Provisional elements and light-curves of the variables 133 and 159 in ω Centauri (discussed and prepared for publication by P. Th. Oosterhoff)

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COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN

Provisional elements and light-curves of the variables 133 and 159 in ω Centauri,

by *H. van Gent* †.

(Discussed and prepared for publication by P. Th. Oosterhoff).

The two variables discussed here have been measured in the Schilt microphotometer on 385 plates taken with the 66-cm refractor of the Yale station at Johannesburg. Variable 133 proved to be of the W UMa-type. Its median brightness is 14·13 and therefore it is not physically connected with ω Centauri. The elements of the primary minimum are:

$$\text{J.D. } 2426473{\cdot}3335 + {\cdot}31709628\, E$$
$$\pm \quad 3 \quad \pm \quad 18 \text{ (m.e.)}$$

Variable 159 is a cluster-type variable of Bailey's subclass *c*. Its median brightness marks it as a physical member of the cluster. The elements of a point on the rising branch of magnitude 14·68 are:

$$\text{J.D. } 2427565{\cdot}3320 + {\cdot}3431150\, E$$
$$\pm \quad 12 \quad \pm \quad 7 \text{ (m.e.)}$$

On account of the fact that all the plates were taken close to the meridian and during only two oppositions which are four years apart, the periods derived are given here with due reserve.

Among the papers of the late Dr H. van Gent there have been found measures and a part of their reduction of the variables 133 and 159 in the globular cluster ω Centauri. Both variables were discovered by Van Gent or Hertzsprung, who between them found 33 new variable stars in this cluster, most of which have been investigated by Martin [1]). The two variables discussed here are however situated near the western border of the plates and do not occur on the plates taken with the 60-cm Zeiss refractor of the Lembang Observatory, which fact causes considerable complications in the determination of the periods, as the observations with the Yale refractor had to be limited to hour angles smaller than 40 minutes. This has probably been the reason why Martin did not include these variables in his programme. The rectangular co-ordinates relative to the centre of ω Centauri [2]) and the equatorial co-ordinates for 1875 are:

	x	*y*	α (1875)	δ (1875)
	″	″	h m s	° ′
var. 133	− 1914	+ 1054	13 16 13	− 46 31·5
var. 159	− 2040	− 891	13 15 59	− 47 4·1

Charts on which the variables have been indicated by open circles are given in the Figures 1 and 2.

The variables and a number of comparison stars were measured in the Schilt microphotometer at Leiden. The photographic magnitudes of the comparison stars have been derived from comparisons with the sequence stars of Martin and with a Selected Area. There exists some doubt about the magnitudes which Van Gent actually adopted in the case of variable 133, the reduction of which he finished himself. The values given below differ in any case very little from the magnitudes he has used. For variable 159 the reduction had still to be carried out and the magnitudes tabulated below were adopted for the comparison stars. But in this case there was no means for their identification.

Figure 1
Var. 133

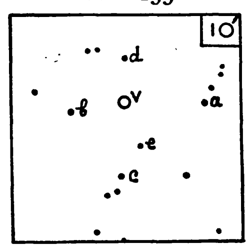
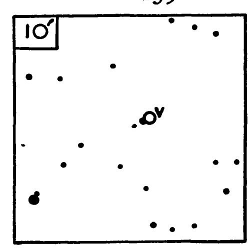


Figure 2
Var. 159



Var. 133		Var. 159	
a	12·63	a	13·65
b	13·68	b	14·32
c	13·90	c	14·48
d	14·42	d	14·88
e	14·88	e	14·87
		f	15·09

The magnitude of the variables is given for each plate in Table 3 together with the J.D. hel. M.A.T. Gr.

[1]) *Annals of the Leiden Observatory*, **17**, part 2, 1938.
[2]) Taken from *Publ. David Dunlap Obs.* **1**, No. 4, 1939.

The letters p, s and r and the phases will be referred to below.

The period of variable 133 has been derived by VAN GENT. The fact that ω Centauri could only be observed for 80 minutes at a stretch and that no other material taken at a widely different longitude was available has aggravated this task considerably. From the observations of Table 3 it is not difficult to find the fractional part of the reciprocal period, but it is a problem how to determine the whole number of periods within one day. In the case of variable 133, which later proved to be a W UMa-type variable, there remained the choice between the reciprocal apparent periods 5·31, 6·31, 7·31 and 8·31, which all give a satisfactory representation of the observed minima. As the first and the last observation of each night are nearly ^{d}·05 apart, their difference in phase must be erroneous by + or − ^{P}·05, if the figure before the decimal point of the reciprocal period differs by one unit from its correct value. Consequently the light-curve obtained from the earliest observations in each night is then shifted systematically by this amount with regard to the light-curve from the last observations. In this manner the reciprocal apparent period of 8·31 could be eliminated, as such a systematic shift was evident. The most probable reciprocal period appeared to be 6·31. This value found some confirmation in the fact that even and odd minima appear to be different in depth by ·06 magnitude, whereas this difference disappears, when the other reciprocals are used, which is to be expected when the reciprocal period adopted is erroneous by one unit. The counting of periods in the large interval between the observations of 1931 and 1935 could be established without undue difficulties, the few observations of 1937 providing a valuable check.

A final value for the period has been derived by least squares from the observations on the descending and rising branches of the primary and secondary minima. The observations used have been indicated in Table 3 by p (primary) and s (secondary). The observations were first reduced to magnitude 14·15 by means of an adopted slope, for the branches of primary and secondary minimum, of ^{m}·01 in ^{d}·000434 and ^{m}·01 in ^{d}·000547 respectively. The results of the two solutions in which the half-width of the minima at magnitude 14·15 was treated as an unknown are:

Primary minimum

$$\text{Epoch}\,(m = 14{\cdot}15) = 2426473{\overset{d}{\cdot}}33353 + {\overset{d}{\cdot}}31709628\,E + {\cdot}02224\,X$$
$$\pm 29 \quad \pm 18 \quad \pm 28 \text{ (m.e.)}$$

Secondary minimum

$$\text{Epoch}\,(m = 14{\cdot}15) = 2426524{\cdot}22885 + {\cdot}31709568\,E + {\cdot}01881\,X$$
$$\pm 35 \quad \pm 15 \quad \pm 34 \text{ (m.e.)}$$

where X equals − 1 for the descending and + 1 for the rising branch. According to these computations the mean error of one observation is found to be ± ^{d}·00195 for the primary and ± ^{d}·00249 for the secondary minimum, which corresponds with a mean error expressed in magnitude of ± ^{m}·045 and ± ^{m}·046 respectively. At magnitude 14·15 the primary minimum is about 20 per cent broader than the secondary. The weighted mean value of the period is:

$$\overset{d}{\cdot}31709593$$
$$\pm 12 \text{ (m.e.)}$$

Phases have been computed according to the formula:

$$\text{phase} = \overset{d^{-1}}{3{\cdot}1536198}\ (\text{J.D.} - 2420000).$$

The mean error of one observation calculated from the differences in magnitude between observations following each other in phase is ± ^{m}·041, which is in fair agreement with the values derived above from the least-squares solutions. The phase of primary minimum has been adoped as ·435 and then phases have been computed counted from the phase of minimum without regard to sign. Normal points of 10 or 15 observations each have been formed, the data of which are given in Table 1. The reflected light-curve is shown in Figure 3.

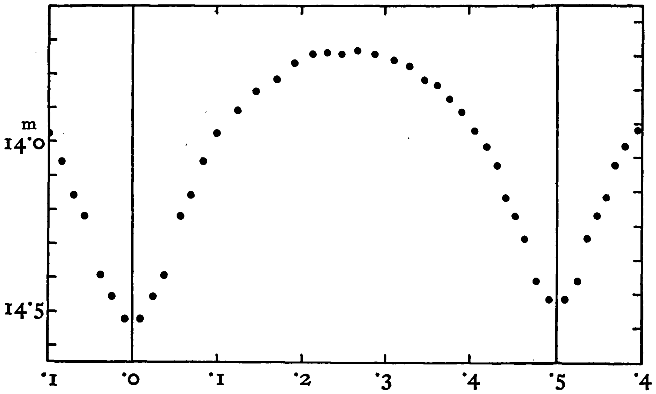
TABLE 1

Var. 133

number of observations	mean phase	mean magnitude	number of observations	mean phase	mean magnitude
	P	m		P	m
10	·0092	14·523	15	·2883	13·743
10	·0242	14·457	15	·3105	13·761
10	·0380	14·393	15	·3289	13·779
10	·0569	14·221	15	·3465	13·820
10	·0697	14·160	15	·3617	13·836
10	·0841	14·060	15	·3763	13·877
15	·0997	13·977	15	·3904	13·915
15	·1242	13·912	15	·4056	13·968
15	·1463	13·854	10	·4201	14·017
15	·1708	13·818	10	·4321	14·072
15	·1923	13·771	10	·4423	14·167
15	·2134	13·744	10	·4534	14·219
15	·2305	13·741	10	·4648	14·285
15	·2483	13·743	10	·4759	14·412
15	·2672	13·733	11	·4906	14·465

FIGURE 3

Variable 133



In order to show the form of the minima more clearly some normal points have been repeated in the left- and right-hand side of this figure.

The mean error of one normal point of 10 observations is $\pm\,^{m}{\cdot}013$ and of one of 15 observations $\pm\,^{m}{\cdot}011$. The total weight of the mean light-curve is about 225000 m^{-2}. The magnitude at maximum is 13·74, at primary minimum 14·53 and at secondary minimum 14·47, the total range ·79. From these figures it may be concluded that the variable is not physically connected with the cluster.

Variable 159 has only been measured by VAN GENT. The determination of the period from the observations of Table 3 met with the same kind of difficulty as has been described for variable 133. As neither maximum nor minimum are well defined, use was made of the observations on the rising and descending branches. This time a choice had to be made from the reciprocal periods 1·91, 2·91 and 3·91. The systematic shift between the light-curves formed from the first and from the last observations of each night respectively is evident, when the smallest value of the reciprocal period is used. It is well indicated when the largest value is used, whereas no trace of a shift is found, when 2·91 is taken as reciprocal period. Consequently this last value has been adopted. The period derived from the observations made during the opposition of 1931 is: $^{d}{\cdot}34306 \pm\,^{d}{\cdot}00007$ (m.e.). The counting of the number of periods in the large interval between the oppositions of 1931 and 1935 is somewhat uncertain, especially because the variable could not be measured on the plates of 1937. Although it is believed that the final period given below is correct, it should be stressed that the evidence on which it is based needs further confirmation and that this period is therefore given with due reserve. The final period has been derived by least squares from the observations on the rising branch after they had been reduced to magnitude 14·68 by means of the adopted slope of $^{m}{\cdot}01$ in $^{d}{\cdot}00156$. The observations used for this least-squares solution are indicated in Table 3 by the letter *r* (rising branch). The resulting ephemeris for a point of magnitude 14·68 on the rising branch is:

$$\text{Epoch } (m = 14{\cdot}68) = 2427565^{d}{\cdot}3320 \pm 12 + {}^{d}{\cdot}3431150 \pm 7\; E \quad \text{(m.e.)}$$

The maximum comes about ·10 days later. The mean error of one observation is $\pm\,^{d}{\cdot}0098$ or $\pm\,^{m}{\cdot}063$.

Phases have been computed according to the formula:

$$\text{phase} = 2^{d^{-1}}{\cdot}914475 \text{ (J.D.} - 2420000).$$

Details about the normal points of 16 observations each are given in Table 2.

FIGURE 4

Variable 159

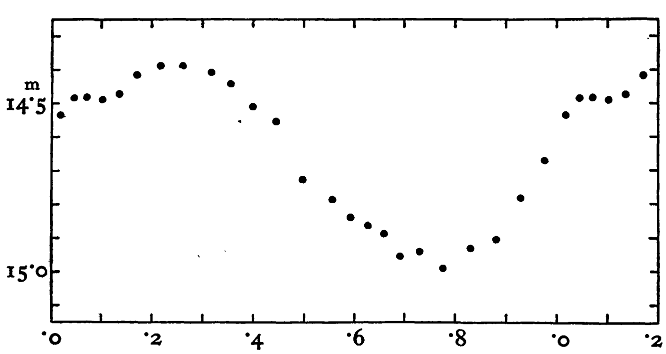


TABLE 2

Var. 159

number of observations	mean phase	mean magnitude
	P	m
16	·0183	14·536
16	·0452	14·485
16	·0708	14·483
16	·1025	14·490
16	·1354	14·473
16	·1709	14·417
16	·2173	14·389
16	·2619	14·390
16	·3176	14·409
16	·3565	14·443
16	·3999	14·512
16	·4461	14·557
16	·4978	14·728
16	·5573	14·788
16	·5934	14·841
16	·6266	14·865
16	·6600	14·888
17	·6918	14·955
16	·7310	14·941
16	·7764	14·991
16	·8308	14·931
16	·8819	14·904
16	·9306	14·783
16	·9766	14·672

The mean error of one observation computed from the differences in magnitude between observations consecutive in phase is $\pm$ m·057, which agrees well with the value derived above from the least-squares solution. The mean light-curve is shown in Figure 4. It is typical for a cluster-type variable of BAILEY's subclass *c*. The increase in brightness shows a remarkable halt at phase ·08. That a similar phenomenon is to be found in several light-curves of MARTIN (variables 22, 35, 50, 101 and others) makes it very probable that this feature is real. The photographic magnitude at maximum is 14·39, at minimum 14·96, the range being ·57. The median magnitude of 14·68 differs by only ·01 from the mean median magnitude of all the cluster-type variables of subclass *c* in ω Centauri as given by MARTIN. Although the variable is situated at an angular distance of 37 minutes of arc from the centre of the cluster, it nevertheless must be considered as a genuine member.

TABLE 3

J. D. — 2420000	var. 133	var. 159	J. D. — 2420000	var. 133	var. 159	J. D. — 2420000	var. 133	var. 159
d	m P	m P	d	m P	m P	d	m P	m P
6406·5403	13·84 ·792		6424·5109	14·42 p ·465	14·46 r ·076	6441·4239	13·84 ·802	14·47 ·369
·5498	13·91 ·822		27·4543	13·68 ·747	14·84 ·655	·4310	13·84 ·824	14·49 ·390
07·5166	14·15 s ·871		·4615	13·79 ·770	14·87 ·676	·4381		14·47 ·410
·5238	14·20 s ·894		·4690	13·88 ·794	14·92 ·698	·4452	14·06 s ·869	14·53 ·431
·5311	14·46 ·917	14·74 ·589	·4764	13·84 ·817	14·85 ·719	·4523	14·32 s ·892	14·54 ·452
10·5117	13·93 ·317	14·33 ·276	·4835	13·90 s ·839	14·85 ·740	·4594	14·42 ·914	14·57 ·472
·5198	14·03 p ·342	14·39 ·300	·4979	14·20 s ·885	15·04 ·782	·4660	14·47 ·935	14·70 ·492
·5285	14·22 p ·370	14·39 ·325	·5040	14·27 s ·904	14·96 ·800	52·3849	14·24 p ·369	14·41 ·314
11·5085	14·50 ·460	14·51 ·181	28·4480	14·20 s ·881	14·73 ·551	·3922	14·36 p ·392	14·44 ·336
·5182	14·24 p ·491	14·42 ·210	·4553	14·30 s ·904	14·69 ·572	·3994	14·41 ·415	14·46 ·357
·5258	14·05 p ·515	14·36 ·232	·4625	14·45 ·927	14·90 ·593	·4067	14·58 ·438	14·44 ·378
·5332	13·97 ·538	14·35 ·253	·4698		14·80 ·615	·4140	14·46 ·461	14·44 ·399
·5407	13·93 ·562	14·40 ·275	·4771	14·27 s ·973	14·94 ·636	·4212	14·30 p ·483	
12·5007	13·79 ·589	14·58 r ·073	·4843	14·23 s ·995	14·84 ·657	·4285	14·10 p ·506	14·43 ·442
·5080	13·72 ·612	14·51 ·094	·4916	14·01 s ·018	14·91 ·678	·4357	13·84 p ·529	
·5153	13·78 ·635	14·54 ·116	·4989	13·92 ·041	14·94 ·699	53·3805	14·14 p ·509	14·44 ·216
·5226	13·74 ·658	14·61 ·137	33·4347	13·74 ·607	14·57 r ·085	·3878	13·92 p ·532	14·42 ·237
·5298	13·78 ·681	14·47 ·158	·4430	13·71 ·633	14·54 ·109	·3951	13·93 ·555	14·41 ·259
·5371	13·70 ·704	14·42 ·179	·4502	13·74 ·656	14·46 ·130	·4023	13·85 ·577	14·40 ·280
15·4830	14·08 s ·994	14·96 ·765	·4575	13·72 ·679	14·56 ·151	·4096	13·83 ·600	14·36 ·301
·5199	13·78 ·111	14·89 r ·872	·4648	13·68 ·702	14·41 ·172	·4169	13·79 ·623	14·43 ·322
·5272	13·79 ·134	14·96 r ·894	·4721	13·71 ·725	14·40 ·194	·4242	13·73 ·646	14·44 ·343
17·4777	13·85 ·285		·4793	13·77 ·748	14·36 ·215	·4314	13·71 ·669	14·49 ·364
·4850	13·92 ·308	14·94 ·600	·4866	13·77 ·771	14·36 ·236	54·3774	13·80 ·652	14·50 ·122
·4923	13·96 ·331	14·94 ·621	34·4321	13·74 ·752	14·61 r ·991	·3847	13·72 ·675	14·51 ·143
·4995	14·09 p ·353	14·85 ·642	·4394	13·74 ·775	14·52 r ·013	·3919	13·74 ·698	14·46 ·164
·5068	14·20 p ·377	14·80 ·663	·4466	13·79 ·798	14·52 r ·034	·3992	13·75 ·721	14·39 ·185
·5141	14·38 p ·400	15·21 ·684	·4539	13·92 ·821	14·58 r ·055	·4065	13·75 ·744	14·38 ·206
·5215	14·54 ·423	14·96 ·706	·4612	13·93 s ·844	14·52 r ·076	·4137	13·84 ·767	14·35 ·227
20·4703	13·74 ·722	14·33 ·300	·4685	14·09 s ·867	14·49 ·098	·4210	13·81 ·790	14·37 ·249
·4776	13·69 ·745	14·34 ·321	·4757	14·14 s ·890	14·50 ·119	·4283	13·89 ·813	14·33 ·270
·4848	13·76 ·768	14·35 ·342	·4830	14·43 ·913	14·40 ·140	55·3749	13·82 ·798	14·53 r ·029
·4921	13·82 ·791	14·50 ·364	35·4295	14·27 s ·898	14·91 r ·898	·3822	13·88 ·821	14·49 r ·050
·4994	13·88 ·814	14·48 ·385	·4367	14·50 ·921	14·86 r ·919	·3895	13·99 s ·844	14·49 r ·071
·5066	13·90 s ·837	14·51 ·406	·4440		14·80 r ·941	·3968	14·07 s ·867	14·51 ·093
·5139	13·96 s ·860	14·61 ·427	·4513	14·24 s ·967	14·74 r ·962	·4040	14·25 s ·890	14·48 ·114
·5212	14·20 s ·883	14·55 ·449	·4585	14·19 s ·989	14·65 r ·983	·4113	14·37 ·913	14·48 ·135
21·4665	13·97 s ·864	14·37 ·204	·4658	14·05 s ·012	14·53 r ·004	·4186	14·47 ·936	14·38 ·156
·4737	14·24 s ·887	14·40 ·225	·4731	13·94 ·035	14·55 r ·025	·4258	14·42 ·959	14·37 ·177
·4810	14·31 ·910	14·44 ·246	·4804	13·89 ·058	14·49 r ·047	56·3723	14·46 ·944	14·72 r ·936
·5198	13·99 s ·032	14·37 ·359	37·4235	13·81 ·186	14·97 ·710	·3868	14·12 s ·989	14·60 r ·978
23·4620	13·76 ·157	14·53 r ·019	·4308	13·76 ·209	14·90 ·731	·3941	14·02 s ·012	14·59 r ·999
·4692	13·75 ·180	14·49 r ·040	·4380	13·75 ·232	14·95 ·752	·4014	13·95 ·035	14·44 r ·020
·4765	13·77 ·203	14·48 r ·062	·4453	13·78 ·255	15·00 ·773	·4087	13·90 ·058	14·47 r ·042
·4838	13·80 ·226	14·42 r ·083	·4526	13·78 ·278	15·04 ·795	·4159	13·87 ·081	14·42 r ·063
·4910	13·81 ·248	14·40 ·104	·4599	13·92 ·301	14·99 ·816	·4232	13·82 ·104	14·53 r ·084
·4983	13·87 ·271	14·39 ·125	·4744	14·02 p ·347	14·88 r ·858	58·3666	13·75 ·233	14·95 ·748
·5058	13·89 ·295	14·44 ·147	38·4207	14·04 ·331	14·82 ·616	·3738	13·85 ·255	14·88 ·769
·5131	13·86 ·318	14·39 ·168	·4280	14·12 p ·354	14·87 ·637	·3811	13·89 ·279	15·00 ·790
24·4593	13·86 ·302	14·80 r ·926	·4352	14·26 p ·377	14·95 ·658	·3884	13·89 ·302	14·73 ·812
·4665		14·79 r ·947	·4425	14·46 p ·400	14·87 ·680	·3957	13·93 ·325	14·93 ·833
·4738	14·00 p ·348	14·67 r ·968	·4498	14·53 ·423	14·96 ·701	·4029	14·06 p ·347	14·79 r ·854
·4811	14·13 p ·371	14·67 r ·990	·4571	14·48 ·446	14·96 ·722	·4102	14·25 p ·370	14·89 r ·875
·4883	14·35 p ·394	14·64 r ·011	·4643	14·36 p ·468	14·92 ·743	·4175	14·32 p ·393	14·86 r ·896
·4963	14·55 ·419	14·50 r ·034	·4716	14·19 p ·492	15·02 ·765	59·3639	14·18 p ·378	14·84 ·655
·5036	14·57 ·442	14·38 r ·055	41·4168	13·78 ·780	14·39 ·348	·3712	14·47 p ·401	14·85 ·676

TABLE 3 *(continued)*

J. D. — 2420000	var. 133	var. 159	J. D. — 2420000	var. 133	var. 159	J. D. — 2420000	var. 133	var. 159
d	m P	m P	d	m P	m P	d	m P	m P
6459·3784	14·52 ·424	14·90 ·697	6471·3309	13·81 ·117	14·75 ·532	7904·4292	13·91 ·564	14·37 ·261
·3857	14·56 ·447	14·96 ·718	·3382	13·78 ·140	14·87 ·553	·4365	13·83 ·587	14·35 ·283
·3930	14·39 p ·470	14·94 ·739	·3453	13·77 ·163	14·82 ·574	·4438	13·82 ·610	14·42 ·304
·4009	14·17 p ·495	15·02 ·762	·3524	13·76 ·185	14·80 ·595	·4510	13·72 ·633	14·46: ·325
·4080	14·01 p ·517	15·05 ·783	·3595	13·77 ·207	14·82 ·615	·4569	13·74 ·652	14·50 ·342
·4151	13·95 ·539	15·03 ·804	·3668	13·73 ·230	14·83 ·637	06·4021	13·87 ·786	
60·3612	14·03 p ·523	14·83 ·561	·3739	13·75 ·253	14·94 ·657	·4093	13·90 ·809	14·50 r ·032
·3684	13·90 ·546	14·79 ·582	·3810	13·81 ·275	14·94 ·678	·4166	13·95 ·832	14·36 ·054
·3757	13·83 ·569	14·76 ·603	72·3281	13·86 ·262	14·39 ·438	·4239	14·01 s ·855	14·48 ·075
·3837	13·83 ·594	14·87 ·627	·3353	13·78: ·285	14·52 ·459	·4311	14·18 s ·878	14·50 ·096
·3916	13·79 ·619	14·83 ·650	·3426	13·99 ·308	14·67 ·481	·4384	14·34 s ·901	14·52: ·117
·3989	13·74 ·642	14·91 ·671	·3499		14·79 ·502	·4457	14·50 ·924	14·49 ·138
·4062	13·70 ·665	15·00 ·692	·3571	14·09 p ·354	14·75 ·523	08·3962	13·85 ·075	14·89 r ·823
·4138	13·72 ·689	14·98 ·715	·3644	14·21 p ·377	14·78 ·544	·4035	13·81 ·098	14·87 r ·844
61·3586	13·84 ·668	14·67 ·468	·3717	14·38 p ·400	14·86 ·566	·4107	13·80 ·121	14·79 r ·865
·3658	13·79 ·691	14·65 ·489	·3790	14·42 ·423	14·87 ·587	·4180	13·78 ·144	14·96 r ·887
·3731	13·76 ·714	14·68 ·510	73·3263	14·47 ·410	14·41 ·348	·4253	13·70 ·167	14·68 r ·908
·3804	13·77 ·737	14·84 ·532	·3336	14·51 ·433	14·51 ·369	·4326	13·68 ·190	14·82 r ·929
·3877	13·68 ·760	14·74 ·553	·3409	14·45 ·456	14·49 ·390	·4398	13·68 ·212	14·75 r ·950
·3949	13·81 ·783	14·79 ·574	·3481	14·38 p ·479	14·61 ·411	·4459	13·73 ·232	14·64 r ·968
·4022	13·86 ·806	14·88 ·595	·3554	14·12 p ·502	14·55 ·432	11·3882	14·19 p ·510	14·83 ·543
·4093	13·97 ·828	14·86 ·616	·3627	14·06 p ·525	14·59 ·454	·3955	14·02 p ·533	14·81 ·564
62·3557	13·82 ·813	14·42 ·374	·3772	13·87 ·571	14·79 ·496	·4027	13·95 ·556	14·79 ·585
·3630	13·91 s ·836	14·50 ·395	6523·2019	13·75 ·699	14·99 ·709	·4100	13·89 ·579	14·81: ·607
·3702	14·00 s ·859	14·52 ·416	·2094	13·76 ·722	15·02 ·731	·4173	13·85 ·602	14·87 ·628
·3775	14·13 s ·882	14·55 ·438	·2167	13·67 ·745	14·95 ·752	·4246	13·80 ·625	14·94 ·649
·3848	14·40 s ·905	14·53 ·459	·2239	13·81 ·768	15·01 ·773	·4318	13·73 ·648	14·97 ·670
·3920	14·63 : ·927	14·67 ·480	·2312	13·82 ·791	14·92 ·794	·4379	13·71 ·667	15·00 ·688
·3993	14·48 ·950	14·71 ·501	·2385	13·89 ·814	14·98 ·816	12·3852	13·77 ·655	14·63 ·449
·4066	14·37 s ·973	14·76 ·522	24·1964	13·93 ·835	14·88 ·607	·3925	13·75 ·678	14·69 ·470
63·3674	14·09 s ·003	14·45 ·323	·2035	14·00 s ·857	14·96 ·628	·4275	13·76 ·788	14·79 ·572
·3745	14·03 s ·026	14·44 ·343	·2106	13·78 ·880	14·92 ·649	·4344	13·93 ·810	14·88 ·592
·3816	13·93 ·048	14·47 ·364	·2177	14·26 s ·902	14·86 ·669	39·3111	13·94 ·569	14·86 r ·924
·3887	13·74 ·071	14·48 ·385	·2248	14·49 ·925	14·99 ·690	·3184	13·86 ·592	14·79 r ·945
·3958	13·86 ·093	14·51 ·405	·2319	14·41 ·947	14·81 ·711	·3257	13·78 ·615	14·73 r ·966
·4031	13·86 ·116	14·58 ·427	6836·3555	13·92 ·266		·3329	13·81 ·637	14·63 r ·987
66·3467	14·44 p ·399	14·59 r ·006	7565·3606		14·54 r ·054	·3402		14·52 r ·009
·3539	14·50 ·422	14·50 r ·027	7891·4433	13·80 ·612	14·58 ·414	·3475	13·78 ·683	14·54 r ·030
·3612	14·52 ·445	14·43 r ·048	92·4405	13·76 ·757	14·39 ·321	·3547	13·74 ·706	14·57 r ·051
·3685	14·45 p ·468	14·44 r ·069	·4477	13·81: ·779	14·45 ·342	·3606	13·75 ·725	
·3758	14·23 p ·491	14·50 ·091	·4550	13·86 ·802	14·43 ·363	40·3088	13·77 ·715	14·91 r ·831
·3830	14·06 p ·513	14·54 ·112	·4623	13·89 ·825	14·54 ·384	·3161	13·80 ·738	15·02 r ·853
·3915	13·96 ·540	14·43 ·136	·4696	14·00 s ·848	14·48 ·405	·3234	13·80 ·761	14·89 r ·874
·3981	13·89 ·561	14·40 ·156	·4768	14·14 s ·871	14·66 ·426	·3306	13·80 ·784	14·88 r ·895
67·3804	13·69 ·659	14·48 r ·018	·4841	14·32 s ·894	14·57 ·448	·3379	13·81 ·807	14·78 r ·916
·3877	13·74 ·682	14·46 r ·040	·4896	14·56 ·911	14·67 ·464	·3452	13·91 ·830	14·75 r ·938
·3949	13·68 ·705	14·46 r ·061	94·4342	13·92 ·044	14·49 ·131	·3524	14·02 s ·853	14·73 r ·959
68·3397	13·72 ·684	14·96 ·814	·4415	13·92 ·067	14·43 ·152	·3585	14·12 s ·872	14·74 r ·976
·3470	13·74 ·707	14·86 ·836	·4488	13·83 ·090	14·34 ·174	43·3018	13·74 ·154	14·79 ·555
·3542	13·76 ·730	14·98 r ·857	·4560	13·81 ·113	14·34 ·195	·3090	13·75 ·177	14·78 ·575
·3615	13·73 ·753	14·87 r ·878	·4633	13·67 ·136	14·34 ·216	·3163	13·70 ·200	14·85 ·597
·3688	13·81 ·776	14·88 r ·899	·4706	13·76 ·159	14·40 ·237	·3236	13·75 ·223	14·77 ·618
·3760	13·85 ·799	14·77 r ·920	·4779	13·67 ·182	14·41 ·258	·3308	13·78 ·245	14·89 ·639
·3833	13·89 ·822	14·72 r ·941	·4838	13·73 ·200	14·47 ·276	·3381	13·83 ·268	14·86 ·660
·3906	13·98:s ·845	14·75 r ·963	95·4317	13·75 ·190	14·47 r ·038	·3454	13·87 ·291	14·91 ·682
69·3396	14·00 s ·837	14·95 ·729	·4390	13·76 ·213	14·55 ·060	·3509	13·87 ·309	
·3469	14·05 s ·860	15·01 ·750	·4463	13·78 ·236	14·48 ·081	49·2841	14·02 s ·020	14·61 r ·990
·3542	14·13 s ·883	15·00 ·771	·4535	13·76 ·258	14·43 ·102	·2914	13·90 ·043	14·58 r ·011
·3613	14·36 ·906	15·01 ·792	·4754	13·90 ·328	14·38 ·166	·3262	13·69: ·153	14·39 ·112
·3684		14·95 ·812	·4812	14·03 p ·346	14·54 ·183	·3329	13·70 ·174	14·44 ·132
·3755	14·37 ·951	14·98 ·833	7901·4153	13·90 ·060	14·72 ·477	62·2526	14·68: ·917	
·3826	14·27 s ·973	15·02 r ·854	·4225	13·88 ·082	14·81 ·498	·2598	14·45: ·940	
·3895	14·19 s ·995	15·04 r ·874	·4298	13·77 ·105	14·84 ·520	·2781	14·17 s ·998	14·92 r ·860
70·3346	14·26 s ·975	14·83 ·628	·4371	13·76 ·128	14·84 ·541	·2854	14·02 s ·021	14·95 r ·882
·3419	14·18 s ·998	14·86 ·650	·4443	13·73 ·151	14·68 ·562	·2927	13·93 ·044	14·90 r ·903
·3492	13·99 s ·021	14·98 ·671	·4516	13·74 ·174	14·81 ·583	·2982	13·79 ·061	14·86 r ·919
·3565	13·96 ·044	14·92 ·692	·4589	13·72 ·197	14·98 ·604	68·2310	13·79 ·771	14·41 ·210
·3637	13·89 ·067	15·08: ·713	·4649		14·92 ·622	·2383	13·81 ·794	14·54 ·231
·3710	13·86 ·090	14·92 ·735	04·4074	14·23 ·496	14·36 ·198	·2456	13·94 ·817	14·40 ·253
·3783	13·69 ·113	15·00 ·756	·4147	14·13 p ·519	14·40 ·219	·2528	14·02 s ·840	14·38 ·274
·3855	13·72 ·136		·4219	13·97 ·541	14·41 ·240	·2601	14·07 s ·863	14·42 ·295