Provisional ephemerides of 26 ne eclipsing variable stars within six degrees of η Carinae (Errata: 3 206)

Hertzsprung, E.

BULLETIN OF THE ASTRONOMICAL INSTITUTES OF THE NETHERLANDS.

1924 October 10 — Volume II. — No. 65.

COMMUNICATION FROM THE OBSERVATORY AT LEIDEN.

Provisional ephemerides of 26 new eclipsing variable stars within six degrees of η Carinae,

by *Ejnar Hertzsprung*.

The continued comparison in the blinkmicroscope of plates taken with the Franklin-Adams instrument of the region round η Carinae has led to the discovery of still more variable stars than those already published in these columns. As a preliminary designation of these variables it is proposed to use the *B. A. N.* number followed by a small letter. The first new variable contained in this note would thus be *B. A. N.* 65, *a*. Therefore as many eclipsing variable stars are published in the present paper as the alphabet has letters.

Two identical spherical stars can never eclipse each other to a greater extent than $^{m}\!\cdot75$. (In case of ellipsoidal stars the total range may be greater). When therefore, as is usually the case, for the discovery of variable stars methods are used, which will hardly reveal any smaller range than about half a magnitude, the eclipsing variable stars actually found represent a strong selection, preferring systems showing unusually great range, such as those consisting of two components of considerable difference in surface-brightness, the smaller one being the brightest. For

TABLE I.

Star	α (1875)	δ (1875)	*C. P. D.*		approximate phgr. mag. at maximum	epoch of min. J. D. hel. M. T. Grw.	period	reciprocal period	depth of minima		number of plates	phase of min. in fraction of period zeropoint J. D. 2420000	fraction of period occupied by minimum
	h m s	° ′		m	m		d	d⁻¹	s	s		P	
a	10 6 30·1	— 60 5·7			13	2423871·050	1·4525	·68846	1·30	·06	339	·063	·15
b	9 3·5	— 58 36·1	— 58°2010	8·6	8·9	3868·292	3·8543	·25945	·223	·0	345	·6285	·10
c	10 32·7	— 59 47·1			13	3877·795	7·5637	·132211	·77	·09	344	·687	·10
d	17 21·9	— 56 36·9	— 56°3198	10·0	11·1	3872·929	·86691	1·15352	·36	·0	344	·501	·19
e	20 18·7	— 59 51·9			12	3849·5	3·9945	·250344	·36	·04	345	·7	—
f	26 39·6	— 61 1·2			12½	3843·447	1·0988	·91C07	·32	·02	194	·806	·10
g	27 21·2	— 55 36·3	— 55°3540	9·8	10·6	3871·249	4·1636	·2402	·45	·0	345	·874	·12
h	32 6·9	— 57 57·6			14½	3869·293	4·2866	·2333	·35	·0	319	·706	·11
i	32 10·0	— 55 23·0			13	3915·6	5·4895	·182166	—	—	341	·29	—
j	32 58·8	— 55 17·7	— 55°3647	9·2	9·7	3700·420	2·87615	·347687	·24	·0	400	·588	·12
k	33 15·1	— 63 36·9			13½	3856·352	4·9695	·201228	·97	—	309	·006	·10
l	35 22·0	— 59 33·0	— 59°2401	9·4	10·0	3840·321	·8405	1·189768	·22	·0	195	·091	·24
m	38 23·0	— 59 22·9	— 59°2517	9·1	9·5	3820·770	·66382	1·5063	·48	·0	251	·226	·35
n	40 9·5	— 61 44·5	— 61°1850	9·8	10·6	3810·13	10·466	·09555	·18	·03	221	·058	·1
o	46 9·6	— 55 44·8	— 55°3917	9·0	9·4	3852·212	1·1679	·85626	·094	·0	255	·495	·35
p	53 3·3	— 58 42·7			13	3899·235	2·3921	·418042	·6	0	390	·044	·15
q	55 21·2	— 56 32·3			13	3899·42	6·578	·15202	·50	·0	394	·79	·08
r	56 43·5	— 57 5·0			13½	3874·264	6·908	·1447	·50	·01	392	·606	·10
s	59 16·2	— 60 37·9			12½	3916·48	13·367	·0748	—	—	395	·953	·08
t	11 0 7·5	— 61 35·5			14	3870·557	·90145	1·1092	1·2	·0	300	·222	·15
u	0 42·5	— 58 58·3			14	3864·54	1·75106	·571082	·35	·0	304	·97	·16
v	1 41·7	— 63 55·2			13½	3912·93	3·46824	·28833	—	—	276	·215	·12
w	6 45·0	— 60 25·0	— 60°2638	8·6	8·9	3906·125	1·7071	·5858	·28	·0	408	·208	·25
x	6 47·8	— 60 2·7	— 60°2640	9·6	10·4	3879·894	1.53498	·651476	·30	—	399	·658	·15
y	14 3·0	— 56 36·3			13½	3870·129	2·15225	·46463	·79	·02	323	·178	·18
z	19 2·7	— 59 39·1			14	3899·932	1·5804	·63275	—	·08	374	·682	·23

the statistics of eclipsing variable stars it is therefore important to extend the field of investigation to those of smaller range. One method, employed with success by STEBBINS, is to examine known spectroscopic binaries for eclipse at the predicted times. But this method practically applies to the brighter stars only. The refinement made possible by the blinkmicroscope in the examination of photographic plates for the discovery of variable stars is therefore very welcome. The nearer the two plates to be compared are equal in quality of the images, gradation and fog, the smaller the perceptible change in a star will be. Though the magnitude equivalent of the estimated "step" used in the present note is not known with any accuracy, it appears that several of the variables found have only a small range. In fact I have tried to go to the limit of the power of the blinkmicroscope, when focal images are used, but I do not personally doubt the reality of the variability of any star announced in the present note.

In cases where there is no evidence of secondary minimum and the range does not exceed $^{m}\cdot75$, the two components may have practically the same surface-brightness, in which case the period will have to be doubled. For a decision spectroscopic observations are required.

Another point must also be borne in mind viz: the possible interference of a third star too near to the variable to be separated from it.

A list of the 26 new variables is given in Table 1. The estimated magnitude at maximum brightness is rather uncertain, but will still be of some use. The number of decimals given in the epoch and the period in some cases exceeds the accuracy obtained. The reciprocal of the period indicates the figures actually used in the calculation of the phases expressed in fractions of the period according to the formula

$$\text{Phase} = P^{-1} \text{ (J. D. hel. M. T. Grw.} - 2420000).$$

The reductions to the sun valid for the centre of the plates ($10^{h}45^{m}, -59^{\circ}\cdot5$) have been adopted throughout.

The scale of steps, in which the brightness has been estimated, is arbitrary. It may even be different for images of different intensity. As the region in question proved to be too crowded for the use of the objective grating, it will be more convenient to fix the magnitude scale by the aid of an instrument with longer focal length. Meanwhile it is assumed that one "step" is equivalent to somewhat more than a magnitude.

The number of plates used for each star is rather different, mainly because the treatment of several stars was finished before all the plates had been taken. The total number of estimates used in the present note is 8502.

The next column gives the phase of the primary minimum expressed in fractions of the period counting from J. D. hel. M. T. Grw. 2420000 as an arbitrary zero point.

The last column gives the estimated duration of the minimum as a fraction of the period. It will be seen that there is a systematic decrease of this fraction with increasing period, but not to such an extent that it would correspond to constant mean density of the components. The longer the period the smaller is the mean density of the eclipsing variables actually found. This result is probably not entirely due to selection. In this connection it may be noted, that the smallest densities found for eclipsing variables of longer period are below the minimum density possible for the shorter periods known.

TABLE 2.

Star	coordinates of comparisonstar counted from the variable		brightness of comp. star in steps	*C. P. D.*	
	s	′	s		m
a	+ 4·0	— ·2	·0		
	+ ·3	— ·5	·67		
	+ 2·1	— ·7	1·24		
b	— 81·5	+ 15·9	·0	— 58° 1985	8·6
	+ 1·5	+ 1·5	·36	— 58° 2011	9·1
c	+ 29·5	+ 2·2	·0		
	— 8·2	+ 1·3	·78		
d	+ 7·0	+ 2·6	·0	— 56° 3202	10·2
	— 9·5	+ 6·7	·15	— 56° 3188	10·0
e	— 69·7	— 8·7	·0		
	— 47·8	— 9·2	·32		
f	+ 13·2	+ 2·2	·0		
	— 19·3	— 1·1	·56		
g	+ 6·5	— 1·0	·0	— 55° 3544	10·1
h	— 19·6	— ·2	·0		
i	+ 8·5	— 2·9	·0		
j	+ 21·0	+ 3·3	·0	— 55° 3655	9·1
k	+ 2·8	+ ·3	·0		
l	+ ·5	+ 5·7	·0	— 59° 2402	9·4
	+ 6·0	+ 2·9	·50	— 59° 2405	9·8
m	— 15·0	+ 3·9	·0	— 59° 2509	8·7
	— 32·0	— ·3	·38	— 59° 2496	9·0
n	— 68·5	+ 7·3	·0	— 61° 1835	9·8
	— 4·5	+ 8·5	·12		
	— 68·0	— ·4	·21		
o	— 67·0	— 3·1	·0	— 55° 3898	8·8
	— 54·0	+ 2·9	·35	— 55° 3903	9·2
p	+ 11·9	+ 1·1	·0		
	— 10·8	·0	·62		
q	— 14·3	+ 2·0	·0		
r	— 36·6	— ·8	·0		
s	— 1·3	+ ·4	·0		
t	+ 15·6	+ 1·0	·0		
	— 1·7	+ 1·2	·55		
u	+ 1·6	+ ·8	·0		
v	— 1·9	— ·7	·0		
w	— 56·7	— 1·3	·0	— 60° 2606	8·6
x	+ 15·2	— ·4	·0	— 60° 2652	9·7
y	— 2·9	+ 1·6	·0		
	— 3·3	+ 2·3	·53		
	+ 1·0	+ ·6	·99		
z	+ 13·4	— ·4	·0		

A list of the comparison stars used is given in Table 2. It will be seen that in half of the cases the variable was compared with only one star.

The plates were all taken during the first 7 months of 1924, except when it is specially mentioned that the variable was found faint on an old plate.

When the observations were completed, the first thing to do was to find the period. For this purpose often simply the epochs were used, when the variable was found below a certain brightness. A least square solution was made, but generally the number of epochs was so small, that no reliable value of the mean error of the period found can be given. I think it possible, though not probable, that the period will have to be substantially altered in a case or two.

By the aid of the adopted period the phase expressed as a fraction of the period was calculated for each observation counting from J. D. hel. M. T. Grw. 2420000. The estimates were then arranged according to phase and divided into groups. To some extent such divisions into groups were preferred, which gave the smoother lightcurves. The latter have thus been somewhat flattered as regards the apparent mean error of a point of the curve. By this procedure however, in one case only the sequence of phases of the individual observations has been very slightly altered, viz: in case of the star *c*, where the adopted mean values of 3 observations each $^{P}\cdot710, ^{s}\cdot63$ and $^{P}\cdot716, ^{s}\cdot43$ would be $^{P}\cdot710, \cdot57$ and $^{P}\cdot716, ^{s}\cdot49$ respectively by unaltered sequence.

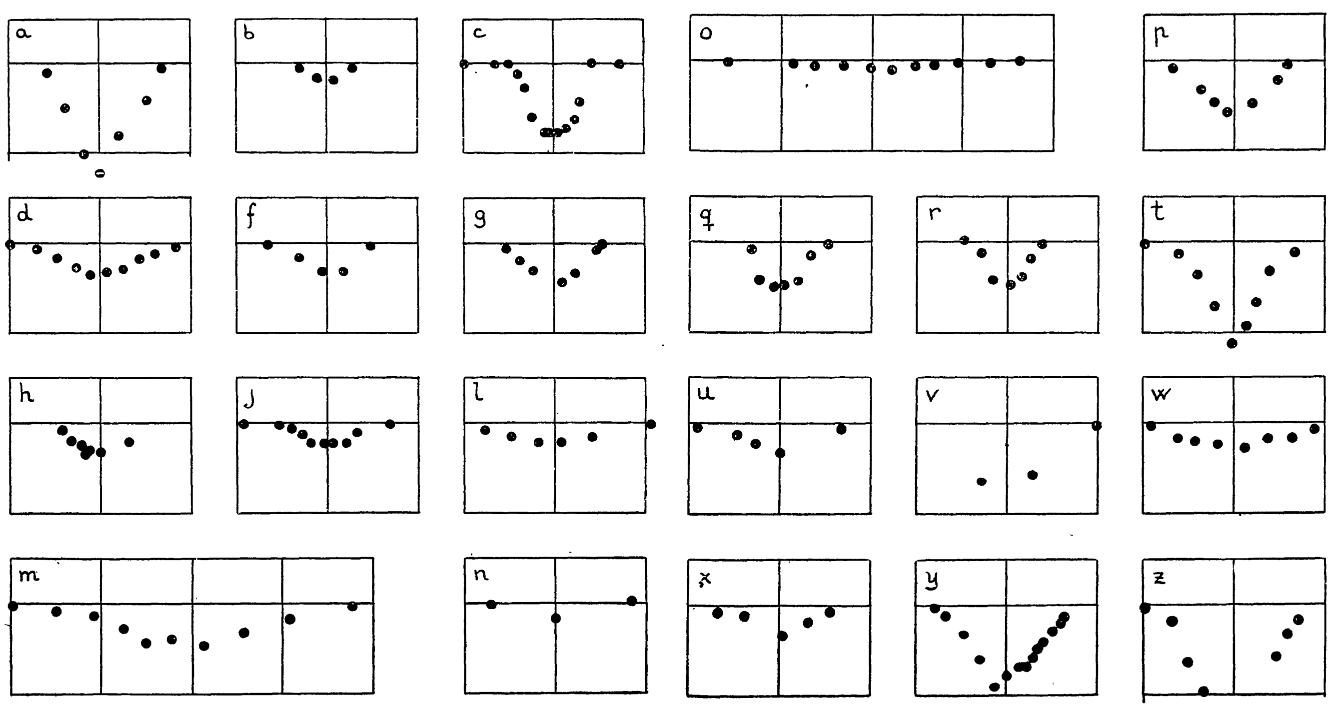
The mean values for each group of phase and brightness in steps are given in Table 3 for the individual stars.

In the accompanying Figure diagrams are shown for 22 of the 26 variables here considered. All these diagrams are on the same scale, one square representing one tenth of the period in the abscissa and one "step" of brightness in the ordinates.

The means represented in the diagrams are in Table 3 marked with an asterisk.

The median period of the 26 variables is $2^{d}\cdot3$ with a mean deviation in the logarithm of $\pm\cdot41$. This is practically the same as found for the 176 eclipsing variable stars tabulated in *V. J. S.* **58**, 249—251; 1923 (omitting B M Orionis of doubtful period) viz: $2^{d}\cdot9$ and $\pm\cdot40$ respectively. (Thus Algol itself has very nearly the median period of all known eclipsing variables).

I wish to express my thanks to the Union Astronomer for all the support, he has given to my work and to Mr. H. E. Wood, who not only introduced me to the mysteries of the Franklin-Adams instrument, but also helped me in several respects.



One square represents one tenth of the period in the abscissae and one "step" of brightness in the ordinates.

TABLE 3.

Columns: number of plates (n) | fraction of period (P) | brightness in steps (s)

a

n	P	s
3	·006	·11*
6	·025	·50*
6	·046	1·01*
6	·063	1·23*
6	·084	·80*
6	·115	·42*
6	·130	·06*
50	·183	—·001
50	·286	—·015
50	·431	—·004
50	·603	·028
50	·757	—·007
50	·912	—·022

b

n	P	s
80	·223	·033
80	·467	·044
5	·598	·107*
5	·618	·217*
5	·635	·240*
5	·655	·101*
80	·736	·048
85	·956	·038

c

n	P	s
20	·032	—·010
20	·108	·000
20	·162	·036
20	·182	·078
20	·225	·044
20	·303	·002
20	·369	—·010
20	·456	—·020
20	·523	—·008
20	·589	·007*
9	·622	·01*
4	·637	·01*
4	·647	·12*
3	·654	·28*
3	·663	·60*
3	·677	·78*
3	·682	·77*
3	·691	·77*
3	·701	·73*
3	·710	·63*
3	·716	·43*
3	·730	·00*
20	·761	·002*
20	·822	·003
20	·879	—·002
20	·942	—·010
20	·986	—·003

d

n	P	s
30	·065	·015
30	·141	·006
30	·232	·007
30	·339	·003
6	·401	·028*
6	·431	·087*
7	·454	·184*
8	·475	·296*
6	·490	·365*
7	·507	·343*
7	·526	·313*
7	·543	·201*
10	·561	·132*
10	·584	·063*
30	·640	·017
30	·740	·028
30	·818	·026
30	·900	·008
30	·985	·012

e

n	P	s
41	·163	·009
40	·187	·025
99	·412	—·014
10	·649	·169
10	·658	·241
10	·663	·241
10	·668	·281
10	·675	·298
10	·680	·320
10	·685	·355
8	·693	·345
8	·708	·326
79	·925	—·009

f

n	P	s
20	·052	—·020
20	·146	—·008
20	·256	·004
20	·393	—·018
20	·481	—·025
20	·553	—·010
20	·664	—·024
6	·741	·008*
5	·775	·152*
7	·801	·310*
7	·824	·297*
9	·853	·033*
20	·935	—·014

g

n	P	s
100	·095	—·345
100	·398	—·340
100	·669	—·337
10	·820	—·28*
7	·836	—·14*
5	·851	—·04*
6	·882	·10*
5	·897	·00*
4	·920	—·26*
8	·928	—·33*

h

n	P	s
100	·226	·022
100	·512	·032
5	·664	·10*
4	·674	·21*
4	·684	·26*
4	·690	·36*
4	·695	·32*
3	·706	·35*
3	·737	·22*
92	·907	—·019

i

n	P	s
22	·054	·054
31	·143	·069
32	·230	·070
4	·303	·425
4	·311	·385
4	·317	·328
4	·320	·165
4	·323	·082
4	·328	·100
4	·336	·050
4	·348	·055
37	·415	·064
29	·503	·086
17	·595	·056
39	·684	·070
24	·772	·078
12	·791	·068
4	·845	·220
4	·856	·125
29	·876	·056
29	·960	·080

j

n	P	s
100	·045	—·009
100	·286	—·007
30	·495	·004*
10	·534	·037*
6	·548	·055*
6	·560	·137*
6	·570	·223*
6	·584	·223*
6	·594	·233*
6	·609	·233*
5	·620	·104*
19	·657	·018*
100	·822	—·006

k

n	P	s
5	·957	—·35
2	·969	—·24
2	·979	—·15
3	·985	·02
2	·004	·65
3	·010	·48
3	·016	·35
3	·021	·09
4	·028	—·04
4	·036	—·13
29	·073	—·322
56	·[illegible]40	—·320
70	·431	—·314
63	·636	—·322
60	·845	—·295

l

n	P	s
8	·014	·074*
8	·045	·141*
8	·074	·202*
8	·098	·199*
8	·132	·150*
16	·197	·007*
19	·286	—·004
20	·398	—·005
20	·473	—·012
20	·569	—·028
20	·690	—·015
20	·848	—·012
20	·942	—·015

m

n	P	s
10	·030	·200*
10	·076	·265*
10	·120	·319*
10	·151	·459*
10	·175	·615*
10	·202	·570*
10	·240	·635*
10	·283	·489*
10	·334	·335*
11	·404	·199*
10	·460	·214
10	·519	·143
10	·569	·192
10	·599	·167
10	·624	·206
10	·650	·152
10	·667	·160
10	·691	·185
10	·724	·184
10	·775	·156
10	·825	·171
10	·866	·159
10	·907	·159
10	·946	·140
10	·984	·185

n

n	P	s
19	·058	·220*
16	·142	·043*
17	·246	·052
19	·362	·040
17	·405	·062
18	·478	·072
18	·574	·079
20	·663	·044
19	·739	·059
21	·832	·045
19	·905	·076
18	·987	·076*

o

n	P	s
20	·042	·141
20	·114	·134
20	·187	·139
20	·246	·143
20	·338	·144*
5	·408	·180*
5	·432	·202*
5	·464	·199*
5	·493	·235*
5	·516	·240*
5	·543	·200*
5	·564	·193*
5	·590	·173*
5	·626	·163*
10	·658	·144*
20	·700	·147
20	·767	·144
20	·821	·126
20	·888	·136
20	·962	·136

p

n	P	s
3	·975	·08*
6	·008	·31*
6	·021	·44*
6	·036	·56*
6	·064	·46*
6	·090	·20*
7	·102	·03*
50	·169	·010
50	·282	—·005
50	·411	—·021
50	·523	—·008
50	·657	—·011
50	·776	—·029
50	·891	—·013

q

n	P	s
3	·757	·08*
3	·766	·42*
6	·782	·50*
6	·793	·48*
6	·809	·44*
3	·822	·15*
3	·842	·03*

r

n	P	s
32	·012	—·008
40	·117	·009
40	·218	·002
40	·311	·005
40	·389	—·008
40	·493	—·002
5	·558	—·02*
5	·576	·11*
5	·590	·41*
5	·609	·47*
5	·621	·39*
5	·631	·19*
5	·643	·02*
45	·743	—·008
40	·847	—·014
40	·944	·004

s

(see remarks)

t

n	P	s
50	·034	—·034
14	·124	—·007*
6	·161	·10*
6	·182	·33*
6	·201	·67*
2	·218	1·10*
3	·236	·89*
2	·246	·64*
4	·261	·29*
7	·289	·08*
50	·421	—·056
50	·589	—·039
50	·749	—·023
50	·906	—·029

u

n	P	s
10	·880	·075*
10	·924	·153*
10	·943	·265*
10	·970	·353*
10	·037	·090*
50	·146	·037
50	·340	·012
50	·468	·022
50	·635	·018
54	·800	·029

v

n	P	s
30	·089	—·060
5	·188	·56*
5	·244	·48*
30	·313	—·051*
40	·456	—·130
40	·544	—·100
40	·677	—·079
10	·751	·008
40	·823	—·054
36	·940	—·064

*) The means marked with an asterisk are represented in the diagrams.

TABLE 3 (Continued).

w

number of plates n	fraction of period P	brightness in steps s
30	·031	—·006
10	·095	·011
10	·117	·023*
10	·146	·150*
10	·166	·183*
10	·191	·226*
10	·220	·266*
10	·246	·155*
10	·272	·154*
10	·297	·064*
10	·319	·036
10	·346	·006
30	·417	—·008
40	·501	—·020
40	·583	—·018
40	·680	—·024
40	·770	—·021
40	·878	—·018
38	·952	—·019

x

n	P	s
49	·054	—·015
50	·162	—·009
50	·290	—·013
50	·394	—·015
50	·517	—·003
10	·591	·061*
10	·619	·102*
10	·662	·296*
10	·688	·185*
10	·713	·068*
50	·805	·009
50	·947	—·012

y

n	P	s
53	·005	—·009
5	·099	·04*
5	·112	·13*
5	·131	·32*
5	·149	·60*
5	·165	·90*
5	·177	·77*
5	·192	·69*
5	·200	·68*
5	·206	·59*
5	·212	·49*
5	·218	·41*
5	·228	·30*
5	·237	·21*
5	·241	·14*
50	·311	·020
50	·505	—·002
50	·679	·029
50	·807	·013

z

n	P	s
40	·070	·001
50	·188	·077
50	·307	—·004
50	·435	·009
30	·516	·010
20	·585	·045*
5	·615	·18*
5	·632	·63*
5	·648	·96*
4	·713	1·28*
5	·728	·56*
5	·741	·33*
5	·753	·17*
20	·782	·068
30	·847	·007
50	·945	—·003

*) The means marked with an asterisk are represented in the diagrams.

REMARKS.

a. There are only 2 good plates well within the minimum at uneven epochs, viz: from J. D. 3926·2145, ^{s}·86 and 3929·2249, ^{s}·41 corresponding to the phases 2703·042 and 2705·114 respectively. The reason for this is, that the uneven minima well observable during the time in question periodically coincide so nearly with moonshine (20 periods = 29^{d}·05) that only a few plates of this kind were obtained. — There is no distinct indication of a secondary minimum.

b. The star is *H. D.* 88892, spectr. B 8.

c. The minimum seems to be constant for about ·035 of the period.

Assuming the depths of the primary and secondary minimum to be 1^{m}·0 and ^{m}·1 respectively the observations are satisfied by supposing the system to consist of two stars with radii $\frac{2}{9}$ and $\frac{1}{9}$ of the distance between their centres. The smaller star contributes ·6 and the bigger one ·4 of the total light, the surface-brightness of the former star being about 6 times that of the latter. Supposing the masses of the two components to be equal the densities come out ·009 and ·075 ⊙ respectively.

d. M. e. of epoch ± ^{d}·0055 and of period ± ^{d}·0001.

e. The apparent period is so nearly equal to 4 days, that only 4 fractions of the period have been observed as yet. The variable has not been observed during increasing brightness, so that no precise epoch of the minimum can be given. There is a slight indication of secondary minimum. M. e. of epoch ± ^{d}·013 and of period ± ^{d}·0007.

f. There seems to be a constant minimum during about ·03 of the period. I estimate the density of the system to be in the neighbourhood of half the density of the sun. There is a doubtful trace of a secondary minimum.

g. The star is also faint (+ ^{s}·15) on a plate from J. D. hel. M. T. Grw. 2420623·254.

h. The star is too faint for accurate estimates on my plates. It was noted as faint or invisible on 7 other plates near minimum. There are only 3 observations supposed to be on the ascending branch of the light-curve. M. e. of epoch ± ·04 and of period ± ^{d}·004.

i. The interpretation of the observations of this star is not yet conclusive. The variable was found to be of the brightness ^{s}·2 on the ascending branch of the light-curve at J. D. hel. M. T. Grw. 2423789·509, 3877·354, 3899·301, 3910.292 and 3943·210. From these epochs the period 10^{d}·979 is derived, giving the differences $O—C = -$ ^{d}·005, + ^{d}·008, — ^{d}·003, + ^{d}·009 and — ^{d}·010 respectively. Consequently the present observations are concentrated into 11 equidistant groups with gaps in between. The descending branch of the light-curve has not yet been observed. Two other less distinct minima gave J. D. 3814·404 and 3858·272 corresponding to ^{s}·2 during ascending brightness. The difference between these two dates is 43^{d}·868 or 4 × 10^{d}·967. It is therefore very probable that these two less distinct minima are real. They will fall nearly midway between two minima, when the period, as is here done, is supposed to be $10^d{\cdot}9790/2$ or $5^d{\cdot}4895$, but a small excentricity of the orbit will then have to be assumed, the secondary minimum coming late. Further observations are needed to settle the question definitively.

j. The star is also faint on an old plate from J. D. hel. M. T. Grw. 2421287·33. After some trial it was supposed to be sufficiently safe also to use this minimum for the determination of the period. The variable seems to remain constant at minimum for about ·04 of the period. M. e. of epoch $\pm\,{}^d{\cdot}01$ and of period $\pm\,{}^d{\cdot}00005$ or $\pm\,{}^d{\cdot}0005$ respectively, if the old observed minimum has been correctly connected or not.

k. There are no observations on the lower part of the descending branch of the lightcurve and none between the phases ·498 and ·547 counting from the primary minimum as zeropoint, but as far as the evidence goes there is no sign of a secondary minimum.

The variable is in the outer region of the cluster surrounding ϑ Carinae.

l. The star is 40′ from the centre of the η Carinae-nebula.

m. The star is only 15′ from the centre of the η Carinae-nebula.

n. The range is small and there are no good comparison-stars near. There is a doubtful indication of a secondary minimum.

o. The variation is so small that I consider the elements given of this variable as being near the limit of what these provisional estimates can reveal, even when the variable is of convenient brightness and good comparison-stars are available. M. e. of epoch $\pm\,{}^d{\cdot}024$ and of period $\pm\,{}^d{\cdot}0008$.

p. As the star is faint, the depth of the minimum is rather uncertain. M. e. of epoch $\pm\,{}^d{\cdot}02$ and of period $\pm\,{}^d{\cdot}0008$.

q. At maximum the brightness of the variable is 0^s. Only the observations near minimum have been treated in detail. The minimum seems to be constant for about ·04 of the period. M. e. of epoch $\pm\,{}^d{\cdot}036$ and of period $\pm\,{}^d{\cdot}005$.

r. M. e. of epoch $\pm\,{}^d{\cdot}04$ and of period $\pm\,{}^d{\cdot}008$.

s. The variable has a companion at about 320°, 15″, making the estimates difficult. As the star fades to invisibility on the plates, the range must be considerable.

t. The variable was noted as faint or invisible on 9 other plates taken near minimum. M. e. of epoch $\pm\,{}^d{\cdot}003$ and of period $\pm\,{}^d{\cdot}00007$.

u. The ascending branch of the light-curve is rather poorly observed. On many plates this variable is too faint for accurate estimates. In consequence of this the observations are rather discordant. The 8 minima used for the determination of the period are J. D. 3787·53, 3815·46, 3829·47, 3845·30, 3880·29, 3915·35, 3929·29 and 3936·29. The residuals *O—C* are + ·05, — ·03, — ·03, + ·04, + ·01, + ·05, — ·02 and — ·03 respectively. The apparent period of $4 \times 1^d{\cdot}751 = 7^d{\cdot}004$ is very conspicuous in the observations, but the difference between the third and fourth minimum given above ($15^d{\cdot}83$) suggests that the real period is shorter, viz: $1^d{\cdot}75$. M. e. of epoch $\pm\,{}^d{\cdot}015$ and of period $\pm\,{}^d{\cdot}0005$.

v. The variable is faint and near the border of the field. On 15 other plates near minimum the star is noted as faint or invisible. No definite value of the range, which seems to be rather considerable, can be given. The observations between minima are suggestive of a secondary minimum about ·54 of the period after the main minimum, but as the mean error of one estimate near maximum is $\pm\,{}^s{\cdot}13$, no definite conclusions of this kind can be drawn from the material. M. e. of epoch $\pm\,{}^d{\cdot}009$ and of period $\pm\,{}^d{\cdot}0008$.

w. The star is *H. D.* 97484, spectr. B 3.

x. The variable was found faint on 3 old plates viz: from J. D. hel. M. T. Grw. 2419878·270 ($+\,{}^s{\cdot}25$), 2420963·321 ($+\,{}^s{\cdot}3$) and 2421287·330 ($+\,{}^s{\cdot}25$). The residuals from the ephemeris given are $+\,{}^d{\cdot}06$, $-\,{}^d{\cdot}11$ and $+\,{}^d{\cdot}02$ respectively. As a whole the residuals *O-C* are not quite satisfactory (m. e. of one epoch of minimum $\pm\,{}^d{\cdot}057$) but the solution given is the best I could find. Though there is still some uncertainty in the connection of the 3 older plates with the newer ones, the ephemeris will be at least approximately correct.

y. The variable was also found faint or invisible on 7 other plates taken at the extreme phases ${}^P{\cdot}161$ and ${}^P{\cdot}196$. Near minimum the estimates are uncertain owing to faintness of the star.

z. On all the 12 plates between the phases ${}^P{\cdot}661$ and ${}^P{\cdot}703$ the variable is invisible. The depth of the primary minimum can therefore not be stated, though the presence of a secondary minimum, which seems rather well marked, puts a limit to the possible range of variability. The variable was also noted as invisible on two plates at the phases ${}^P{\cdot}652$ and ${}^P{\cdot}713$ respectively.