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:

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 792 and 13^m 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: $m_{164a} - m_{l_2} = - \text{m·o32}$ and $m_{168a} - m_{64a} = + \text{m·122}$, thus $m_{164a} = 13\text{m·696}$ and $m_{168a} = 14\text{m·914}$. For the Lembang plates I found: $m_{164a} = 13\text{m·72}$ and $m_{168a} = 14\text{m·80}$. 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·7 and 14^m·0. On the Lembang plates this star is nearly ^m·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·o32.

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·21. From 12 epochs a period of

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

was found with the aid of least squares.

TABLE I

J. D. hel. M. Astr. T. Grw.	E	O-C				
d 2426424'477 33'480 34'450 53'392 62'391 71'372 72'346 7892'466 7901'453 11'414 12'393 40'352	0 28 31 90 118 146 149 4569 4597 4628 4631 4718	d '000 + 6 + 13 - 2 + 1 - 14 - 4 0 - 10 - 9 + 6 + 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'oog. The phases have been computed according to the formula

phase =
$$3^{d^{-1}}$$
.112421 × (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.

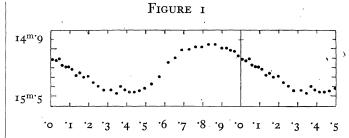
Figure 1 shows the mean light curve. The median

^{1) &}quot;Photographic photometry of variable stars in the globular cluster ω Centauri." *Ann. van de Sterrewacht te Leiden*, Deel XVII, tweede stuk.

TABLE 2

Normal points 168 S

P m P m P m P m P m P m P m P M P				, T		-		
10	n	phase	m		r	;	phase	m
10							P	
10 '0436 '110					1			15.300
10 '0436 '110 10 '2036 '301 10 '0589 '176 10 '2452 '411 10 '0780 '194 10 '3133 '431 10 '0948 '194 10 '3747 '407 10 '1105 '218 10 '4487 '462 10 '1504 '263 10 '4487 '462 10 '1524 '305 10 '5206 '389 10 '1977 '295 10 '5717 '283 10 '1977 '295 10 '5717 '283 10 '2784 '443 10 '7688 15'039 10 '3463 '473 10 '7686 15'039 10 '3688 '404 10 '8299 14'965 10 '4965 '421 10 '8299 14'965 10 '4965 '421 10	10		.158		1	0	1746	.311
10					1	0	. 2036	.301
10 '0948 '194 - 10 '3747 '407 10 '1105 '218 10 '4161 '421 10 '1504 '263 10 '4487 '462 10 '1504 '263 10 '4843 '451 10 '1724 '305 10 '5206 '389 10 '1977 '295 10 '5717 '283 10 '2494 '400 10 '6651 '669 10 '2784 '443 10 '7686 15'039 10 '3463 '473 10 '7886 15'039 10 '3463 '473 10 '7886 15'039 10 '3688 '404 10 '8299 14'965 10 '3893 '439 10 '8704 14'966 10 '4965 '421 10 '9113 14'965 10 '4965 '421 10 '9289 15'028 10 '6896 '019 10	10		.176		1	0	2452	411
10 '0948 '194 - 10 '3747 '407 10 '1105 '218 10 '4161 '421 10 '1324 '286 10 '4487 '462 10 '1504 '263 10 '4487 '462 10 '1724 '305 10 '5206 '389 10 '1977 '295 10 '5717 '283 10 '2221 '362 10 '6264 '142 10 '2494 '400 10 '6651 '069 10 '2784 '443 10 '7688 15'039 10 '3463 '473 10 '7886 15'039 10 '3688 '404 10 '8299 14'965 10 '438 '462 10 '9113 14'966 10 '4965 '421 10 '9113 14'965 10 '5295 '376 168 (1935) 168 (1935) 10 '6896 '019 10 '			·194		1	0	.3133	. 431
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<u>.</u>		.0814	· 182		. ,			
	10	1110	444		•			,



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 \pm ^m·o69.

The characteristics of the light variation are:

ı	and characteristics of the light varie	mon arc.
	period	d·3212933
ļ	mean error	± '0000012
	reciprocal period	3 ^{d-1} .112421
	mean error	\pm .000011
	magnitude of maximum M	14 ^m ·96
	magnitude of minimum m	15 ^m ·46
	amplitude	m·50
	median magnitude $\frac{M+m}{2}$	15 ^m ·21
	Δ m in ^P ·05 on rising branch	m·12
	$\epsilon' = \text{time from min. to max. in periods}$	s ^P ·45
	γ = average magn. minus median mag	gn. ^m ·01
	$m_{\Delta P = 5} = magnitude$ for which t	he
	phase difference between t	he
	rising and descending bra	ın-
	ches is one half period	15 ^m ·22
	phase on rising branch of $m_{\Delta P=\cdot 5}$	P.600
	$\zeta = m_{\Delta P = .5}$ minus median magnitude	m.OI
	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	
164s	168 _s	164s	168 _s	164s	$168_{\rm s}$	164 _s	168 _s	164s	$168_{\rm s}$	164s	168s	164s	168 _s	164s	168 _s
3.82	5.20 5.00	3.80 3.81 3.72 3.82 3.74 3.77	5 ³⁵ 5 ⁴¹ 5 ³³ 5 ⁴⁰ 5 ⁴⁴ 5 ³⁶	3.91 3.90 3.87 3.80 3.80 3.78	4.98 5.01 5.04 5.05 5.06 5.12	3.79 3.71 3.74 3.74 3.73 3.74	4.97 4.89 4.97 5.00 4.90	3.88 3.86 3.81 3.82 3.81 3.82	4.94 4.91 4.94 4.97 4.93 4.98	3.93 3.96 4.03 3.99 3.97 3.99	5.53 5.45 5.38 5.57 5.51 5.37	3.79 4.08 3.94 3.95 4.09 4.02	5.53 5.06 4.98 4.87 5.00 5.16	4.06 4.09 4.09 4.18 4.06 4.11	5.09 5.06 4.83 4.93 4.95
3.92 3.94 3.83	5.03 4.06 2.14	3.86 3.78 3.79	5.40 5.53	3.77 3.79 3.74	5.11 —	3.76 3.76 3.76	4'94 4'96 5'02	3.81 3.84 3.85	4.96 2.00	3.99 3.09	5`41 5`42 5`47	3.98 3.01	5.12 5.03	4.120 3.09	5.41 2.20
3.88 3.01 3.01	5.10 4.98	3.77 3.83 3.71	5'39 5'42	3.82 3.48		3.79 3.68 3.70	5.02 4.99 5.15	3.81 3.82 3.85	5.06 2.00	3.88	5.23 5.40	4.00 4.00	5.10 2.11	3.98 4.17 4.17	′ — — —
3.87 3.86 3.92 3.91	4.81 4.88 5.02 4.91	3.82 3.81 3.85 3.82	5°25 5°24 5°04 5°07	3.79 3.74 3.77 3.76	5:20 5:30 5:29	3.75 3.72 3.72 3.75	4.98 5.06 5.16 5.14	3.81 3.83 3.87 3.83	5.08 5.25 5.16 5.20	3.88 3.85 3.88	5.07 5.03	4'07 4'07 4'02 4'01	5'23 5'12 5'12 5'30	4'22 4'17 4'13 4'10	5 [.] 07