of Martin's publication. The plates have been measured in the old Schilt microphotometer with the same diaphragm with which they were measured formerly. The galvanometer readings have been converted into provisional magnitudes m', with the aid of a table frequently used for that purpose. Small corrections had to be applied to these provisional magnitudes to make them linear with Martin's magnitude system (see section 3 of Martin's publication).

For each plate the differences $m'_{164} - m'_{164a}$, $m'_{164a} - m'_{l_2}$, $m'_{168} - m'_{168a}$ and $m'_{168a} - m'_{64a}$ were divided by the gradation factors taken from Table 14 of Martin's publication.

From the differences, thus corrected for gradation, the following mean values for the Johannesburg plates were derived: $m_{164a} - m_{l_2} = -\,^{m}{\cdot}032$ and $m_{168a} - m_{64a} = +\,^{m}{\cdot}122$, thus $m_{164a} = 13^{m}{\cdot}696$ and $m_{168a} = 14^{m}{\cdot}914$. For the Lembang plates I found: $m_{164a} = 13^{m}{\cdot}72$ and $m_{168a} = 14^{m}{\cdot}80$. With these magnitudes of the comparison stars the magnitude of the variable was then derived for each plate.

In Table 3 the magnitudes thus obtained, diminished by 10^{m}, are given. In the head of this table the first and last J.D.'s are given of the pages 61 to 67 inclusive and 124 of Martin's publication.

No. 164.

The brightness of this irregular variable changes slowly between the limits $13^{m}{\cdot}7$ and $14^{m}{\cdot}0$. On the Lembang plates this star is nearly $^{m}{\cdot}2$ fainter than on the Johannesburg plates, so that it is probably a red star. The mean error of one observation derived from the differences in magnitude of consecutive observations in one night is $\pm\,^{m}{\cdot}032$.

No. 168.

As epochs for the determination of the period were used the J.D.'s of the points on the descending branch for which the brightness was $15^{m}{\cdot}21$. From 12 epochs a period of

$$^{d}{\cdot}3212933 \pm {}^{d}{\cdot}0000012 \text{ (m.e.)}$$

was found with the aid of least squares.

Table 1

J. D. hel. M. Astr. T. Grw.	E	O—C
d 2426424·477	0	d ·000
33·480	28	+ 6
34·450	31	+ 13
53·392	90	— 2
62·391	118	+ 1
71·372	146	— 14
72·346	149	— 4
7892·466	4569	0
7901·453	4597	— 10
11·414	4628	— 9
12·393	4631	+ 6
40·352	4718	+ 13

Table 1 gives the epochs, the counting of the periods and the O—C's of the least squares solution. The counting of the periods could be checked with the Lembang plates of 1934 and 1935. The mean error of one epoch is $\pm\,^{d}{\cdot}009$. The phases have been computed according to the formula

$$\text{phase} = 3^{d^{-1}}{\cdot}112421 \times (\text{J.D.hel.M.astr.T.Grw.} - 2400000).$$

The observations were then arranged according to phase and divided into groups generally containing ten observations. For each group the average phase and magnitude have been computed. This was done for the observations of 1931 and 1935 separately and also for the combined material. The Lembang observations have been omitted on account of their deviating effective wavelength.

The normal points thus obtained are given in Table 2.

Figure 1 shows the mean light curve. The median

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[1]) "Photographic photometry of variable stars in the globular cluster ω Centauri." *Ann. van de Sterrewacht te Leiden*, Deel XVII, tweede stuk.

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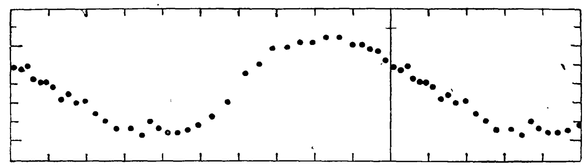
Table 2

Normal points 168 S

n	phase	m
	P	m
10	·0086	15·113
10	·0279	·128
10	·0436	·110
10	·0589	·176
10	·0780	·194
10	·0948	·194
10	·1105	·218
10	·1324	·286
10	·1504	·263
10	·1724	·305
10	·1977	·295
10	·2221	·362
10	·2494	·400
10	·2784	·443
10	·3176	·443
10	·3463	·473
10	·3688	·404
10	·3893	·439
10	·4138	·462
10	·4404	·461
10	·4660	·449
10	·4965	·421
10	·5295	·376
10	·5715	·300
10	·6182	·150
10	·6525	·102
10	·6896	·019
10	·7289	15·012
10	·7612	14·986
10	·7946	14·987
10	·8287	14·959
9	·8638	14·960
9	·8986	14·996
9	·9234	14·998
9	·9466	15·022
9	·9663	·033
9	·9868	15·081
	168 (1931)	
10	·0180	15·130
10	·0481	·155
10	·0814	·182
10	·1118	·244

n	phase	m
	P	m
10	·1454	15·300
10	·1746	·311
10	·2036	·301
10	·2452	·411
10	·3133	·431
10	·3747	·407
10	·4161	·421
10	·4487	·462
10	·4843	·451
10	·5206	·389
10	·5717	·283
10	·6264	·142
10	·6651	·069
10	·7088	15·039
10	·7505	14·978
10	·7886	15·003
10	·8299	14·965
10	·8704	14·966
10	·9113	14·965
9	·9489	15·028
8	·9812	15·079
	168 (1935)	
10	·0186	15·108
10	·0549	·128
10	·0921	·207
10	·1348	·228
10	·2201	·348
10	·2864	·431
10	·3411	·491
9	·3811	·436
9	·4527	·474
4	·5738	15·298
5	·6950	14·992
5	·8214	14·978
8	·9331	15·016
7	·9790	15·059

Figure 1



magnitude is half a magnitude fainter than that of the other c-type stars in the ω Centauri cluster.

The mean error of one observation derived from the differences in magnitude between observations consecutive in phase is ± m·069.

The characteristics of the light variation are:

period	d·3212933
mean error	± ·0000012
reciprocal period	$3^{d^{-1}}$·112421
mean error	± ·000011
magnitude of maximum M	14m·96
magnitude of minimum m	15m·46
amplitude	m·50
median magnitude $\frac{M + m}{2}$	15m·21
Δm in P·05 on rising branch	m·12
ε′ = time from min. to max. in periods	P·45
γ = average magn. minus median magn.	m·01
$m_{\Delta P = \cdot 5}$ = magnitude for which the phase difference between the rising and descending branches is one half period	15m·22
phase on rising branch of $m_{\Delta P = \cdot 5}$	P·600
ζ = $m_{\Delta P = \cdot 5}$ minus median magnitude	m·01
number of observations, total	364
,, ,, ,, in 1931	247
,, ,, ,, ,, 1935	117

Table 3

6406·5403 6427·4543 incl		6427·4615 6441·4452 incl		6441·4523 6459·4080 incl		6459·4151 6469·3895 incl		6470·3346 7894·4415 incl		7894·4488 7912·4275 incl		7912·4344 7971·2725 incl		7543·0467 7988·0469 incl	
164_s	168_s	164_s	168_s	164_s	168_s	164_s	168_s	164_s	168_s	164_s	168_s	164_s	168_s	164_s	168_s
—	—	3·80	5·35	3·91	4·98	3·79	4·97	3·88	4·94	3·93	5·53	3·79	5·53	4·06	—
—	—	3·81	5·41	3·90	5·01	3·71	4·89	3·86	4·91	3·96	5·45	4·08	5·06	4·09	5·09
—	—	3·72	5·33	3·87	5·04	3·74	4·97	3·81	4·94	4·03	5·38	3·94	4·98	4·09	5·06
—	—	3·82	5·40	3·80	5·05	3·74	5·01	3·82	4·97	3·99	5·57	3·95	4·87	4·18	4·83
3·91	5·50	3·74	5·44	3·80	5·06	3·73	5·00	3·81	4·93	3·97	5·51	4·09	5·00	4·06	4·93
3·85	5·06	3·77	5·36	3·78	5·12	3·74	4·90	3·82	4·98	3·99	5·37	4·02	5·16	4·11	4·95
3·92	5·17	3·86	5·40	3·77	5·20	3·76	4·94	3·81	4·96	4·03	5·41	4·01	5·15	4·17	5·41
3·94	4·96	3·78	—	3·79	5·11	3·73	4·96	3·84	—	3·96	5·42	3·94	5·07	4·20	5·59
3·83	5·03	3·79	5·23	3·74	—	3·76	5·02	3·85	5·00	3·93	5·47	3·98	5·03	3·99	—
3·91	5·01	3·77	5·39	3·82	—	3·79	5·02	3·81	5·00	3·91	5·53	4·00	5·08	3·98	—
3·91	5·10	3·83	—	3·78	—	3·68	4·99	3·82	5·06	—	—	4·00	5·11	4·17	—
3·88	4·98	3·71	5·42	—	—	3·70	5·15	3·85	5·17	3·98	5·40	4·01	5·10	4·17	—
3·87	4·81	3·82	5·25	3·79	5·20	3·75	4·98	3·81	5·08	3·98	—	4·07	5·23	4·22	—
3·86	4·88	3·81	5·24	3·74	5·20	3·72	5·06	3·83	5·25	3·85	5·07	4·07	5·21	4·17	5·07
3·92	5·02	3·85	5·04	3·77	5·30	3·72	5·16	3·87	5·16	3·91	5·07	4·02	5·12	4·13	—
3·91	4·91	3·82	5·07	3·76	5·29	3·75	5·14	3·83	5·20	3·88	5·03	4·01	5·30	4·10	—

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