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COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN

ADDITIONAL OBSERVATIONS AND IMPROVED EPHEMERIS OF VV PUPPIS,

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This paper contains a discussion of photographic observations of VV Puppis made with the Franklin-Adams camera and of photographic and visual observations made with the 74-inch Radcliffe reflector. Between September 1948 and June 1949 the variable had at least two intervals of activity with a range of about two magnitudes and two intervals of inactivity with a range under ·3 magnitude. All epochs of maximum however are reasonably well represented by a linear ephemeris which dates back to the earliest observations in 1929. During 1948 and 1949 the brightness at minimum has been quite constant near the photographic magnitude 17.

The interesting features of this variable star are its short period of 100 minutes, its changing light-curve and the large variations in the median brightness. In January 1948 OORT and HILTNER tried to observe the star with the 82-inch reflector of the McDonald Observatory, Texas, U.S.A. However, the variable then proved so faint that it could not be identified for certain. In this connection we may recall that the median magnitude varied from 14^m to 15^m in the years from 1928-1931[1]). In 1935 and 1936 its average brightness was about a magnitude fainter. In his discussion of the observations made with the 60-inch Mt Wilson reflector OOSTERHOFF concluded[2]) that all epochs of maximum were well represented by a linear ephemeris in spite of the considerable irregularities in the light-variation with respect to light-curve and median brightness. The elements that were derived in *B.A.N.* **8**, 44, were based on observations made from 1928-1936. Therefore this formula has to be extrapolated considerably if used for the observations of the present time.

Since 1936 the Leiden plate collection of the region containing VV Puppis increased by nearly 100 plates, but unfortunately the variable is visible on only a fraction of these. The most recent plates of this collection were made in the beginning of 1940. The additional Leiden plates were measured in the Schilt photometer by Mr L. GAYKEMA. The magnitudes derived, which are given in Table 1, have the same scale and zeropoint as those given by WESSELINK in Table 2 of *B.A.N.* **8**, 335. The phases in the third column of Table 1 were also computed with WESSELINK's formula for the phase given in *B.A.N.* **8**, 334.

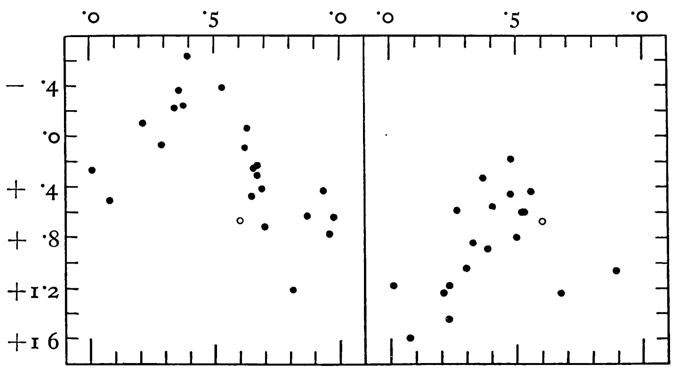
1) *B.A.N.* **8**, 336, 1939.
2) *B.A.N.* **8**, 44, 1936.

TABLE 1

J.D. Hel. − 2420000	Δm	phase
d	m	P
6299·4145	− ·36	·359
·4363	+ ·23	·672
6303·4118	+ ·31	·671
·5479	+ ·09	·622
·5697	+ ·43	·935
05·5419	− ·10	·211
06·4710	− ·38	·532
·4945	+ ·63	·869
09·5083	+ ·51	·080
·5302	− ·63	·394
10·4582	+ ·72	·699
·4799	+ ·27	·010
23·4973	+ ·48	·648
·5189	+ ·77	·958
24·4548	− ·24	·377
·4766	+ ·42	·689
25·4289	− ·22	·343
·4507	+ ·26	·655
37·3997	+ ·64	·975
·4216	+ ·07	·289
38·5041	+ 1·21	·810
62·4149	− ·06	·633
6476·2394	+ ·67	·600
7365·4834	+ 1·24	·207
·5053	+ ·60	·521
7748·4740	+ ·33	·366
·4955	+ 1·24:	·674
8219·3298	+ 1·04	·299
8656·2190	+ 1·18	·232
8965·3574	+ ·60	·529
·4236	+ ·18	·478
9380·2091	+ ·80	·498
94·2557	+ 1·06	·893
99·2483	+ ·46	·474
9400·2198	+ ·56	·403
02·2302	+ 1·45	·228
·2531	+ ·44	·556
9672·2790	+ 1·60	·074
·3005	+ ·89	·382
·3443	+ 1·18	·010
·3663	+ ·84	·326
·4317	+ ·59	·263

It is clear from this table that the median brightness decreases with time. The earlier observations, including J.D. 2426476, have been plotted in the left-hand part of Figure 1, the remaining observations,

FIGURE 1



J.D. 2426299—2426362 J.D. 2427365—2429672
The open circle is J.D. 2426476

also including J.D. 2426476, in the right-hand part of the same figure. Between the plots there is a systematic difference of nearly a magnitude. This drop in median magnitude must have occurred between J.D. 2426362 and J.D. 2427365. It is even possible that it took place between J.D. 2426362 and J.D. 2426476. But the evidence for such a change would depend on a single observation marked in both light-curves by an open circle and would consequently be extremely weak.

Since the star was inconveniently faint for the Leiden observer at Johannesburg, observations were begun with the 74-inch Radcliffe reflector at Pretoria in September 1948. Table 2 gives information concerning the comparison stars used. The list is a continuation of that given in *B.A.N.* **8**, 44, the extension being necessitated by the fainter present-day median brightness.

The photographic observations are given in Table 4. The plates were 103aO Kodak and the Newtonian focus was used. Observations on different plates but of the same night have been separated by an open line. The first column contains the Julian Date of mid-exposure reduced for light-time on the sun by means of the formula:

$$\text{reduction on sun: } + \cdot 002993\, X - \cdot 003758\, Y,$$

where X and Y are the rectangular co-ordinates of the sun, taken from the *Nautical Almanac*. The phases contained in the second column have been calculated with WESSELINK's formula from *B.A.N.* **8**, 334. The phase of the maximum epoch of OOSTERHOFF's ephemeris then equals ·563. The third column contains the photographic magnitude. The values given are mean values of results independently obtained by THACKERAY and WESSELINK from estimates made with an eyepiece enlarging ten times.

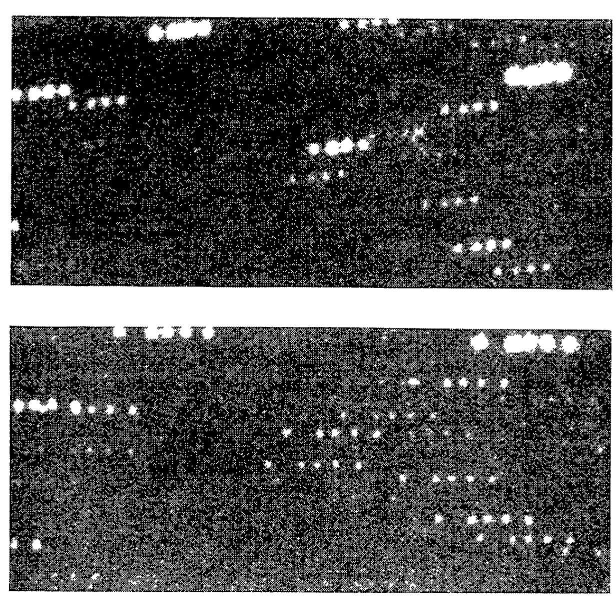
Exposures covering a complete cycle were made on J.D. 2432822 and J.D. 2432829, which showed the star practically constant at 17·0 mpg (see Table 4). The variable proved to be slightly brighter than mini-

TABLE 2
Comparison stars.

(1)	(2)	(3)	(4)	(5)	(6)
		m	m	′	′
1	*a*	13·90	·74	+ ·80	− 2·48
2	*b*	14·35	·51	+ ·53	− ·99
3	*c*	14·50	1·84	+ 1·15	− 1·74
4	*d*	15·20	2·17	+ ·08	− 1·71
5	*e*	15·75	3·07	− 2·26	− ·29
6	*f*	16·20	3·45	− 1·03	+ 1·21
7	*g*	16·65	4·15	− ·50	+ 1·10
	h	16·30	3·23	+ 1·03	− ·19
	k	16·50	4·00	+ ·70	+ ·08
	l	16·80	4·35	− ·18	− ·10

(1): Designation *B.A.N.* **8**, 44.
(2): Proposed new designation and additional comparison stars.
(3): Photographic magnitudes; for the first seven stars according to *B.A.N.* **8**, 44. The magnitudes of the remaining three stars were derived from estimates and by extrapolation.
(4): Visual magnitudes; the zero point is arbitrary. The magnitudes were derived from a photovisual plate carrying two exposures (27 minutes and 3 minutes). The authors are indebted to Dr R. H. STOY and Mr A. W. J. COUSINS for measuring the plate in the Schilt photometer of the Royal Observatory at Cape Town.
(5): $\Delta\alpha \cos \delta$ relative to the variable.
(6): $\Delta\delta$ relative to the variable.

FIGURE 2



mum on the first exposure on J.D. 2432822, near epoch 70726 of the ephemeris obtained later on in this note. However there is no indication of a maximum for epoch 70827 on J.D. 2432829, which is well covered by the observations.

Thereafter the star was not observed until February 1949 when several plates showed the star brighter and again varying. In particular on J.D. 2432970 epoch 72845 was well observed with the variable reaching 15·1 mpg. A reproduction of two plates taken during phase of maximum is shown in Figure 2. The upper half represents the plate taken on J.D. 2432970, when the maximum was pronounced. The other half shows the plate taken on J.D. 2433001, when the variable remained practically constant.

FIGURE 3

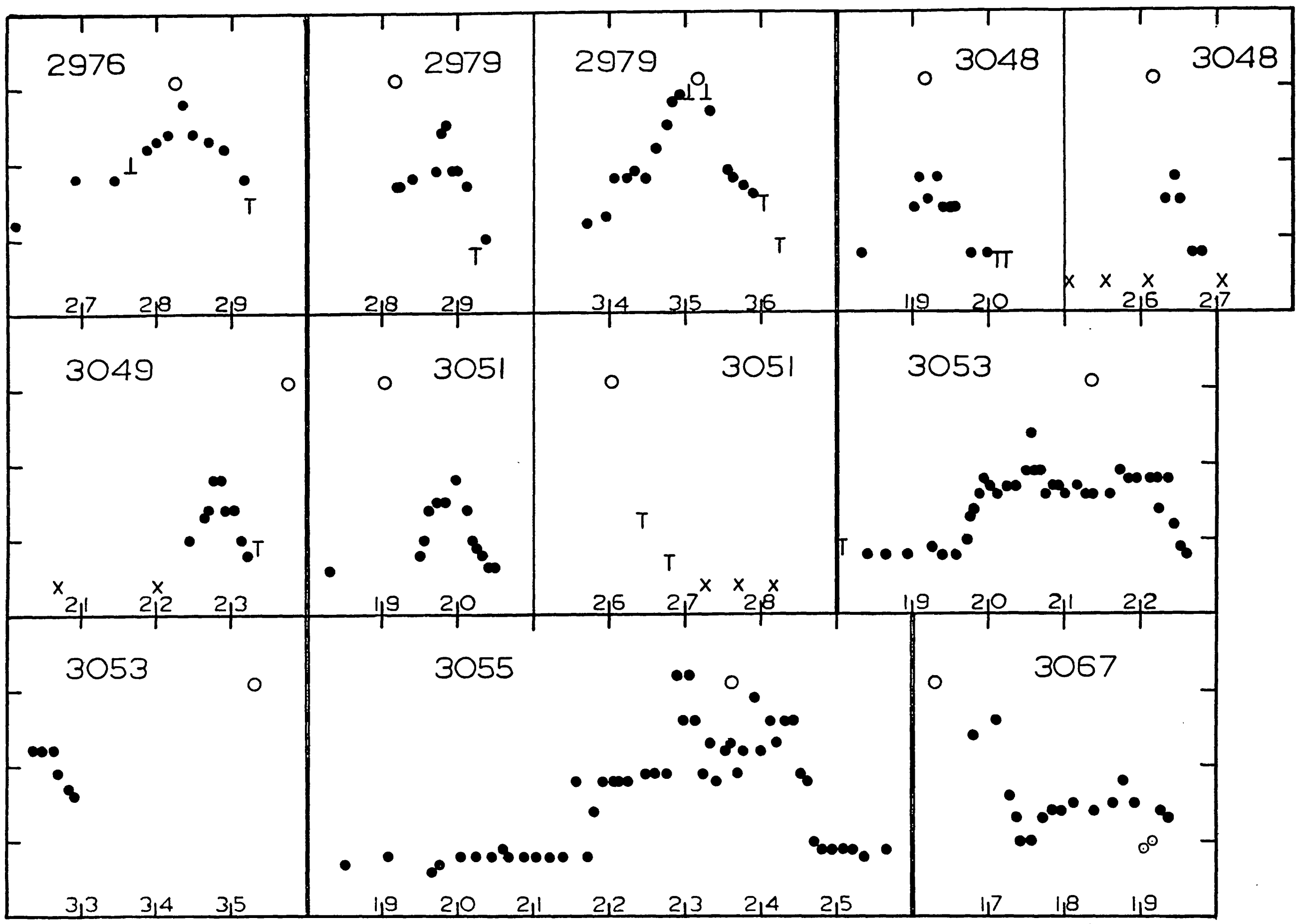
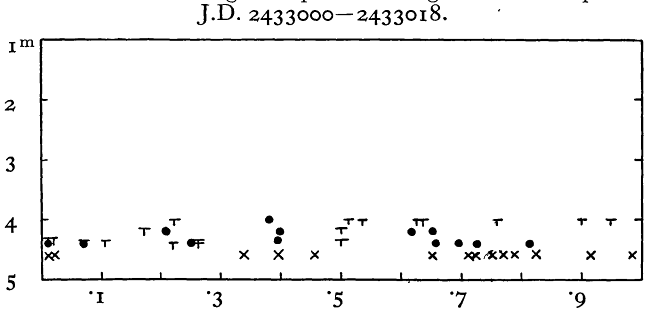


FIGURE 4

Visual observations against phase during the inactive period J.D. 2433000—2433018.



● — observation
x — VV Pup invisible
T — fainter than brightness indicated by horizontal line
⊥ — brighter ,, ,, ,, ,, ,, ,,
o — indicates epoch according to formula (1)

In view of the rapid changes and of the fact that exposures of 10 minutes were required to show the star well at minimum, a series of visual observations was begun. All visual observations are given in Table 5. They are shown graphically in the Figures 3 and 4.

A bright maximum was observed on J.D. 2432976 and two consecutive ones, the second of the two being definitely the brighter, on J.D. 2432979.

A joint visual programme with WESSELINK was planned for the night of March 24 (J.D. 2433000). Despite a watch covering three hours, which according to the ephemeris should have included 2 maxima, no maximum was observed, the star remaining throughout near the border of visibility, slightly fainter than 17 mpv[1]).

A photographic series was obtained the following night by THACKERAY, which shows the variable constant within the errors of observation at 16·8 mpg throughout a cycle.

Scattered visual observations were continued with the 74-inch reflector by THACKERAY as opportunities allowed between other work. In view of the past behaviour of the star, notably the occurrence of maxima, if they did occur at all, not very far from the times predicted by OOSTERHOFF's ephemeris (*l.c.*), many of these observations were made purposely near the times of predicted maxima. The consequential slight preference for the range of phase ·25—·75 can be seen by studying Table 5.

The interval during which no activity has been observed lasted at least 18 days. The individual observations are shown in Figure 4 against phase.

It was not until J.D. 2433048 that the next maximum was observed; it was faint, about 16 mpv, but very near to the ephemeris (Figure 3). A second similarly faint maximum was observed 100 minutes later and a third the next day. On J.D. 2433051 one faint maximum was observed. Just after the predicted time of the next maximum the star was found faint. The possibility that an early maximum had just been missed should not be excluded. On J.D. 2433053 two consecutive maxima were observed, both considerably brighter than those of the preceding nights. The time of the second maximum cannot be determined satisfactorily as the rise has not been observed. Nevertheless there is little doubt that this maximum has preceded the predicted time by at least half an hour. A still brighter maximum was observed jointly by THACKERAY and WESSELINK on J.D. 2433055 and this lasted an unusual length of time, nearly half a period elapsing between the initial rise and the final fall. Two more bright maxima were observed on J.D. 2433057 by THACKERAY and D. S. EVANS and on J.D. 2433058 by THACKERAY and H. KNOX-SHAW. On these occasions no special effort was made at accurate estimates of magnitudes, the chief purpose being to test certain phenomena suspected to be merely subjective and to attempt observations of the spectrum with a direct-vision prism; so far as the spectrum could be seen at maximum it was judged to be "mainly continuous".

All visual observers agreed in judging that the final drop was extremely rapid and amounted sometimes

1) When the mirror was re-silvered a few months later, VV Puppis had disappeared in the evening twilight, but it is certain that the star would be easily visible even at minimum with the mirror freshly silvered.

TABLE 3

	d	*E*	d		d	*E*	d
WESSELINK	2425564·504	− 33337	+ ·006	MAYALL	2426391·767	− 21476	+ ·002
,,	5613·390	− 32636	·000	ALDEN	6407·324	− 21253	+ ·006
,,	44·429	− 32191	+ ·001	,,	10·324	− 21210	+ ·007
,,	·498	− 32190	+ ·001	,,	6814·219	− 15419	− ·002
,,	46·582	− 32160	− ·008	,,	7149·288	− 10615	+ ·003
,,	51·258	− 32093	− ·005	,,	7500·326	− 5582	+ ·005
,,	52·437	− 32076	− ·012	,,	04·299	− 5525	+ ·003
,,	5968·331	− 27547	− ·001	,,	37·217	− 5053	·000
,,	6009·489	− 26957	+ ·007	OOSTERHOFF	7748·474	− 2024	− ·006
,,	40·450	− 26513	·000	MT WILSON	7889·642	0	− ·005
,,	42·408	− 26485	+ ·005	,,	·712	1	− ·005
,,	64·373	− 26170	·000	,,	8159·923	3875	+ ·007
,,	87·249	− 25842	− ·001	,,	60·896	3889	+ ·003
,,	6115·216	− 25441	− ·003	,,	·960	3890	− ·002
,,	6241·582	− 23629	− ·018	OOSTERHOFF	8965·424	15424	+ ·002
,,	49·546	− 23515	− ·005	,,	9399·248	21644	+ ·001
,,	65·528	− 23286	+ ·005	,,	9400·220	21658	− ·004
,,	69·575	− 23228	+ ·007	,,	02·253	21687	+ ·006
,,	73·544	− 23171	·000	,,	9672·432	25561	− ·014
,,	76·480	− 23129	+ ·007	THACKERAY	2432970·358	72845	+ ·004
OOSTERHOFF	99·414	− 22800	− ·006	,,	76·284	72930	+ ·001
,,	6306·471	− 22699	+ ·007	,,	79·288	72973	+ ·006
,,	09·530	− 22655	− ·003	,,	·351	72974	·000
,,	24·455	− 22441	− ·004	,,	3048·192	73961	·000
,,	25·429	− 22427	− ·007	,,	·264	73962	+ ·003
V. D. B., V. G., HE.	32·486	− 22326	+ ·006	,,	49·228	73976	− ·010
ALDEN	44·481	− 22154	+ ·005	,,	51·200	74004	+ ·009
,,	64·431	− 21868	+ ·007	,,	53·206	74033	− ·007
,,	77·398	− 21682	+ ·001	,,	55·230	74062	− ·006

to 2 magnitudes, in agreement with OOSTERHOFF's previous conclusion (*l.c.*) and also that during these bright maxima the star brightened and faded several times. All available and well determined epochs of maximum have been collected in Table 3. A least-squares solution yields the following elements:

Epoch of maximum

$$= \text{J.D. } 2427889^{d}{\cdot}6474 + {}^{d}{\cdot}069746814\, E.$$
$$\pm \quad 8 \quad \pm \quad 23 \quad \text{(m.e.)}$$

The mean error of a single maximum epoch is $\pm\, {}^{d}{\cdot}0059 = \pm\, {}^{P}{\cdot}085$. The maximum residual in Table 3 is ${}^{d}{\cdot}018$ or nearly half an hour. It is clear, also from Figure 3, where besides the observations the time of maximum as calculated with the above formula is shown, that the residuals are far larger than can be attributed to observational error. On the contrary, we believe that the dispersion in the epochs of maxima of nearly one tenth of the period is mainly intrinsic in the star. On no occasion, however, did we have any difficulty in the counting of the epochs.

It is remarkable that it is possible to represent the observed epochs so well over an interval of more than 100000 cycles by means of a linear formula. In fact, the irregularity in the period of VV Puppis may be classified as that of EDDINGTON's and PLAKIDIS' type 3: "The irregularity may be a fluctuation of phase rather than of period; the primary cause of the light change may have an entirely regular period, but its visible effect may be delayed or accelerated by casual circumstances, so that the date of maximum differs from the ephemeris date by an accidental fluctuation"[1]).

It is further strange that the star continues to count epochs when it is inactive for apparently at least hundreds of cycles at a stretch so that when it is active again, the maxima occur again at the same phase as before. It would therefore be extremely interesting if we could observe something of the hidden periodicity, which we know to exist during the inactive intervals. It might be hoped that short exposures with a large reflector of at least the size of the 74-inch Radcliffe telescope when recently silvered, and measured with a photometer would give results accurate enough to show the hidden periodicity.

The main conclusions to be drawn from these observations of VV Puppis are as follows:

1. In the interval between September 1948 and June 1949 the variable has had at least two intervals of activity with a range of about two magnitudes, and two intervals of inactivity with a range not exceeding ·3 magnitude.

2. Whenever a maximum occurs, the time agrees reasonably well with a linear formula dating back to the earliest observations of the star in 1929.

3. Brightness at minimum during these recent observations has not deviated greatly from the range 16·8 to 17·0 mpg.

4. The latest period of activity appears to have set in rather abruptly in May 1949, the range having increased from 1 magnitude on J.D. 2433048 to 2 magnitudes on J.D. 2433053.

Whether these alternate cycles of activity and inactivity have followed any regular law cannot be determined from these observations.

It would be of further interest to observe as many consecutive cycles as possible. The maximum interval at Pretoria is about 9 hours, or over 5 cycles. This could be extended by international cooperation between observers situated at different longitudes.

1) *M.N.* **90**, 65, 1929.

TABLE 4
Photographic observations of VV Puppis with the 74″ reflector at Pretoria.

J.D. Hel. M.A.T. Grw. — 2430000	phase	m_{pg}	exposure time	J.D. Hel. M.A.T. Grw. — 2430000	phase	m_{pg}	exposure time	J.D. Hel. M.A.T. Grw. — 2430000	phase	m_{pg}	exposure time
d	P	m	min	d	P	m	min	d	P	m	min
2822·5671	·582	16·1	10	2951·3540	·074	16·6	20	3001·2569	·561	16·7	9
·5779	·736	16·7	10	·3810	·461	16·6	20	·2639	·661	16·7	9
·5904	·916	16·8:	10					·2708	·760	16·7	9
				2952·4161	·302	16·6	15	·2777	·859	16·8	9
·6056	·134	16·7	10					·2847	·959	16·7	9
·6133	·244	16·8	10	2970·3343	·206	15·8	10				
				·3448	·356	15·5	10	3001·3014	·199	16·8	9
2829·5658	·926	16·9	11	·3552	·505	15·1	10	·3104	·328	16·7	9
·5756	·067	16·8	10·3	·3656	·654	15·8	10	·3187	·447	16·7	9
·5846	·196	16·9:	10					·3277	·576	16·6:	9
				3000·2993	·831	17·0	10	·3347	·676	16·7	9
·5985	·395	16·8	10	·3222	·160	17·0	10				
·6075	·524	16·8	10					3030·2652	·470	16·8	18
								·2742	·599	16·8:	6

Table 5

Visual observations with the 74″ reflector at Pretoria, mainly by A. D. Thackeray. Observations by A. J. Wesselink are indicated by an asterisk.

J.D. Hel. M.A.T. Grw. — 2430000	phase	bright-ness	
d	P	m	
2976·2612	·183	3·8	Observations of this maximum made in gaps between thin clouds.
·2696	·303	3·2	
·2745	·374	3·2	
·2766	·404	—	Brighter than *e*.
·2787	·434	2·8	
·2800	·453	2·7	
·2814	·473	2·6	
·2835	·503	2·2:	Clouds.
·2849	·523	2·6	
·2870	·553	2·7	
·2891	·583	2·8	
·2918	·622	3·2	Rapid change.
·2925	·632	—	Fainter than *f*.
2979·2819	·493	3·3	
·2823	·498	3·3	
·2840	·523	3·2	
·2871	·567	3·1	
·2878	·577	2·6	
·2885	·587	2·5	
·2892	·597	3·1	
·2899	·607	3·1	
·2913	·627	3·3	
·2920	·637	—	Sudden fading.
·2927	·647	—	Fainter than *g*.
·2937	·662	4·0	
·3371	·284	3·8	Observations of this maximum made in gaps between thin clouds.
·3396	·320	3·7	
·3406	·334	3·2	
·3423	·359	3·2	
·3434	·374	3·1	Clouds.
·3448	·394	3·2	Clouds.
·3462	·414	2·8	Clouds.
·3476	·435	2·5	
·3482	·443	2·2	
·3493	·459	2·1	
·3507	·479	—	Brighter than *d*.
·3524	·503	—	Brighter than *d*?
·3531	·513	2·2	
·3555	·548	3·1	
·3562	·558	3·2	
·3576	·578	3·3	
·3590	·598	3·4	
·3604	·618	—	Fainter than *f*.
·3625	·648	—	Fainter than *k*.
3000·2531	·169	—	Fainter than *g*.
·2596	·262	—	Fainter than *l*.
·2770	·512	—	Fainter than *k*.
·2944	·761	— *	Fainter than *h* and *k*.
·3041	·900	— *	Fainter than *h* and *k*.
·3076	·950	—	Fainter than *h* and *k*.
·3117	·009	4·4:	VV Pup glimpsed.
·3159	·069	—	VV Pup glimpsed; fainter than *l*.
·3263	·218	4·4	VV Pup and *l* glimpsed.
·3291	·258	4·4:*	
·3648	·770	—	VV Pup not seen; fainter than *h*.
·3798	·985	—	VV Pup not seen; fainter than *f*.
·3815	·010	— *	VV Pup not seen; fainter than *f*.
3001·2527	·501	—	Fainter than *g*.
·2881	·008	—	VV Pup seen; fainter than *l*.
·2923	·068	4·4	
·3048	·248	4·4	
·3142	·382	4·0	
·3225	·501	—	VV Pup glimpsed; fainter than *l*.
·3381	·725	4·4	
3004·3442	·825	—	Fainter than *k*; VV Pup not certainly seen.
·3504	·914	—	Fainter than *k*; VV Pup not certainly seen.
3005·2642	·016	—	VV Pup glimpsed; fainter than *l*.
·2705	·106	—	VV Pup glimpsed; fainter than *l*.
·2906	·394	4·4	VV Pup glimpsed; equal to *l*.
3006·3370	·397	4·2	
·3551	·657	4·4:	VV Pup glimpsed.
3007·3287	·616	4·2	
·3342	·695	4·4	
·3426	·815	4·4	
3009·3229	·208	4·2	
·3538	·651	4·2	
3011·3464	·220	—	VV Pup glimpsed; fainter than *k*.
3012·3519	·636	—	VV Pup glimpsed; fainter than *k*.
3014·3310	·012	—	VV Pup not seen; *k* glimpsed.
3015·2739	·531	—	VV Pup glimpsed; fainter than *k*.
·2823	·651	—	VV Pup not seen; fainter than *k*.
·2864	·710	—	VV Pup not seen; fainter than *k*.
·2892	·750	—	VV Pup not seen; fainter than *k*.
3016·2627	·708	—	VV Pup not seen; fainter than *k*.
·2683	·788	—	VV Pup not seen; fainter than *k*.
·3065	·336	—	VV Pup not seen; fainter than *k*.
·3106	·395	—	VV Pup not seen; fainter than *k*.
3018·3376	·457	—	VV Pup not seen; fainter than *f*.
3048·1832	·370	4·0	VV Pup glimpsed; fainter than *k*.
·1902	·471	3·6	
·1909	·481	3·2	
·1919	·495	3·5	
·1933	·515	3·2	
·1940	·525	3·6	
·1950	·540	3·6	
·1957	·550	3·6	

TABLE 5 (*continued*)

J.D. Hel. M.A.T. Grw. — 2430000	phase	brightness	
d	P	m	
3048·1978	·580	4·0	
·1999	·610	4·0	
·2013	·630	—	VV Pup fainter than *k*; both seen.
·2023	·644	—	VV Pup glimpsed; fainter than *k*.
·2502	·331	—	VV Pup not seen; *k* glimpsed.
·2554	·406	—	VV Pup? glimpsed.
·2610	·486	—	VV Pup not seen; *k* glimpsed.
·2631	·516	3·5	
·2645	·536	3·2	
·2652	·546	3·5	
·2668	·569	4·0	VV Pup glimpsed.
·2680	·586	4·0	VV Pup glimpsed.
·2707	·625	—	VV Pup not seen.
3049·2071	·051	—	VV Pup not seen; *h* and *k* seen.
·2202	·239	—	VV Pup not seen; *h* and *k* seen.
·2244	·299	4·0	
·2265	·329	3·7	
·2269	·335	3·6	
·2276	·345	3·2	
·2286	·359	3·2	
·2292	·368	3·6	
·2303	·383	3·6	
·2314	·399	4·0	
·2321	·409	—	VV Pup seen? m·2 fainter than *k*.
·2335	·429	—	VV Pup glimpsed; fainter than *k*.
3051·1830	·380	—	VV Pup glimpsed; ? m·4 fainter than *k*. *l* glimpsed, fainter than VV Pup.
·1945	·545	4·2	
·1955	·560	4·0	
·1962	·570	3·6	
·1972	·584	3·5	
·1983	·600	3·5	
·1997	·620	3·2	
·2011	·640	3·6	
·2021	·654	4·0	Sudden fading.
·2025	·660	4·1	
·2032	·670	4·2	
·2040	·681	— ?	Equal to *l*.
·2049	·694	— ?	Equal to *l*.
·2643	·546	—	VV Pup glimpsed; m·3 fainter than *h*.
·2678	·596	—	VV Pup glimpsed; ? m·2 fainter than *k*.
·2726	·665	—	VV Pup not seen; *h* and *k* seen.
·2771	·730	—	VV Pup not seen; *h* and *k* seen.
·2816	·794	—	VV Pup not seen; *h* and *k* seen.
3053·1807	·023	—	VV Pup glimpsed, fainter than *k*.
·1839	·068	4·2	
·1863	·103	4·2	
·1893	·146	4·2	
·1926	·193	4·1	
·1939	·212	4·2	
·1958	·239	4·2	
·1971	·258	4·0	
·1975	·263	3·7	
·1981	·272	3·6	
·1988	·282	3·4	
·1994	·291	3·2	
·2002	·302	3·3	
3053·2012	·316	3·4	
·2023	·332	3·3	
·2035	·349	3·3	
·2050	·371	3·1	
·2055	·378	2·6	
·2061	·387	3·1	
·2067	·395	3·1	
·2077	·410	3·4	
·2083	·418	3·3	
·2092	·431	3·3	
·2101	·444	3·4	
·2115	·464	3·3	
·2128	·483	3·4	
·2138	·497	3·4	
·2159	·527	3·4	
·2173	·547	3·1	
·2183	·562	3·2	
·2194	·577	3·2	
·2211	·602	3·2	
·2222	·618	3·2	
·2225	·622	3·6	
·2235	·636	3·2	
·2243	·648	3·8	
·2253	·662	4·1	
·2260	·672	4·2	
·3236	·071	2·8	
·3249	·090	2·8	
·3263	·110	2·8	
·3270	·120	3·1	
·3284	·140	3·3	
·3291	·150	3·4	
3055·1852	·762	4·3:	VV Pup glimpsed.
·1869	·787	4·1*	
·1907	·841	4·2:	VV Pup glimpsed.
·1931	·875	4·2*	
·1966	·926	4·4:	VV Pup glimpsed.
·1977	·941	4·1*	
·1984	·951	4·3:	VV Pup glimpsed.
·1994	·966	4·1*	
·2004	·980	4·2	
·2015	·996	4·2*	
·2025	·010	4·2	
·2036	·026	4·1*	
·2046	·040	4·2	
·2056	·055	4·1*	
·2060	·060	4·1	
·2067	·070	4·2*	
·2070	·075	4·2	
·2077	·085	4·2*	
·2088	·101	4·2	
·2095	·111	4·2*	
·2105	·125	4·2	
·2112	·135	4·1*	
·2122	·149	4·2	
·2133	·165	4·0*	
·2140	·175	4·2	
·2143	·179	4·1*	
·2157	·200	3·2	
·2161	·205	3·6*	
·2171	·220	4·2	After apparent fluctuations near *l*.
·2175	·225	3·6*	
·2180	·233	3·6	
·2185	·240	3·5*	
·2192	·250	3·2	
·2195	·254	3·2*	
·2206	·270	3·2	Fluctuations.
·2209	·274	3·2*	