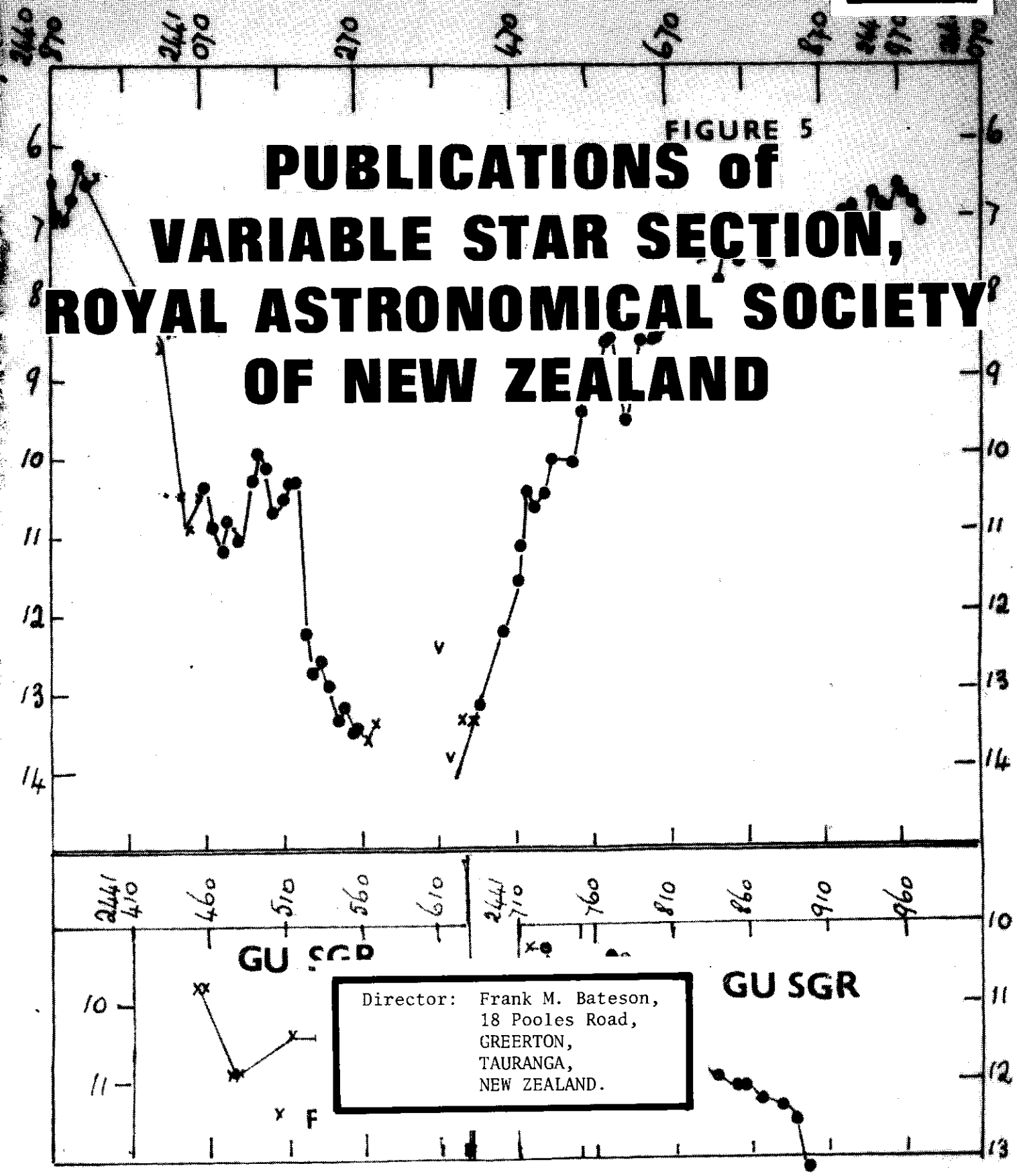
No 1 (C73)

PUBLICATIONS of VARIABLE STAR SECTION, ROYAL ASTRONOMICAL SOCIETY OF NEW ZEALAND

FIGURE 5



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PUBLICATION No. 1 (C 73)

of

VARIABLE STAR SECTION, ROYAL ASTRONOMICAL SOCIETY

OF NEW ZEALAND.

INTRODUCTION.

When Circular 199 was published subscribers were advised that the format of the Circulars was being changed. The objective in so doing was to present the observations in a more useful form than that of tabulated ten day means, and to provide a more suitable publication for the results of the Section. At the same time alterations were made to the methods of handling the records. These changes have taken considerable time since it was desired to make certain that the new systems functioned adequately, and that they would result in a steady output of published material.

Publications now replace the former Circulars and will be numbered from 1 onwards, followed by the last two digits of the year. Thus the present publication contains the 1973 issue of what formerly were termed Circulars. This latter term is retained for the Monthly Circulars (M Series) that have appeared regulargly since May 1972, and for the Special Circulars (S Series). The former give monthly preliminary data on Eruptive and Unusual Variables; the latter, issued irregulargly contain matters such as novae discoveries which require prompt notification to observers.

Publications will appear, for the present, once or twice a year. Observations of Mira Cet; Semi-regular; Irregular and other slowly varying stars will be presented as light curves. Rapidly changing stars, such as those of U Gem, R CrB types, etc., will be given in ten day or daily means and light curves. Articles on observational techniques and instruments will also appear. Predictions will also be published together with lists of observed maxima and minima.

Now that the extensive changes at headquarters have been completed the aim is to bring all records up to date promptly. For that reason the 1974 Publications will be available in a few weeks time.

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1974 September 1

MAXIMA OF VW HYDRI IN 1972-73

Frank M. Bateson

SUMMARY: The light curve reproduced covers the interval J.D. 2,441,315 to 2,442,048, and is derived from 2,000 visual observations. The daily means are tabulated and a list of the observed maxima is given.

INTRODUCTION: VW Hyi, a U Gem type variable, has been consistently followed by observers of the Variable Star Section, Royal Astronomical Society of New Zealand, for the past two decades. Observations to 2,440,954 have appeared in the Circulars of the V.S.S. A detailed paper, discussing all the results, will appear in Memoir No. 2, V.S.S., R.A.S.N.Z., currently under preparation. Preliminary discussions of some of the results have been published (Bateson 1957; Bateson 1965; Bateson & Jones 1956).

CHARTS & SEQUENCES: A chart (Jones 1954; Bateson & Jones, 1956) has been used by observers. This chart was also reproduced by Brun & Petit 1957.

The visual magnitudes adopted for the sequence stars were determined by Bateson from step estimates by Jones. C.P.D. -70°276, with a visual magnitude of 7.62 from Harvard Mimegrams, Series 111, No.1, was taken as the zero point for the sequence. It is probable that the adopted visual magnitudes are compressed, especially at the fainter limits. However, as the determination of the times and nature of the outbursts are the objective of visual observations, no amendments to the adopted magnitudes have been made. This enables the observations to be compared with those previously published. Photoelectric magnitudes are awaited from the Auckland Observatory. Preliminary values show that the minima magnitudes of VW Hyi are fainter than indicated on the adopted visual scale. This does not alter the form of the light curve, nor the types and dates for maxima.

OBSERVATIONS: Daily means for the interval J.D. 2,441,315 to 2,442,048 appear in Table 1. The first column contains the last two digits of the Julian Day to be added to the date shown at the head of this column. The decimal of the Julian Day appears in the second column. This is given in tenths except where it is useful to express it in hundredths. The longitudes of our observers are such that observations each night are centred around midnight G.M.A.T. Thus two entries for the same Julian Date sometimes appear, e.g., 2,441,320.0 and 2,441,320.9. The former refers to the mean of observations for the night 2,441,319-320; the latter to the mean for the following night.

The third column of Table 1 gives the number of observations included in each mean. When the variable was fainter than the magnitude shown, this indicates that there were no positive observations. Usually there were a number of records at different thresholds, but only the faintest is given for each date. If there were more than one observation at this limit this is shown, but those at brighter limits have been ignored.

The final column in Table 1 gives the mean magnitude for each date. When the magnitude depends on a single observation it is given to tenths; otherwise it is given in hundredths. Occasionally, when the variable was changing very rapidly means are listed for half day intervals, or less.

LIGHT CURVE: An inspection of the light curve reproduced, on a small scale, shows how completely the star has been observed. The only breaks of more than two successive nights were:-

2,441,507 - 510 inclusive
640 - 644 "
877 - 881 "

A maximum may have gone unobserved during the second of the above intervals. Otherwise it is most unlikely that any maxima have been missed.

MAXIMA OBSERVED: These are given in Table 2. The first column gives the date for each maximum, followed by its mean magnitude and the interval, in days, between successive maxima. The fourth column gives the weight assigned to each date on the usual scale of 5, excellent, to 1, poorly determined. These dates have been determined from plotting on a much larger scale than used for the light curve reproduced in this paper.

Supermaxima are noted in the final column. These are defined as those maxima when the variable remains brighter than magnitude 10.0 for six days, or longer. At such times, VW Hyi usually, but not always, attains a brighter magnitude than normal at maximum.

DISCUSSION: There are marked differences in the heights, form and widths of the light curve at maxima. Bateson 1965 pointed out that supermaxima tend to recur at an average interval of 179 days. This tendency has persisted throughout the two decades over which VW Hyi has been observed. Other maxima can be separated into a number of distinct types, dependent on their widths, rates of rise and fall,and heights. There are well defined relationships in the intervals between successive maxima of the same type.

There is also a definite tendency for the time spent at minimum to be related to the type of maxima that precedes and follows the minimum phase.

Since these relationships form part of the extensive study of VW Hyi that is to appear in Memoir No. 2 they are not further discussed here.

ACKNOWLEDGEMENTS: I wish to express sincere appreciation to all observers for so consistently following this most interesting variable.

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TABLE 1.

DAILY MEANS.

2,441,300+ JD	D.	N.	MAG.
15.0		2	8.70
16	-	-	-
17	-	-	-
18.0		1	10.5?
19.0		3	9.97
20.0		3	9.60
20.9		5	9.47
21.9		10	9.72
22.9		1	10.7
24.0		3	11.47
25.0		1	13.0
25.9		2	13.15
26.1		1	13.1
27.0		4	12.98
28	-	-	-
29.0		2	13.20
30.0		1	13.2
31.0		2	13.05
32.0		3	13.23
32.9		1	13.0
34.0		2	13.15
35.1		1	13.4
36.0		2	12.90
37.0		5	10.34
38.0		3	11.47

2,441,300+ JD	D.	N	MAG
39	.0	3	12.97
39	.9	2	<12.5
41	.0	2	<13.2
42	.0	1	<13.2
43	.0	3	<12.7
44	.0	1	<12.5
45	.0	1	<12.1
46	-	-	-
47	.0	1	<13.2
48	.0	1	<12.7
49	-	-	-
50	-	-	-
51	.0	1	<13.2
52	.0	1	<13.2
52	.9	1	13.2
54	.0	1	12.7
55	.0	4	10.12
56	.0	1	11.6
57	.0	2	13.05
58	.0	1	13.3
58	.9	2	<12.5
60.0		3	13.30
60	.9	3	13.37

2,441,300+ JD	D	N	MAG
62	.0	2	13.50
62	.9	2	13.40
64	.0	1	13.5
65	-	-	-
66	.0	1	<13.2
67	.1	1	<13.2
67	.9	1	13.2
69	.0	1	<12.7
70	.0	1	<12.7
71	.0	1	<12.7
73	.1	1	<13.2
74	.0	2	<12.7
74	.9	2	<12.7
76	-	-	-
77	-	-	-
78	.0	1	12.9
78	.9	2	9.80
79	.9	3	10.97
81	.0	1	<12.1
81	.9	1	13.3
82	.9	2	13.45
84	.0	1	<13.2
85	.0	1	13.0

TABLE 1. DAILY MEANS VW HYDRI (cont).

2,441,300+

JD D	N.	MAG.
86.0	1	13.2
86.9	2	13.30
87.9	3	13.30
88.9	3	13.30
89.9	2	13.30
90.9	4	13.47
91.9	3	13.37
92.9	3	13.27
93.9	3	13.40
94.9	3	13.37
95.9	1	13.5
97.0	1	13.6
98.2	1	13.7
98.8	1	13.5
99.9	1	13.0

2,441,400+

JD D	N	MAG
00.8	1	13.6
01.9	1	13.2
02.9	1	13.4
03.9	1	<12.7
04.9	1	<12.7
05.9	1	<12.7
06.9	1	<12.7
07.9	1	<13.0
08.8	1	<13.2
09.9	1	<13.2
10.9	1	<12.7
11.9	3	13.17
12.9	2	13.15
13.9	5	9.52
14.9	9	9.81
16.0	6	11.15
16.9	5	12.44
17.9	3	13.07
18.9	2	13.30
19.9	2	13.30
20.9	1	<13.2
21.9	2	<12.7
23.0	2	13.40
24.2	1	<13.2
24.9	3	13.10
25.9	1	13.5
27.0	1	13.4
27.9	1	<13.2
28.9	1	13.5
29.9	1	13.2
30.9	1	<12.1
31.9	1	<12.7
33.2	1	<13.2
34.2	1	<13.2
35 -	-	-

2,441,400+

JD D	N	MAG
36.2	1	<12.1
37.9	1	<13.1
38.9	1	<12.1
39.9	1	13.4
40.9	2	<13.2
41.9	1	13.6
42.9	1	<12.7
44.2	1	<13.2
44.9	2	<13.2
46.2	1	<13.2
46.9	1	<13.2
48	-	-
49.0	1	<13.2
49.9	1	<12.7
50.9	1	<11.6
51	-	-
52.9	1	<13.2
53.9	1	<13.2
55.0	1	<13.2
55.8	1	13.4
56.9	1	13.0
57.8	1	<13.2
59.3	1	<13.2
60.0	1	<12.7
60.9	1	<12.7
61.9	1	<12.7
62.9	1	<12.1
63 -	-	-
64 -	-	-
65.8	1	<12.7
66.9	1	<12.1
67.9	2	8.95
68.9	3	9.20
69.9	2	9.10
70.9	6	9.05
71.9	2	9.40
72.9	10	9.23
73.9	5	9.62
75.0	6	9.52
76.0	3	9.77
77.0	3	9.77
78.0	4	9.87
78.9	6	9.98
79.9	5	10.28
80.9	3	11.27
81.8	1	12.8
83.1	2	13.00
84 -	-	-
85.2	1	13.1
86.1	2	13.25
87.0	2	13.20

2,441,400+

JD D	N	MAG
88.3	1	13.4
88.9	1	<12.5
90.2	1	13.2
90.9	1	10.3
92.1	3	11.13
93.1	2	12.65
94.3	1	<12.7
95.3	1	13.1
96.3	1	<12.7
97.3	1	<12.7
98 -	-	-
99.8	1	13.2

2,441,500+

JD D	N	MAG
00.8	1	<13.2
02.0	1	13.4
02.9	1	12.9
04.0	2	13.40
06.2	1	13.6
06.9	1	<12.5
07 -	-	-
08 -	-	-
09 -	-	-
10 -	-	-
12.0	3	11.27
13.0	2	13.00
13.9	1	<12.5
14 -	-	-
16.2	1	13.2
17.3	1	13.1
18.3	1	13.2
19 -	-	-
20.3	1	13.3
21.2	1	13.5
22.2	1	13.5
23 -	-	-
24.8	1	<11.5
25.8	1	<12.5
26 -	-	-
27.9	1	<12.7
29.0	1	13.4
29.9	1	<12.7
30.9	1	<12.7
32.0	1	<13.2
34.2	2	13.20
34.9	2	13.25
36.2	1	13.5
37.1	1	13.2
38.9	1	<11.5
39.8	1	<12.7
40 -	-	-
42.0	3	9.97

2,441,500+

JD D	N	MAG
42.9	3	11.17
44.0	1	12.8
45.2	1	13.5
46.2	1	13.2
47 -	-	-
49.2	1	<13.2
50.8	1	<12.5
52.2	1	13.4
53.0	1	<12.5
54.8	1	<11.5
56.0	2	<12.7
56.8	1	<12.5
57.9	1	<12.7
58 -	-	-
60.0	1	<12.7
61.0	1	<12.7
62.0	1	<12.5
63.1	1	<13.2
64.9	1	<13.2
66.2	1	<12.7
66.9	1	<13.2
67.8	1	<12.7
68.9	1	<12.5
69.9	1	12.5
70.2	1	9.2
71.0	5	9.56
72.0	4	10.98
73.0	5	12.50
73.9	1	12.9
75.0	1	12.9
76.2	1	13.2
78.2	1	13.5
80.2	1	<13.2
81.2	1	13.5
82.9	1	<12.7
83.8	1	<12.7
84.9	1	<12.7
85.9	1	<12.7
86.9	1	13.6
87.9	1	<13.6
88 -	-	-
90.1	1	13.6
91.1	2	<13.2
92.0	1	<13.2
92.9	1	13.3
93.9	1	12.9
95.2	2	13.2
96 -	-	-
97.0	2	13.30
98.0	2	<13.2
98.9	1	13.6

TABLE 1. DAILY MEANS VW HYDRI (cont).

2,441,600+			2,441,600+			2,441,700+			2,441,700+		
JD D	N	MAG.	JD.D	N	MAG	JD D	N	MAG.	JD D	N	MAG.
00.0	1	<13.2	51.1	1	13.3	00 -	-	-	49.0	2	13.50
00 -	-	-	52.0	3	<13.2	01.9	1	13.2	49.9	3	13.13
01.9	1	13.2	53.0	2	13.10	02.9	1	<12.7	50.9	3	13.17
03.0	1	13.2	53.9	2	13.35	03.9	2	13.45	51.9	2	13.15
03 -	-	-	55.1	1	<13.2	05.0	1	<11.6	52.9	1	13.4
04.9	1	<13.2	56.0	1	13.4	05.9	1	12.9	53.9	1	13.0
06.0	1	<13.2	56 -	-	-	06.9	8	10.42	54.9	1	<11.5
06.9	1	<12.5	58.0	2	13.55	07.9	2	11.35	56.2	1	<12.5
08.1	1	13.6	59.0	1	13.4	08.9	1	12.9	57.0	1	<11.5
08 -	-	-	59.9	2	13.25	09.9	2	13.40	58.2	1	13.3
09.9	2	9.50	60.9	1	13.5	11.0	2	13.25	58.9	1	<12.7
10.9	6	9.45	61.9	1	13.4	11.9	1	13.2	59 -	-	-
11.9	2	10.60	63.0	8	9.25	12.9	1	13.4	61.0	1	<10.9
12.8	1	12.0	63.9	6	8.88	14.0	1	13.6	61.9	1	<12.7
13.9	2	13.05	65.0	10	8.79	15.0	2	13.40	62.9	1	13.2
14 -	-	-	66.0	7	8.89	16.0	1	<12.7	63.9	9	9.86
15.9	1	<12.5	67.0	6	8.73	17.0	4	13.22	65.0	6	9.73
16.9	2	13.30	67.9	4	9.05	18.0	4	13.45	65.9	7	11.20
17.9	2	13.55	68.9	4	9.22	19.0	2	13.35	66.9	7	12.83
18.9	2	13.50	70.0	4	9.32	20.0	2	13.25	67.9	1	13.0
19.9	2	<13.2	71.0	7	9.34	20.9	2	13.20	68.9	1	<13.2
21.0	2	13.60	72.0	4	9.32	22.0	3	13.30	69.9	3	13.23
22.9	2	13.35	72.9	4	9.55	23.0	3	13.40	71.2	1	<12.7
23.9	1	<12.7	73.9	9	9.63	24.1	2	13.45	71.9	1	13.5
24.9	3	<12.7	75.0	4	9.95	25 -	-	-	72.9	2	13.25
25.9	1	<13.2	76.0	4	10.27	26.1	1	13.7	73.9	1	13.4
27.0	1	<13.2	77.0	2	11.70	26 -	-	-	74.9	1	13.1
28.9	1	<13.2	77.9	2	12.70	28.1	1	13.8	75.9	1	13.2
29.9	1	13.4	78.9	3	12.87	29.2	1	<12.7	76.9	2	<13.2
30.9	1	13.4	80.0	2	12.95	29.9	1	13.4	77.9	2	<13.2
32.0	1	<13.2	81.0	3	13.27	31.2	1	<12.5	78.9	3	13.33
32.9	1	<10.9	81.9	3	13.27	31.9	1	<10.9	79.9	2	13.35
33.9	1	<13.2	83.0	1	13.3	32.9	3	10.90	80.9	2	13.40
35.0	1	<12.7	84.0	3	13.27	33.2	1	9.4	81.9	2	13.50
35.9	1	<13.2	85.0	1	13.2	33.9	4	10.00	82 -	-	-
36.9	1	13.2	86.0	3	13.33	34.9	5	11.04	83.8	1	<13.2
38.1	1	<13.2	87.0	4	13.17	36.0	4	13.02	84.9	2	13.30
38 -	-	-	88.9	6	12.35	36.9	4	13.17	86.0	1	<10.9
40.1	1	13.6	89.0	7	10.23	37.9	2	13.30	86.9	1	<12.5
40 -	-	-	89.9	6	11.33	38.9	2	13.35	87.9	1	<10.9
41 -	-	-	90 -	-	-	39.8	1	13.3	88.9	2	<12.5
42 -	-	-	91.9	1	<12.7	40.9	2	<12.7	89.9	1	<12.1
43 -	-	-	93.0	1	<11.5	41.9	1	13.3	90.9	1	<12.7
44 -	-	-	94.0	1	13.1	42.9	1	13.4	91 -	-	-
45.8	1	13.6	95.0	2	13.35	43.9	1	13.4	93.0	4	13.70
47.2	1	13.2	96.1	1	<12.7	44.9	1	13.4	93.9	2	<13.2
48.0	1	<12.7	97 -	-	-	46.0	4	13.40	94.9	1	13.6
49.0	1	<11.6	99.0	1	<11.5	46.9	4	13.25	95.9	1	12.9
50.1	1	13.3	99.9	1	13.2	48.0	2	13.35	96.9	2	<13.2

TABLE 1. DAILY MEANS VW HYDRI (cont).

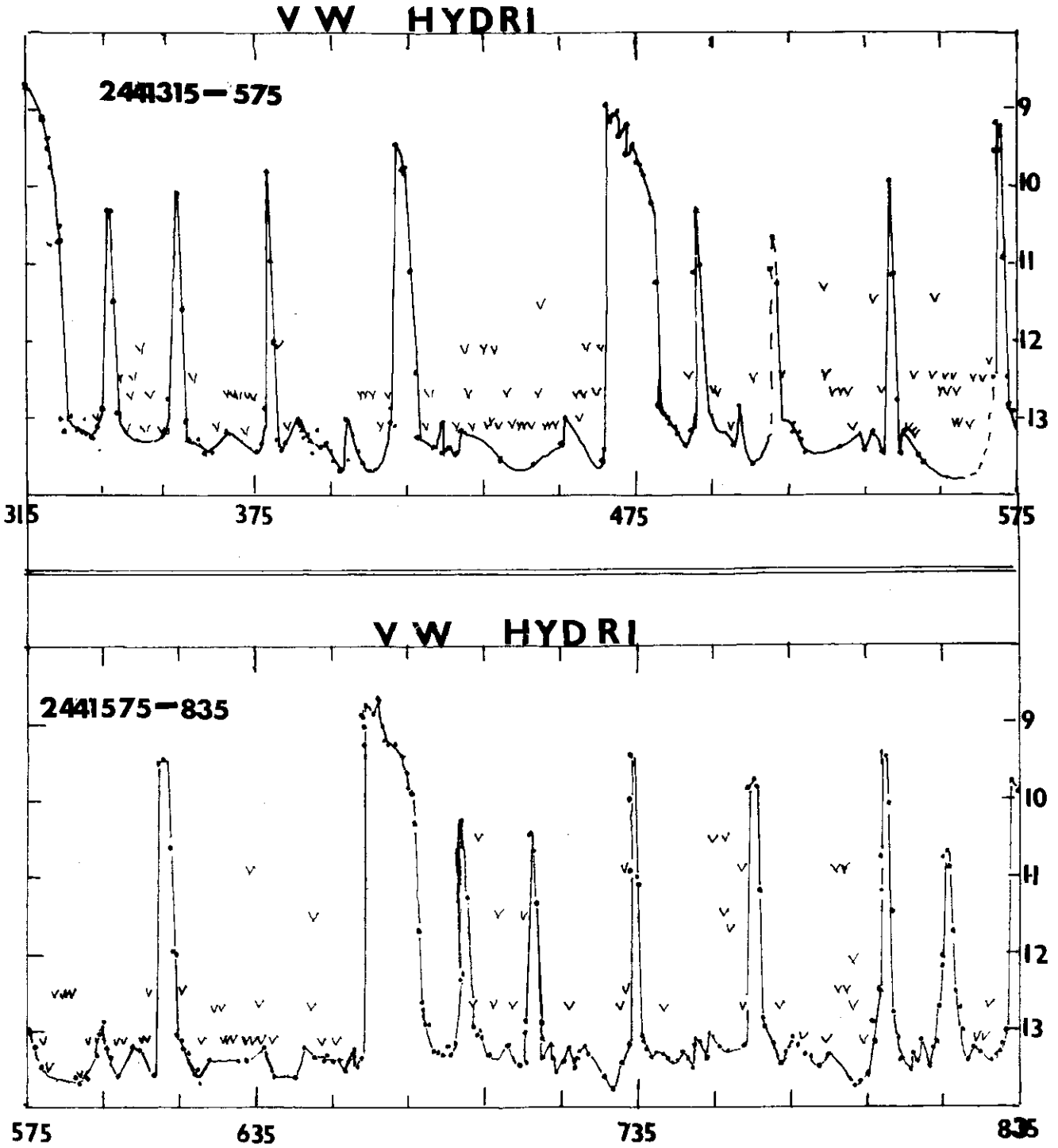
2,441,700+			2,441,800+			2,441,800+			2,441,900+		
JD D	N	MAG.	JD D	N	MAG.	JD D	N	MAG.	JD D	N	MAG.
97.9	2	12.45	41.9	3	9.67	88.0	2	12.20	34.8	1	<12.1
98.2	1	10.7	43.1	7	9.66	90.2	3	<12.7	35.9	1	<10.9
98.9	1	9.4	43.9	3	10.03	91.2	3	<12.7	37.1	2	13.80
99.9	6	10.03	44.9	3	10.43	91.9	1	12.9	38.9	1	<12.5
2,441,800+			45.9	4	11.12	92.9	1	<12.5	39.9	1	<12.5
00.9	5	11.50	46.9	1	12.3	94.2	1	<12.7	40.90	4	11.02
01.9	2	12.80	47.9	1	<12.7	95.2	1	13.2	41.01	4	10.47
02.9	2	13.15	48.8	1	<11.5	96.1	2	<12.7	41.9	4	9.42
03.8	1	13.4	49 -	-	-	97.0	2	<12.7	42.9	6	11.23
04.9	2	<12.7	50 -	-	-	98.2	1	13.4	43.9	2	12.60
05.8	1	13.5	51.9	1	12.9	99.0	1	<10.9	45.0	2	13.40
06.8	1	13.3	52.8	1	<12.7	2,441,900+			47.0	1	<12.5
07.9	2	13.45	53.8	1	<12.7	00.0	2	<12.7	47.9	1	<12.7
08.8	1	13.1	54.9	1	13.2	01.2	1	13.6	48 -	-	-
09.9	1	<11.5	55.8	1	<13.2	02 -	-	-	50.0	1	<12.7
10.9	1	13.5	56.9	1	<12.1	04.2	1	13.1	51.0	1	<13.2
11.9	1	13.2	58.0	1	<12.7	05 -	-	-	51.9	2	<12.7
13.2	1	<13.2	59.0	1	13.0	06.9	1	<10.9	52.9	1	13.4
13.9	2	<12.7	59.9	5	10.44	07.9	1	<10.9	54.0	1	13.2
14.8	3	12.17	60.1	2	9.95	08 -	-	-	54.8	1	<13.2
15.3	3	10.77	60.8	2	11.05	09.9	1	<12.5	55.9	1	<12.7
15.8	2	10.70	61.2	2	11.40	10 -	-	-	56.9	1	13.6
16.3	1	10.9	61.9	3	12.50	11.8	1	<13.2	57.9	1	13.2
16.8	3	11.70	63.3	1	13.2	12.9	1	<11.5	59.0	1	13.1
17.2	2	12.50	64.0	1	<12.7	13.9	1	<12.5	59.9	1	13.4
18.9	1	<12.5	64.9	1	13.5	14.9	1	<12.7	61.0	1	13.2
19 -	-	-	65.8	1	13.2	16.3	1	<12.7	62.0	1	<12.7
20.8	1	<12.7	67.2	1	13.4	17.0	1	<13.2	63.0	1	<13.2
21.9	1	13.4	67.9	2	<12.5	17.9	2	<13.2	64.9	1	<12.7
22.9	1	13.2	68.9	1	<12.1	18.0	3	12.77	65.9	2	<12.1
23.8	1	<13.2	69.9	1	<10.9	18.85	2	10.25	66.9	1	<11.6
24.9	3	13.33	71.1	2	13.45	18.92	3	9.57	67 -	-	-
25.9	1	<13.2	71.8	1	<12.5	18.98	5	9.30	68.9	1	13.4
26.8	1	<12.7	72.9	1	<12.1	19.9	5	10.44	69.9	1	<12.7
27.9	2	13.40	73.9	1	13.2	20.2	4	10.95	70.9	1	<13.2
29.0	2	13.35	74.8	1	<12.5	20.8	2	11.90	71.9	2	<13.2
29.9	2	13.30	75.9	1	<10.9	21.9	1	<12.1	72 -	-	-
30.9	1	13.2	76.9	1	<11.6	22.9	1	12.7	73.9	2	13.40
31.9	1	13.0	77 -	-	-	24.0	4	<12.7	74.9	1	<13.2
33.0	20	9.76	78 -	-	-	25.0	2	13.60	75.9	1	9.6
33.9	16	9.80	79 -	-	-	26.0	1	<13.2	76.9	6	9.68
35.0	10	9.89	80 -	-	-	27.0	1	<12.7	77.92	2	11.00
35.9	3	9.40	81 -	-	-	27.9	1	<11.5	78.02	3	11.47
37.0	4	9.37	82.9	1	<12.7	28.9	1	<10.9	79.1	1	12.7
37.9	3	9.90	83.9	1	13.1	29.8	1	<12.7	79.9	1	13.3
38.9	3	9.77	84.9	1	12.6	30.9	1	<12.7	81.0	2	13.30
40.1	2	9.90	85.9	3	9.90	32.2	1	<12.1	81.9	1	<13.2
40.8	3	9.57	86.9	4	10.75	33.1	1	13.8	82.9	1	13.5

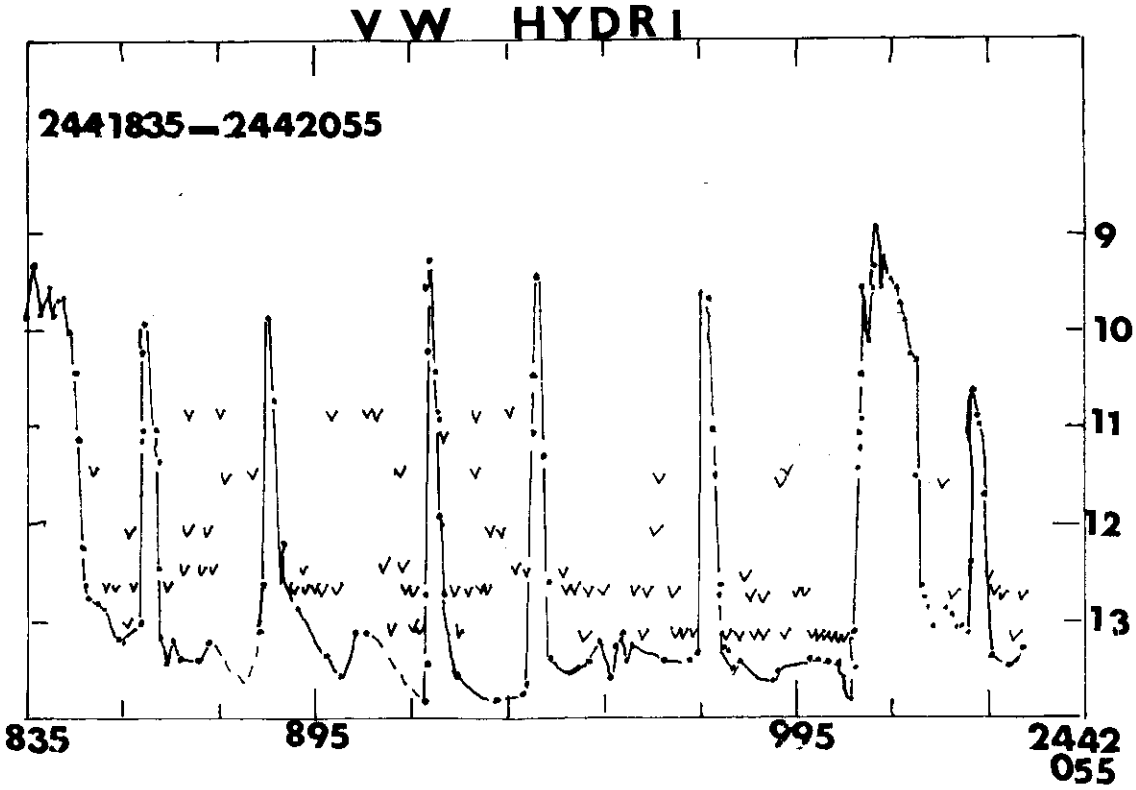
TABLE 1. DAILY MEANS VW HYDRI (cont).

2,441,900+			2,442,000+			2,442,000+			2,442,000+		
JD D	N	MAG.	JD D	N	MAG.	JD D	N	MAG.	JD D	N	MAG.
83.9	1	13.4	00.9	1	<13.2	14.9	12	9.15	32.0	2	13.05
84.9	1	<13.2	02.0	1	<13.2	15.9	7	9.40	33.0	2	12.35
86.0	2	<12.5	02.9	2	13.40	17.0	8	9.50	33.91	4	10.45
86.9	1	<12.7	03.9	1	<13.2	17.9	10	9.67	33.99	3	10.90
88.0	1	<13.2	04.9	1	13.4	18.9	2	9.85	35.0	2	11.60
89.0	1	<13.2	05.9	2	<13.2	19.9	4	10.20	35.9	1	<12.5
89.9	2	<12.7	07.0	2	<13.6	20.9	6	10.23	36.9	2	<12.7
90.9	1	13.6	07.9	3	13.07	22.2	1	11.5	37.9	2	13.35
91.9	1	13.5	08.92	13	11.21	22.9	1	12.6	38.9	1	<12.7
92.9	1	<11.6	08.97	3	10.97	24.0	2	12.80	39 -	-	-
93.9	1	<11.5	09.06	2	10.40	24.9	1	13.0	40.9	1	13.4
94.9	1	<13.2	09.93	7	9.53	25 -	-	-	42.0	1	<13.2
95 -	-	-	10.91	10	10.06	26.9	1	<11.6	43.0	1	<12.7
96.9	1	<12.7	11.05	8	9.50	27.9	2	12.80	43.9	1	13.2
97.9	1	<12.7	11.9	6	9.32	29.0	3	<12.7	45.0	2	<13.2
98.9	1	13.4	12.9	6	8.92	30.0	1	13.0	46 -	-	-
99.9	2	<13.2	14.3	1	9.5	31.0	1	13.0	47.8	1	<13.6

TABLE 2. VW HYDRI--MAXIMA 1972-73.

J.D.	MEAN MAG.	INT d	Wt.	REMARKS
2,441,337.1	10.34	24.1	5	
355.0	10.12	17.9	5	
379.0	9.80	24.0	3	
413.9	9.52	34.9	5	
467.9	8.95	54.0	5	Supermaximum
491	10.3	23.1	3	
511 ?	10.6?	20	2	Possibly 511.5 & brighter than 10.6
542.0	9.97	31.0	4	
570.9	9.20	28.9	4	
610.5	9.2 ?	39.6	4	
663.9	8.88	53.4	5	Supermaximum
689.0	10.23	25.1	5	
706.9	10.42	17.9	5	
733.2	9.4	26.3	5	
764.5	9.2 ?	31.3	4	
799	9.4	34.5	4	
815.6	10.4	16.6	5	
835.9	9.40	20.3	5	Supermaximum
860.1	9.95	24.2	5	
886	9.90	26.1	5	
919.0	9.30	33.0	5	
942	9.42	23.0	5	
976.0	9.50	34.0	5	
2,442,013.0	8.92	37.0	5	Supermaximum
033.9	10.3	20.9	5	


VW HYDRI
2441315—575
-9
-10
-11
-12
-13
315
375
475
575
VW HYDRI
2441575—835
-9
-10
-11
-12
-13
575
635
735
835


VW HYDRI
2441835—2442055
9
10
11
12
13
835
895
995
2442
055

W PHOENICIS-- A Mira type Variable

Frank M. Bateson

SUMMARY: Observations of W Phe for the interval J.D. 2,436,076 to 2,441,562 are given in the form of light curves. Maxima and minima are tabulated. Elements found are:-

Epoch Max. J.D. 2,436,461 $\pm$ $332^{d}.4$. M-m $140^{d}.4$. Mean Max. 8.91_{v}; mean min. 14.02_{v}. Extreme range 8.1 to 14.4.

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OBSERVATIONS: Light curves give the visual observations of W Phe from J.H. 2,436,076 to 2,441,562. Charts 117 and 118 (Bateson et al 1967) were used by observers. There is generally little scatter between individual estimates.

Some degree of uncertainty exists concerning the exact shape of the light curve at minimum phase, because there are few positive observations at this phase. This is partly due to W Phe being below the threshold of most of the instruments used at its minimum phase. However, the variable has been well observed down to 13.5, enabling minima to be determined with reasonable accuracy from the standard light curve.

MAXIMA AND MINIMA:

Table 1 lists the maxima observed. The first column gives the number assigned to each maximum on the basis of the Epoch given by Kukarkin 1970 as 2,430,193 + $331^{d}.3$. Successive columns give observed date; visual magnitude; the interval, in days, between successive maxima, and the assigned weight, on the usual scale of 5 (well determined) to 1 (poor). Two sets of O-C residuals are given in columns 6 and 7. Those in the sixth column are based on Kukarkin's epoch and period; those in the seventh column are for the Epoch 2,436,461 $\pm$ $332^{d}.4$. The respective average O-C residuals are $\pm$ $22^{d}.4$ and $\pm$ $7^{d}.8$.

Table 2 gives the dates of minima, derived by using the standard light curve when observations are lacking at minimum. These dates are of a lower accuracy than those of maxima.

DISCUSSION: W Phe is a typical Mira Cet variable with generally narrower maximum than minimum. The extreme range is 8.1v to 14.4v, but the variations in amplitude are not abnormal for this class of variable.

The elements found for W Phe are:-

EPOCH MAX. J.D. 2,436,461 $\pm$ $332^{d}.4$ M-m $140^{d}.4$ (42.2% of period)
MEAN RANGE:- 8.91v to 14.02v

REFERENCES:-

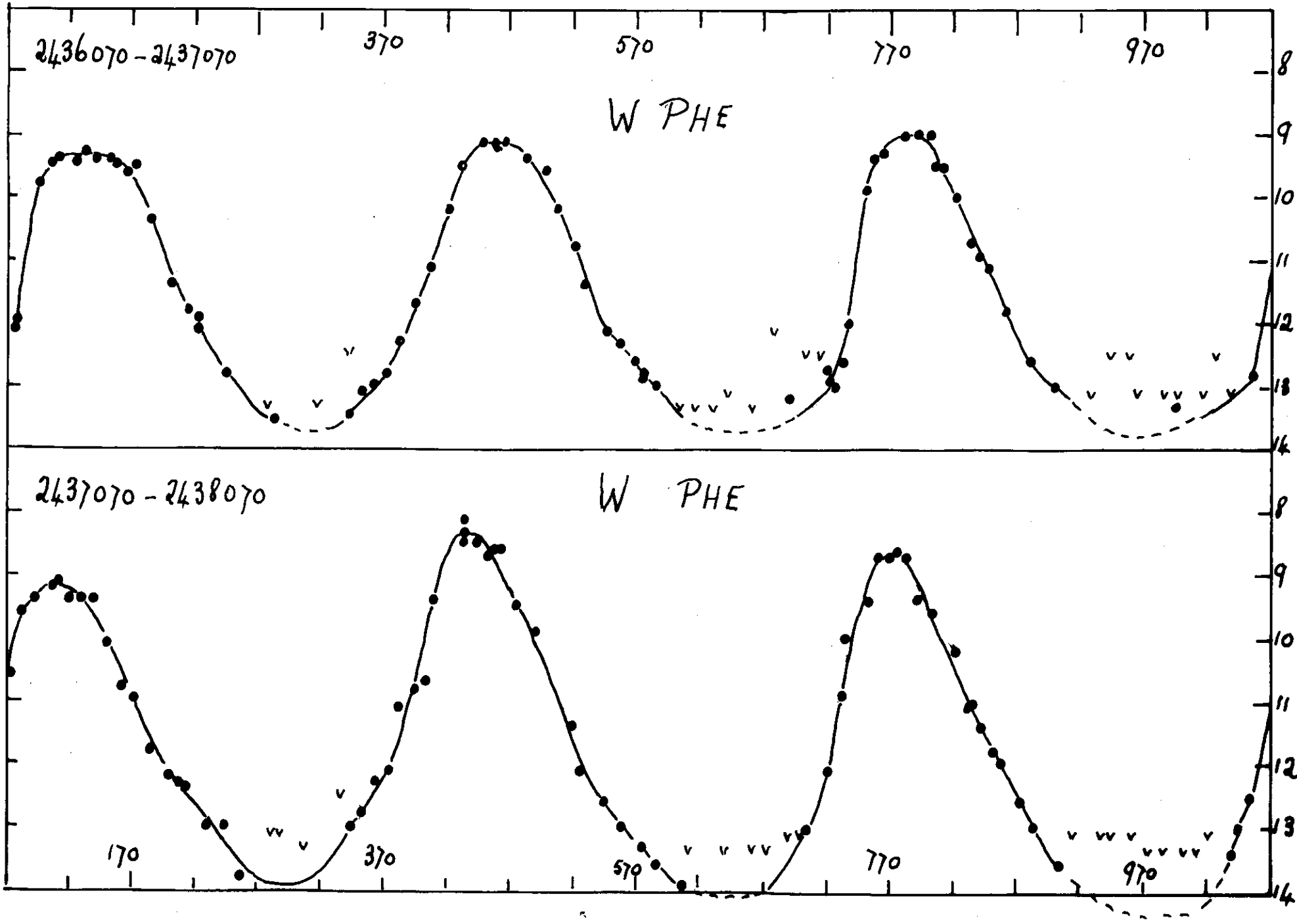
Bateson, F.M; Jones, A.F; Stranson, I. 1967 "Charts for Southern Variables." Series 4. Publ. by F.M. Bateson
Kukarkin, et al. 1970. General Catalogue of Variable Stars. Vol. 2. Moscow.

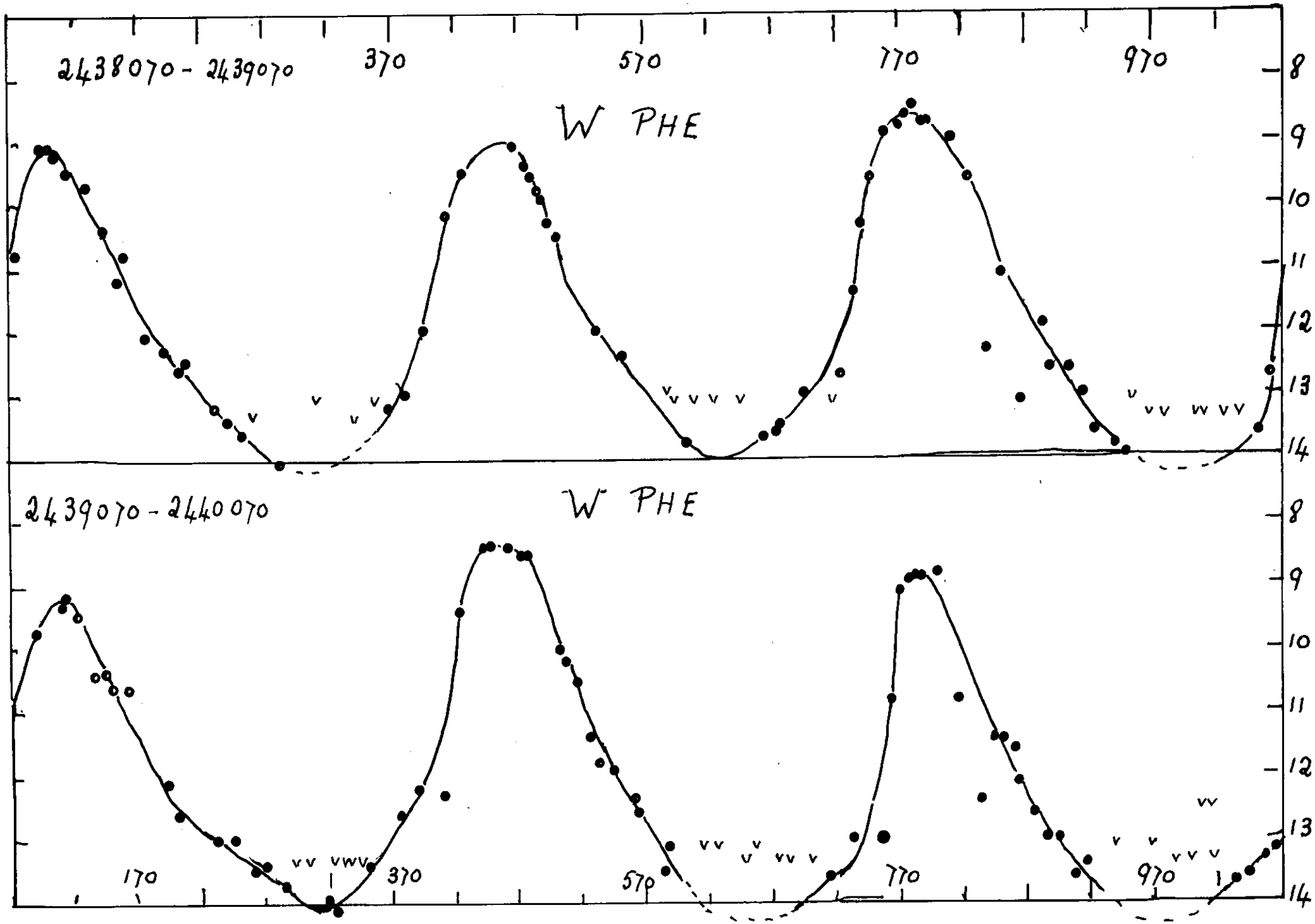
TABLE 1.
OBSERVED MAXIMA OF W PHOENICIS.

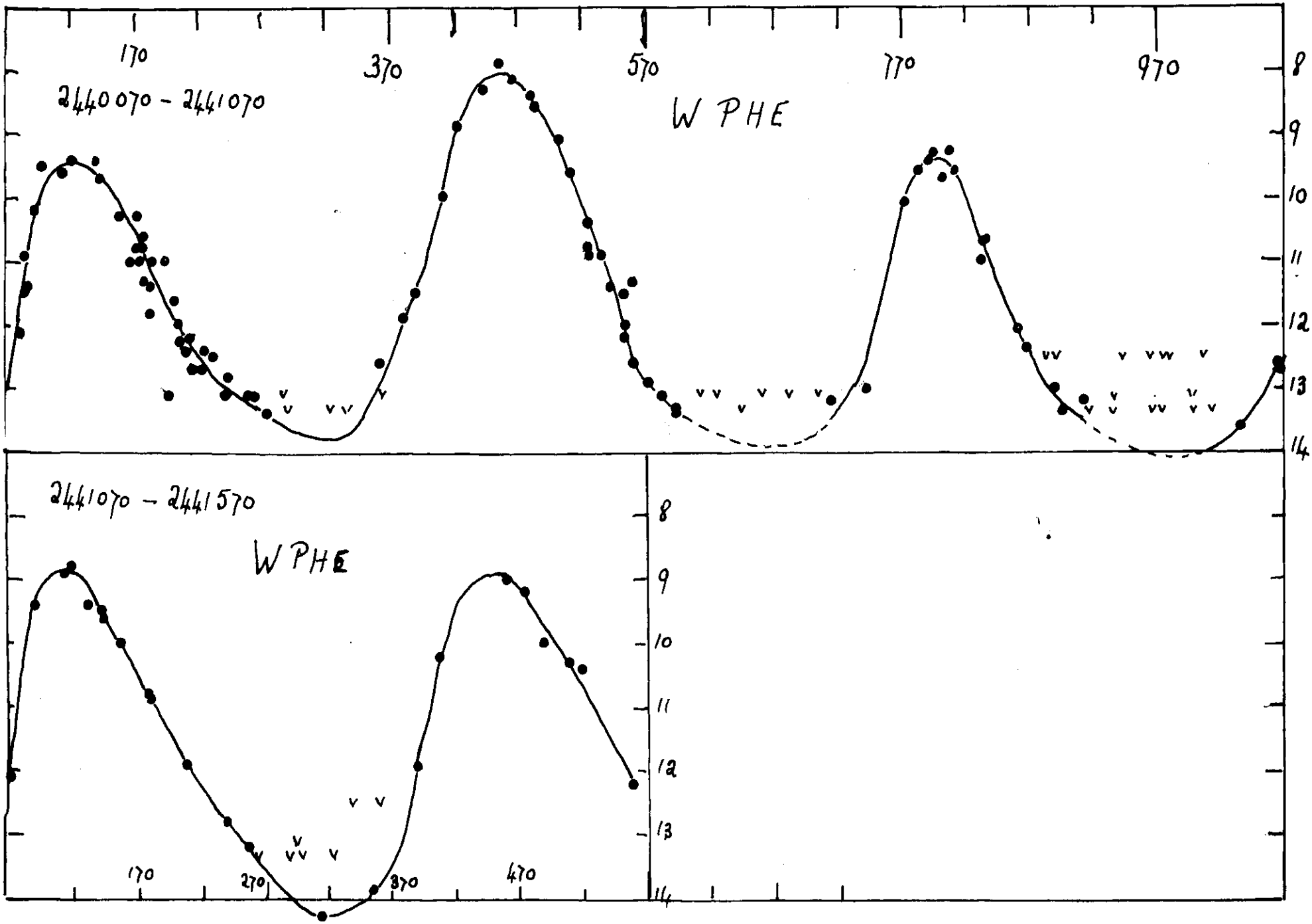
N.	J.D.	MAG_v	INT_d	Wt	$O-C_d$	$O-C_d$
18	2,436,135	9.4	...	3	-21	+ 6
19	461	9.1	326	5	-27	± 0
20	778	9.0	317	4	-41	-15
21	2,437,113	9.2	335	4	-37	-13
22	437	8.4	324	4	-45	-21
23	768	8.7	331	5	-45	-23
24	2,438,111	9.1	343	4	-33	-12
25	456	9.0	345	4	-19	+ 1
26	780	8.6	324	5	-27	- 8
27	2,439,119	9.2	339	3	-19	- 1
28	452	8.4	333	4	-17	- 1
29	783	8.9	331	4	-18	- 2
30	2,440,123	9.4	340	5	- 9	+ 6
31	457	8.1	334	5	- 6	+ 7
32	793	9.5	336	3	- 2	+11
33	2,441,120	8.9	327	3	- 6	+ 5
34	448	8.9	328	2	- 9	+ 1

TABLE 2.
MINIMA OF W PHOENICIS.

J.D.	MAG_v	INT_d	$M-m_d$
2,436,317	13.7	...	144
649	13.6	332	129
974	13.6	325	139
2,437,294	14.0	320	143
625	14.0	331	143
973	14.4	348	138
2,438,311	14.2	338	145
637	14.0	326	143
969	14.2	332	150
2,439,303	14.0	334	149
649	14.2	346	134
976	14.4	327	147
2,440,322	13.8	346	135
658	13.8	336	135
979	14.0	321	141
2,441,317	14.4	338	131


2436070 - 2437070
W PHE
370
570
770
970
8
9
10
11
12
13
14
2437070 - 2438070
W PHE
170
370
570
770
970
8
9
10
11
12
13
14


2438070 - 2439070
370
570
770
970
W PHE
8
9
10
11
12
13
14
2439070 - 2440070
W PHE
170
370
570
770
970


2440070 - 2441070
W PHE
170
370
570
770
970
8
9
10
11
12
13
14
2441070 - 2441570
W PHE
170
270
370
470

THE VISUAL COMPARATOR

Eric Harries-Harris

SUMMARY:- The development and construction of a visual comparator is described. Methods of testing and calibration are detailed, and a statistical analysis is given of the results on various comparison stars. Procedures adopted for the use of the comparator in observing variable stars are discussed. This paper was originally delivered at the 1974 National Convention of Australian Amateur Astronomers held in Adelaide, South Australia.

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INTRODUCTION:

The main objective in variable star observing is the production of accurate light curves. Allied with this is, naturally, accurate determinations of the times of maxima and minima; periods, and other elements.

Satisfactory results, within the limits of the various techniques are obtained by three methods, viz:-

(a) Photoelectric Photometers.
(b) Photometers of the extinction type, meridian or Zollner type.
(c) Visual observations.

I have omitted photographic techniques since these are beyond the scope of this paper. Of the above methods, (a) is by far the most accurate and provides not only very accurate results but gives much more information since the observations are usually made in three colours. Whilst it is in use by a limited number of part-time astronomers it does suffer the defect to them that it requires a considerable outlay in cash and must be augmented by facilities for reduction.

The second type of photometers (b) preceded the use of the photomultiplier tube and one form is the subject of this paper.

Visual observations continue to be carried out by part-time astronomers, organised into national and international groups. Indeed, most of our knowledge of the behaviour of many classes of variable stars is entirely, or almost entirely, dependent on the observations made visually.

However, visual observing, even in the hands of very experienced observers, does have certain drawbacks. Firstly, many of the stars, for instance those of Mira Ceti, irregular and semi-regular types are red stars; quite often very red. Because the comparison stars used are of earlier spectral type, a colour error is introduced. This is unavoidable in visual work since most red stars are variable. Secondly, most observers have a systematic deviation which makes their estimates either too bright or too faint. The effect of this is to a great extent overcome by pooling the results from a large number of observers when the systematic errors tend to cancel out, or corrections can be applied.

To do this means that there must be a large number of estimates for each star. Thirdly, in visual observing no account is taken of the varying atmospheric effects on the observations. They are also subjected to errors due to the orientation of the field.

The application of standard methods of observing, as laid down by the Variable Star Section, Royal Astronomical Society of New Zealand, tends to keep the errors of observation in visual results to a minimum. The results achieved by visual methods cannot be duplicated in any other way, except by patrol photography, and this method is no more accurate than visual observing.

COMPARATOR:

To overcome the drawbacks of visual observation, I have constructed an aid to more accurate observations. This is a natural development from the photometers that have been in use in many countries.

I decided that the crux of the matter was the comparison star, and I decided to carry with me, a comparison star that would always be in the field, alongside the variable star that I was viewing; and which could be matched simply to the brightness of the variable star.

The result was the Visual Comparator. Unfortunately, I am not a good handyman, and I am an even worse electrician. I have no doubt that in the hands of a skilled craftsman, or even a more patient one than I, a visual comparator could be made that would incorporate all the refinements that I am unable to make myself.

Bearing in mind my limitations, I set to work to produce a variable false image of a star that would stay conveniently within the field of view. There are two ways of doing this. One would have been to interrupt the light coming

from the star and by using plain glass, optically flat, project a light source directly into the eye-piece. The other way was to view binocularly; the right eye at the telescope eye-piece, and the left eye at the false eye-piece where I could simulate a star image.

I chose the latter, not having sufficient confidence in my ability to collimate an otherwise complicated optical train.

The essentials of my requirements were thus:-

(a) A light source that had to be constant, (i.e. DC, and independent of the town's mains and its fluctuating voltages).

(b) Two separate systems to vary that light source.

(c) A device to reduce the light to a false star image.

(d) A method of introducing that image into the field of any variable star.

I have just discussed the choice of "d." I comment on the other requirements:-

(a) For the power source, I used the battery of my car through a convenient instrument-panel plug. The decay curve on a good battery in daily use is minimal enough to be neglected over the short period that it is in use.

(b) It was necessary to employ two variation systems, one to bring the false image to a matching brightness of a known comparison star, and the other to vary that setting by a measurable distance to match the variable star with a maximum of movement for accuracy.

My first attempt, which was in use for many years was to make variation system No. 1 of two polarised filters, one fixed and the other capable of turning through ninety degrees.

Variation system No. 2 consisted of a rheostat that was calibrated in tenths of a visual magnitude. Calibration is discussed in detail later in this paper.

(c) A diaphragm was made of aluminium foil to interrupt the light source and pierced carefully. The technique for piercing holes in foil came from MNRAS, 1936 March, p.452. It is worth quoting this advice:-

"The principal difficulty in making pinholes 0.0025mm diameter by piercing a hole in tin foil with a needle, lay in making the needle really sharp. But Mr. J.M. Dodds of the Metropolitan Vickers Co. solved this difficulty by the following technique."

"The needle, mounted on a rod is first honed on a fine stone until the diameter of its point does not exceed 0.01mm. This is not difficult provided one inspects the point frequently during honing with a microscope. The final honing is done on glass."

"Lay the needle on a glass plate and press heavily with one finger behind its point. Lift the needle so that it is bent through several degrees, then still pressing with the finger, simultaneously twist and withdraw. This honing quickly results in a sharp needle."

"The foil is tacked to a glass plate by its edges only, and the needle point is then gently placed on it and the needle rotated without pressure through at least one revolution and then lifted off. Some practise is needed to avoid dragging the point sideways in lifting off. If the needle is not rotated the hole will not be reasonably circular. Not every pierce is successful, but one can in this way make reasonably circular pinholes 0.002mm in diameter."

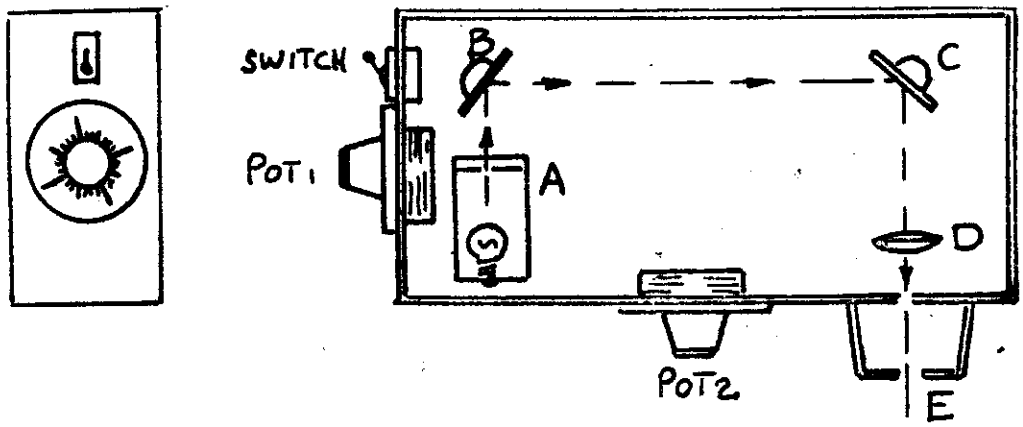
I found that with trial and error, (many more errors than trials it seemed to me), I was able to make one successful diaphragm out of ten; which will give some idea of the time spent on this stage of the construction.

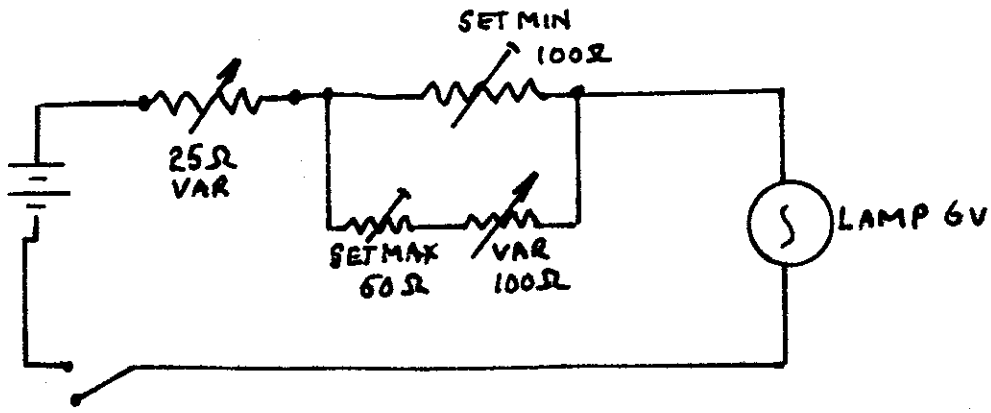
ASSEMBLY:

The components were then assembled as compactly as possible to accommodate them close to the telescope tube adjacent to the eyepiece. To achieve this, I purchased a rectangular plastic box and mounted the bulk container, (an old screw-top aluminium film container) with the diaphragm attached to the cap in such a way that the pierced hole was concentric. (Labelled A in the diagram on page 20). This was pointing towards a flat piece of aluminised plate glass mounted upon a dowel and turned through 45°, (B in the diagram on page 20). This turned the beam of light from the diaphragm and directed it to an identical mirror at C which in turn directed the beam through 45°, where it passed through a lens at D which brought it to a point image. This then passed through a hole drilled in the side of the box and through a small tube fixed to the outside of the box with 'Araldite' adhesive, (Labelled E in the diagram).

This served as the false eyepiece. The 6v standard

THE COMPARATOR LAYOUT





CIRCUIT DIAGRAM

bulb used was suitably 'frosted' with sand paper, and considerable care taken in the soldering of wire leads to the contact at the base, (it melts easily!).

The electrical circuit was originally very simple, with one rheostat providing the full range of variation 2. A friendly electrical engineer pointed out to me that both variations 1 and 2 could be achieved with the use of rheostats, and then proceeded to design me a circuit built around the power source of a 12v battery and the type of standard 6v bulb that I was using.

It was important that the full amount of movement of the final potentiometer in the circuit had to remain within the linear part of the filament heating curve of the bulb. The effect of current passing through the filament is logarithmic when one plots I (Current) against E (Voltage). But it must be remembered that the curve is reasonably linear between $I_o/2$ against V/3 and tends to flatten out at I_o against V_o. Therefore it is important that the movement of POT 1, which I term the rheostat that will be used for measurement of magnitude difference, and POT 2 do not affect the logarithmic part of the curve.

The design was as follows:-

Lamp res: 5.5v = 300 ma.....18.3 Ohms
2.5v = 200 ma.....12.5 Ohms

at 12v 200ma.....R = 60 Ohms
12v 300ma.....R = 40 Ohms

Therefore required R 60 -12.5 = 47.5 Ohms
=40 -18.3 = 21.7 Ohms

Diff = 25.8 Ohms

The two variable rheostats (POT 1 & POT 2) had controls that protruded through the box and had marked discs that could be read at the telescope; the knobs were smooth and featureless, but had a slot milled in them which could be inspected to see the position of the knob. A switch was also fitted conveniently by the main rheostat, (POT 1) and the whole arranged so that a single screw would affix the box to the telescope in such a manner that the false eyepiece on the box was always adjacent to the eyepiece on the telescope and to its left.

It was also capable of limited movement around the optical eyepiece. It could also swing inwards and outwards to accomodate the correct distance between the two eyes in comfort.

I discovered that it was of considerable importance not to know where the indicator on POT 1 was, through knobs or pointers protruding through etc., otherwise anticipation automatically followed. The milled slot could not be felt with the fingers, nor could it be seen until deliberately looked at after the assessment.

This then, was the set-up, ready for calibration. The whole was connected to its power source and a good clear night selected for testing.

When viewed binocularly, the false image appeared in the telescope eyepiece field slightly to high left at all times. Stars selected for calibration were viewed at high right, to keep the two images horizontal (Figure 1, page 23).

CALIBRATION PROCEDURE:

(1) A star of visual magnitude 6.0 was selected near zenith.

(2) An arbitrary mark indicating 6.0 was made on the POT 1 disc near its hypothetical lowest resistance.

(3) POT 2 brought the false image's brightness to match with the comparison star.

(4) A star of visual magnitude 7.0 was selected in the same field.

(5) It was matched carefully with POT 1 and the dial marked '7.0'. This was repeated ten times using the mean arbitrary '7.0' mark (Figure 2, page 23).

(6) A star of visual magnitude 8.0 was selected, also in the field.

(7) It was matched carefully with POT 1 and the dial marked '8.0' through the mean of ten such readings.

(8) A star of visual magnitude 9.0 was selected also in the same field. It was matched carefully with POT 1 and the dial marked '9.0' through the mean of ten such marks.

In actual fact, the marks were so close together that the spread was little more than one degree, the pencil marks running into one another (Figure 2, page 23).

The dial was checked to see if the marks indicated a linear relationship (i.e. regularly spaced around the dial); if they had not been, the procedure would have been to repeat the testing at a different commencing setting on POT 1 until it was so. However, the markings were well within the space

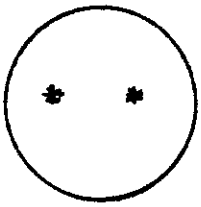


fig 1

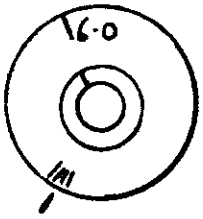


fig 2

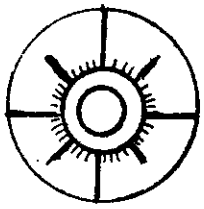


fig 3

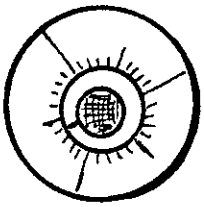


fig 4

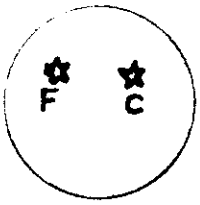


fig 5

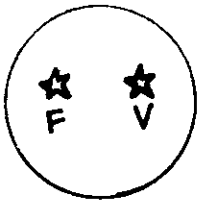


fig 6

of one degree of being linear, and so the dial was filled with divisions equally marked off in tenths, each fifth mark slightly larger than the tenths, and the tenth mark, larger still (Fig.3, page 23).

No figures were allowed on the dial at all.

A series of ten entirely different readings were then taken on another night, on a different 6.0 visual magnitude star. This was done by bringing the false image from minimum intensity up to matching brilliance and the result read off directly. The next reading was made by bringing the false image from maximum intensity down to matching brilliance and again, read off directly, and so on until all ten readings were recorded. The same procedure was repeated for comparison stars of visual magnitudes 6.5; 7.0; 7.7; 8.0 and 8.6.

The results are tabulated below. The graph, on page 30, has the arithmetic means of the ten observations plotted against the six comparison stars used, showing the standard deviations produced by using the visual comparator.

1) Comparison star = 6.0 readings

	Δ	Δ^2
5.9.....	0.1.....	0.01
5.8	0.0	0.00
6.0	0.2	0.04
6.1	0.3	0.09
5.8	0.0	0.00
6.2	0.4	0.16
6.2	0.4	0.16
6.1	0.3	0.09
6.0	0.2	0.04
5.9	0.1	0.01

Arithmetic Mean = $\bar{X}$ = $\underline{60.0}S$ = $\underline{2.0}$ $S\Delta^2$ = $\underline{0.60}$

Subtracting $(S\Delta^2 - \frac{S^2}{N})$ = (0.6 - 0.4) = $\underline{0.20}$

$\therefore$ No of Obs - 1 = $\frac{0.20}{9}$ = 0.022 = σ^2 = variance

Standard Deviation = $\sqrt{\sigma^2}$ = $\sqrt{0.022}$ = $\underline{0.148}$

95% C limit = $\frac{0.148.2.25}{3.16}$ = $\underline{0.11}$

2) Comparison = 6.5 Readings

	Δ	Δ^2
6.6.....	0.3.....	0.09
6.4	0.1	0.01
6.5	0.2	0.04
6.3	0.0	0.00
6.4	0.1	0.01
6.4	0.1	0.01
6.4	0.1	0.01
6.4	0.1	0.01
6.5	0.2	0.04
6.6	0.3	0.09

Arithmetic Mean = $\bar{X}$ = 64.5 S = 1.5 SΔ^2 = 0.31

$S^2 = 2.25 \quad \therefore \quad \frac{S^2}{N} = 0.225$

Subtracting $(S\Delta^2 - \frac{S^2}{N}) = (0.31 - 0.225) = 0.085$

$\div$ (No of Obs - 1) = $\frac{0.085}{9} = 0.009 \quad \sigma^2$ = variance

$\therefore$ Standard Deviation $= \sqrt{\sigma^2} = \sqrt{0.009} = 0.094$

95% C limit = $\frac{0.094 . 2.26}{3.16} = 0.072$

3) Comparison = 7.0 readings

	Δ	Δ^2
7.2.....	0.4.....	0.16
6.9	0.1	0.01
6.9	0.1	0.01
6.8	0.0	0.00
6.8	0.0	0.00
6.8	0.0	0.00
7.3	0.5	0.25
7.0	0.2	0.04
6.9	0.1	0.01
7.1	0.3	0.09

Arithmetic Mean = $\bar{X}$ = 69.7 $S = 1.7$ $S\Delta^2 = 0.57$

$$S^2 = 2.89 \therefore \frac{S^2}{N} = 0.289$$

Subtracting $\left(S\Delta^2 - \frac{S^2}{N} \right) = (0.57 - 0.289) = \underline{0.281}$

$\div$ (No of Obs - 1) = $\frac{0.281}{9} = 0.031$ σ^2 = variance

$\therefore$ Standard Deviation = $\sqrt{\sigma^2} = \sqrt{0.031} = \underline{0.176}$

95% C limit = $\frac{0.176 . 2.25}{3.16} = \underline{0.133}$

4) Comparison = 7.7 Readings.

	Δ	Δ^2
7.7.....	0.2	0.04
7.8	0.3	0.09
7.7	0.2	0.04
7.5	0.0	0.00
7.8	0.3	0.09
7.7	0.2	0.04
7.6	0.1	0.01
7.8	0.3	0.09
7.7	0.2	0.04
7.5	0.0	0.00

Arithmetic Mean = $\bar{X}$ = 76.8 S = 1.8 $S\Delta^2$ = 0.44

$$S^2 = 3.24 \quad \therefore \quad \frac{S^2}{N} = \frac{3.24}{10} = 0.324$$

Subtracting $(S\Delta^2 - \frac{S^2}{N}) = (0.44 - 0.324) = 0.116$

$\div$ (No of Obs - 1) = $\frac{0.116}{9}$ = 0.013 σ^2 - variance

$\therefore$ Standard Deviation = $\sqrt{\sigma^2} = \sqrt{0.013} = 0.114$

95% C limit = $\frac{0.114 . 2.26}{3.16} = 0.086$

5) Comparison Readings 8.0

	Δ	Δ^2
8.2	0.5	0.25
7.9	0.2	0.04
8.0	0.3	0.09
8.1	0.4	0.16
7.7	0.0	0.00
7.9	0.2	0.04
7.8	0.1	0.01
8.2	0.5	0.25
8.1	0.4	0.16
7.8	0.1	0.01

Arithmetic $\underline{79.7}$ S= $\underline{2.7}$ Sσ^2=$\underline{1.01}$

Mean = $\bar{X}$ = S^2=7.29 $\therefore$ $\frac{S^2}{N}$ =$\underline{0.729}$

Subtracting ($S\Delta^2 - \frac{S^2}{N}$) = (1.01 - 0.729) = $\underline{0.281}$

$\div$ (No. of Obs - 1) = $\frac{0.281}{9}$ = 0.031 σ^2 = variance

Standard Deviation = $\sqrt{\sigma^2}$ = $\sqrt{0.31}$ = $\underline{\underline{0.176}}$

95% C limit = $\frac{0.176.2.26}{3.16}$ = $\underline{\underline{0.134}}$

6) Comparison 8.6 Readings

	Δ	Δ^2
8.5	0.0	0.00
8.6	0.1	0.01
8.7	0.2	0.04
8.8	0.3	0.09
8.5	0.0	0.00
8.7	0.2	0.04
8.8	0.3	0.09
8.7	0.2	0.04
8.6	0.1	0.01
8.6	0.1	0.01

Arithmetic Mean = $\bar{X}$ = 86.5 S = 1.5 SΔ^2 = 0.33

$S^2 = 2.25 \quad \therefore \quad \frac{S^2}{N} = 0.225$

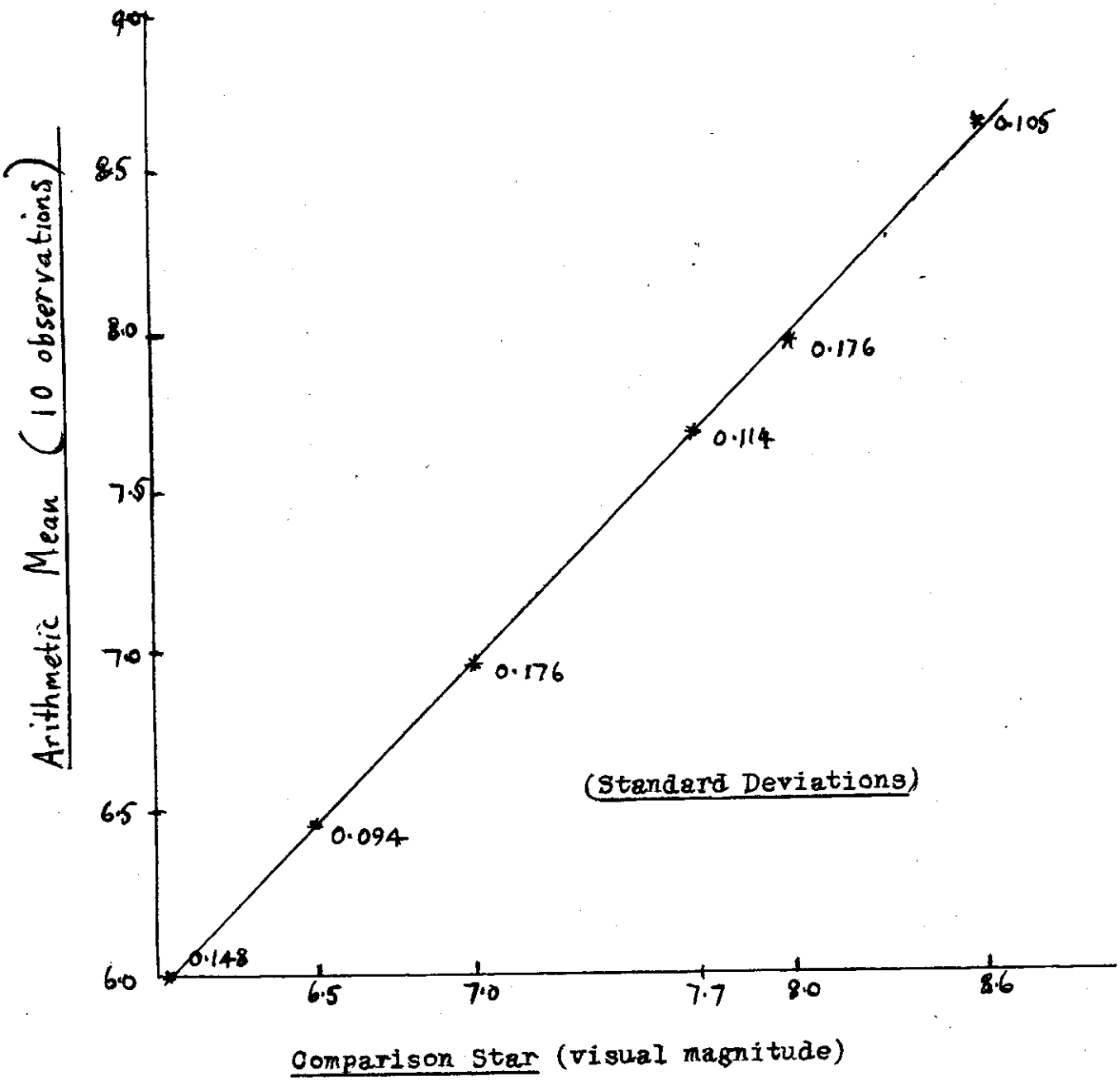
Subtracting $(S\Delta^2 - \frac{S^2}{N}) = (0.33 - 0.225) = 0.105$

$\div$ (No of Obs - 1) = $\frac{0.105}{9} = 0.011$ $\quad \sigma^2$ = variance

Standard deviation $= \sqrt{\sigma^2} = \sqrt{0.011} = 0.105$

95% C limit = $\frac{0.105 . 2.226}{3.16} = 0.0795$

Graph of Arithmetic Means of 10 observations plotted against 6 comparison stars



OBSERVING VARIABLE STARS WITH THE VISUAL COMPARATOR.

The field of the variable is selected and a quick glance at the variable made to ensure selection of the comparison star closest to its apparent brightness. This ensures that the interval is kept to a minimum.

The POT 1 is then set to the comparison star's value. (Bearing in mind that there are no figures on the dial; only markings). Figure 4, page 23, illustrates what is meant by say, 6.6. Looking through the two eyepieces with both eyes open, which is a very restful position, the false star image is brought horizontal and adjacent to the comparison star. (Figure 5, page 23).

A rich field, like that of GV Car, can cause problems in identification of the false image, particularly when it is faint. Switching on and off usually fixes this.

POT 2 is then turned to bring the false star image to match the comparison star.

POT 1 is then moved away from its setting and brought back to match the comparison star as a check. If it registers within a tenth of a misual magnitude it is considered alright to proceed.

The variable is then brought horizontal and adjacent to the false image and POT 1 turned to bring the false star image to match. (Figure 6, page 23).

The new reading is noted and the comparison star re-matched for a check. The procedure is repeated and if the same results ensue the matched reading is used as the value of the variable.

At an early stage, I used to take the mean of ten such readings, but the rapid acquirement of skill at matching, plus its comparative ease and speed usually produced a row of identical results. My present procedure is to take as many separate readings as there are variations over three, and this has always been no more than four on any occasion.

I stress how easy it is to match two brightnesses accurately. I would also stress that the above procedure sounds and reads much slower than it is in actual fact.

The whole operation on any one star takes but a few seconds, and is no slower than taking assessments with ordinary methods of visual observing, if those are properly carried out.

It was a simple procedure to check the performance of the observer, using the comparator, against normal visual observations. This required only a few seconds extra of observational time. The results were quite comparable and gave me confidence to apply to the Director, Variable Star Section, R.A.S.N.Z., Frank M. Bateson requesting assistance and guidance.

He was most enthusiastic and immediately supplied me with two Cepheid variables to study, saying that it would be in the area of the Cepheids that the comparator would have the best application. I started work on S and X Cru with the aim of determining the value of continuous observations of stars of limited range. Other stars added to the programme include thr brighter Cepheids, Beta Dor, Kappa Pav, l Car and ER Car.

Under Bateson's guidance, I have studied the stars S and X Cru for a number of years. Bateson is currently preparing a paper on the observational shortcomings and advantages of the comparator which should make a valuable contribution to any further activity by part-time astronomers who might be moved to use such a device.

In reviewing this paper, Bateson pointed out that in the hands of an average observer, the comparator produces more reliable results than those he would obtain visually. It was also pointed out that the visual comparator is best employed in the observation of Cepheids, rather than in the observation of Mira type variables, where there is likely to be a sufficiently large number of visual observations capable of producing a light curve that is as reliable as that from a single observer with a comparator.

I know of at least three other persons who have built and used visual comparators; two here in South Australia and one in Warsaw, Poland. I would be interested to hear of any others.

CONCLUSION:

The Visual Comparator does work. It fulfils the objects that I set out to achieve. I urge all variable star observers to seriously consider the advantages to be gained by constructing one. These advantages would immediately benefit the Variable Star Section as a whole. I repeat, the visual comparator is not a photometer; it is not a device for measurement at all. It is an aid to judgement superior to the generally accepted methods of judgement at present in use. I am sure that any variable star observer who has read my arguments will immediately see potentialities in this

idea for improvement and refinement.

I also ask any members who may be moved by this paper to build and use a Visual Comparator to contact Bateson for further directions. I, too, would be most interested to share and compare with them on their results.

ACKNOWLEDGEMENTS;

I would like to acknowledge the help and guidance given me throughout the development and use of this device by Frank M. Bateson. Also I wish to thank Mr. Brian Waters, of Bridgewater, South Australia, who closely cooperated with me in the early stages; also to Mr. Peter Davies of General Motors-Holden, who designed a vastly improved electrical circuit for me.

.....o

FOUR R CrB TYPE VARIABLES.

Frank M. Bateson.

SUMMARY: Observations of the four R CrB type variables, UW Cen; S Aps; GU Sgr and RY Sgr are continued from previous publications. The observations are given in ten day means and shown in light curves.

OBSERVATIONS:

Table 1 lists the ten day means in the usual form. Observations of UW Cen were published by Bateson & Jones (1972a) to 2,440,833 (1970 Sept. 3). Records since that date to 2,442,045 (1973 Dec. 28) are now published.

Bateson (1971) published observations of S Aps and RY Sgr to 2,440,860 (1970 Sept 30). These are now extended to 2,442,045 and 2,442,000 respectively.

Bateson & Jones (1972b) published observations of GU Sgr to 2,440,536 (1969 Nov 10). These are now extended to 2,441,947 (1973 Sept. 21).

LIGHT CURVES:

Light curves, covering the intervals included in Table 1, are shown in Figures 1 to 8, inclusive, and discussed below.

UW Cen: This star commenced a major decline about 2,440,853.

After 2,440,926 UW Cen was below the threshold of the instruments used. It remained invisible to 2,441,371, when it was observed at magnitude 12.0. Negative observations between these dates have been omitted from Table 1.

The width of the minimum from 12.0 on the fall to 12.0 on the rise was 490 days. The date UW Cen reached minimum is pure conjecture. It appears that it might have been about 2,440,950 which gives an interval of 820 days since the previous minimum (Bateson & Jones 1972a).

The light curve, from ten day means, after the variable became visible again is shown in Figure 8, in which crosses represent single observations. The semi-regular variation, previously noted by Bateson & Jones (1972a), persists, although this is not as obvious in the small scale light curve reproduced as in that on a larger scale.

A few photoelectric observations communicated by the Auckland Observatory, during the interval covered by the observations now published, show that the visual estimates were consistently too faint by 0.14 magnitudes compared to the V magnitudes.

S Aps: The light curve is shown in two sections in Figures 1 and 2. Large dots represent ten day means derived from ten or more observations; small dots means from 2 to 9 observations whilst crosses denote single observations.

S Aps declined very steeply to a deep minimum. From 2,441,095 to 2,441,331 it was invisible, being below 13.4 for most of this time, and probably below 14.0. It was observed at 12.2 on 2,441,335. The width of the minimum, represented by the time below magnitude 12.0, was 289 days. S Aps probably reached minimum about 2,441,110, making the interval since the preceding minimum 1,367 days.

The small semi-regular variation persists, but is shown much clearer in the large scale plot from daily means than in Figures 1 and 2.

GU Sgr: The light curve is shown in four segments in Figures 3,4, 6 and 7, because of breaks in the observing season due to proximity to the Sun. In the figures crosses denote that there was only a single observation within a ten day interval; dots represent means from two or more observations.

Except for the intervals shown in Figures 3 and 7 GU Sgr was poorly observed. When the observations are sufficient the semi regular variation in about 38 days persists (Bateson and Jones 1972b).

A decline to a deep minimum commenced about 2,441,790. This fall was comparatively slow. GU Sgr was invisible and below 13.7 after 2,441,914.

RY Sgr; Figure 5 shows the light curve from ten day means on a small scale. Crosses represent single observations. RY Sgr was well observed, and, because of the small scale used and the frequency of the means, no attempt has been made to show different sizes of dots to represent the number of estimates in any one mean. Omitting the few ten day intervals in which there was only one observation, the average number of estimates used for each mean is 10.2.

RY Sgr probably reached a deep minimum on 2,441,310 with a width, at magnitude 12.0 of 260 days. Minimum magnitude was probably <15.0. The well known semi-regular variation is well shown in larger scale curves. The interval from the previous deep minimum is about 1,545 days.

REFERENCES:

Bateson, F.M. 1971 Circ. 168, V.S.S., R.A.S.N.Z.
Bateson, F.M.; Jones, A.F. 1972a. Circ. 185. V.S.S., R.A.S.N.Z.
Bateson, F.M. &Jones, A.F. 1972b. Circ. 193, V.S.S., R.A.S.N.Z.

TABLE 1.

TEN DAY MEANS.

UW Cen 123753			UW Cen 123753			UW Cen 123753			UW Cen 123753		
2,440,000+			2,441,000 +			2,441,000+			2,441,000+		
839.9	9.45	2	442.4	10.75	2	649.2	9.63	3	830.8	9.49	14
846.9	9.4	1	451.0	10.97	3	660.8	9.73	3	840.9	9.55	8
856.8	9.8	1	459.9	10.6	1	669.2	9.7	1	850.4	9.60	11
871.3	10.2	1	472.7	10.34	5	680.3	9.74	5	859.6	9.63	11
884.2	12.8	1	479.2	10.23	3	688.6	9.65	4	869.4	9.69	8
901.2	<12.2	-	490.2	10.38	5	699.9	9.68	5	879.9	9.59	7
912.1	12.3	1	501.9	10.25	2	711.1	9.52	4	890.0	9.57	7
918.6	12.80	2	512.9	10.23	3	718.3	9.57	8	899.6	9.58	10
926.1	12.9	1	519.6	10.22	6	730.2	9.62	5	911.5	9.62	5
942.0	<12.8	-	529.7	10.21	8	739.6	9.69	8	920.6	9.67	7
			539.1	10.38	6	748.9	9.57	14	927.9	9.73	3
2,441,000 +			552.3	10.30	2	763.1	9.57	4	940.4	9.58	9
371.3	12.00	3	561.1	10.02	8	770.5	9.71	15	951.5	9.61	7
390.2	11.36	5	572.3	9.76	5	779.2	9.72	16	967.3	9.4	1
396.2	11.23	3	578.1	9.92	4	791.1	9.53	9	983.2	9.6	1
413.0	10.95	2	589.6	10.17	3	801.6	9.53	10	994.2	9.4	1
415.7	11.13	3	627.2	9.6	1	808.5	9.58	10	2,442,000+		
428.0	10.95	2	639.2	9.6	1	818.9	9.45	8	002.3	9.3	1
									010.5	9.30	3

TABLE 1 (cont).

UW Cen
123753
2,442,000+
017.2 9.3 1
030.6 9.30 2
039.4 9.63 3
045.2 9.5 1

S APS
145971
2,440,000+
868.0 10.20 3
879.8 10.20 10
889.9 10.33 6
914.9 9.95 2
917.8 10.14 7
925.9 10.0 1
939.0 9.95 2
950.1 10.15 2
972.1 10.13 3
980.2 10.22 4
998.3 10.22 5
2,441,000+
010.0 10.25 10
018.7 10.23 3
031.9 10.22 12
041.0 10.18 11
048.7 10.40 9
060.0 10.60 10
068.8 10.95 28
081.2 12.55 8
088.4 14.10 2
095.0<13.4 -
106.0<13.4 -
121.2<13.4 -
128.1<13.4 -
144.0<13.4 -
159.0<13.4 -
172.9<13.4 -
178.0<14.5 -
189.1<13.4 -
200.2<13.4 -
211.1<13.4 -
220.9<13.4 -
230.5<13.4 -
241.4<13.4 -
250.6<13.4 -

S Aps.
145971
2,441,000+
263.9<13.4
272.4<13.4
319.0<11.2
331.1<11.9
340.2 12.16 5
350.0 12.12 4
358.7 12.10 6
368.5 11.89 8
382.5 11.62 6
390.3 11.33 22
400.8 10.85 11
411.6 10.83 12
419.3 10.74 14
427.9 10.68 9
441.1 10.61 11
450.7 10.41 16
457.8 10.35 6
471.5 10.57 13
480.1 10.46 14
490.8 10.34 10
500.2 10.45 11
511.2 10.42 6
[illegible] 10.45 8
530.6 10.41 23
539.3 10.45 15
551.2 10.31 7
561.1 10.28 18
572.2 10.31 10
578.9 10.24 9
590.2 10.35 14
600.0 10.28 11
609.2 10.24 7
620.0 10.28 9
628.9 10.24 5
639.6 10.30 4
653.3 10.37 3
660.0 9.9 1
680.0 10.0 1
687.6 10.35 4
697.5 10.15 2
712.8 10.27 4
719.2 10.30 7
732.0 10.17 4

S Aps.
145971
2,441,000+
739.7 10.04 16
749.4 10.14 18
761.7 10.34 11
770.5 10.26 28
779.7 10.21 27
791.9 10.27 12
800.7 10.35 21
810.1 10.34 15
819.8 10.18 15
830.3 10.37 30
839.6 10.35 21
850.3 10.35 18
860.4 10.17 26
869.3 10.18 23
882.8 10.07 6
890.8 10.08 19
898.7 10.01 20
912.5 10.10 8
919.5 10.14 24
928.2 10.11 13
940.8 10.05 13
950.5 10.10 20
959.4 10.11 12
970.5 10.11 10
980.3 10.14 16
989.4 10.13 7
2,442,000+
001.2 9.99 8
009.5 10.00 4
019.5 10.10 5
031.7 10.07 3
040.1 10.07 6
045.4 10.00 2

GU Sgr.
181824
2,440,000+
710.2 10.50 2
719.6 10.55 2
733.3 10.50 3
740.4 10.47 6
762.0 10.3 1
770.5 10.52 4
779.5 10.30 2

GU Sgr.
181824
2,440,000+
791.6 10.60 3
797.6 10.40 3
807.5 10.25 2
820.7 10.25 4
832.3 10.40 3
837.4 10.20 2
851.3 10.10 3
861.9 10.30 2
879.6 10.27 4
891.9 10.7 1
904.9 10.4 1
907.9 10.7 1
915.9 10.7 1

2,441,000+
069.7 10.70 2
091.7 10.00 3
100.0 10.9 1
117.9 10.9 1
129.5 10.30 2
144.9 10.3 1
152.0 10.3 1
158.7 10.40 3
175.0 10.0 1
185.9 9.8 1
202.9 9.8 1
209.7 10.25 4
219.0 10.1 1
232.9 10.5 1
242.0 9.8 1
263.9 10.55 2

452.1 9.8 1
458.3 9.8 1
472.9 10.9 1
480.0 10.9 1
504.9 11.4? 1
513.0 10.4 1
531.6 10.43 3
540.0 10.30 2
561.6 10.57 3
573.9 10.4 1
587.5 10.25 2
599.9 9.8 1
621.9 10.35 2

TABLE 1 (cont).

GU Sgr
181824
2,441,000+

717.2	10.3	1
729.5	10.30	3
738.1	10.70	2
749.0	10.62	8
756.7	10.65	2
770.9	10.40	3
780.4	10.44	8
790.0	10.67	8
800.8	11.40	4
808.2	11.70	13
817.8	11.81	8
830.3	11.81	10
840.4	11.98	6
854.0	12.10	2
859.7	12.09	8
869.1	12.24	5
882.9	12.35	2
890.1	12.56	5
897.3	13.23	3
914.0	<13.5	-
922.5	<13.7	-
929.0	<12.0	-
942.2	<13.7	-
946.9	<13.7	-

RY Sgr.
191033
2,440,000+

871.1	6.54	5
880.0	6.86	19
890.4	6.92	16
898.1	6.66	5
910.5	6.25	13
919.3	6.54	8
931.9	6.5	1

2,441,000+

012.2	8.6	1
030.2	8.4	1
044.2	10.5	1
050.3	10.9	1
062.1	10.5	1
069.8	10.39	15
079.5	10.90	2
093.8	11.20	3
098.9	10.80	2
120.5	11.02	6

RY Sgr
191033
2,441,000+

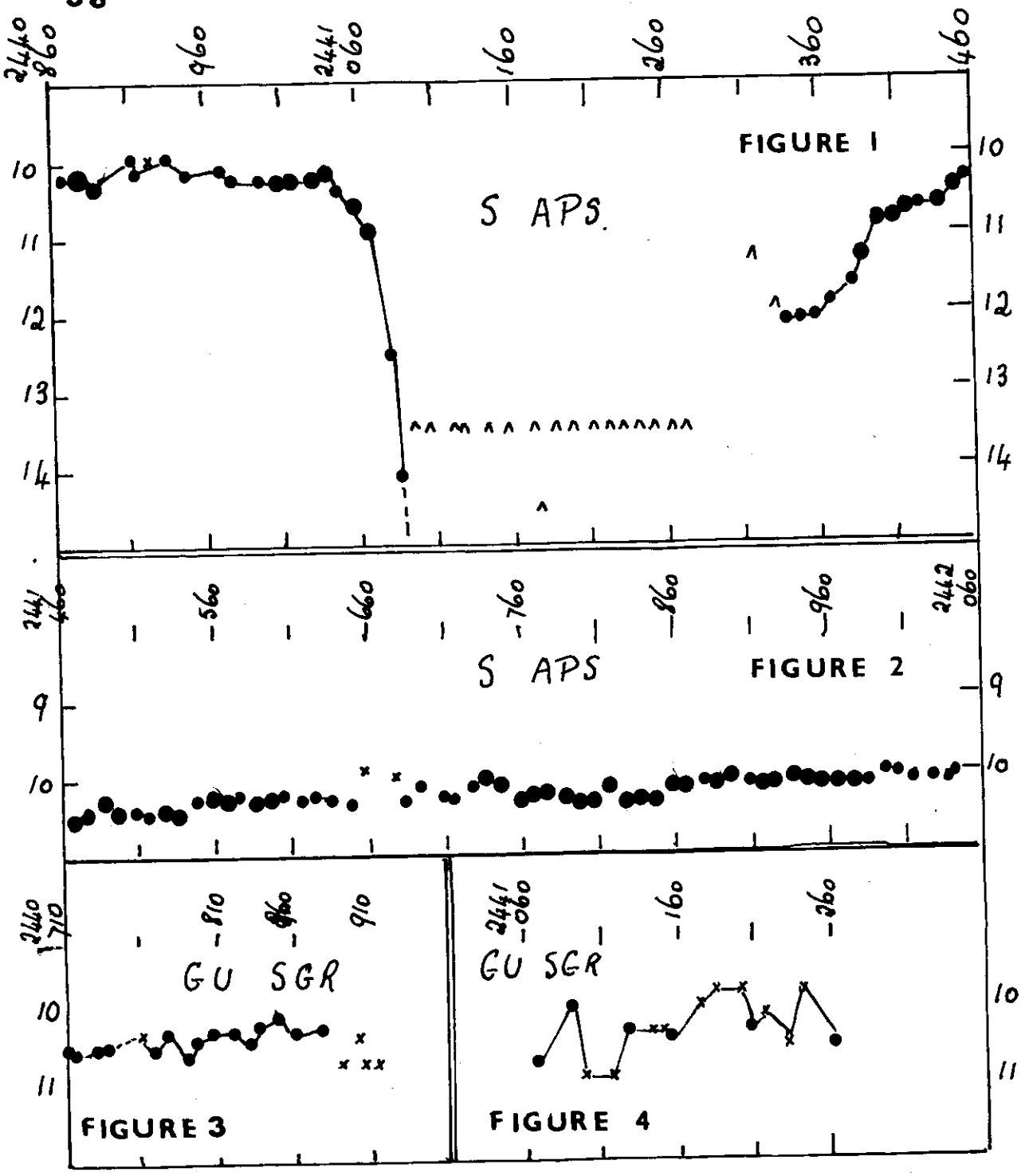
130.8	10.31	9
140.0	9.95	2
151.1	10.14	5
160.7	10.70	13
171.1	10.55	6
179.8	10.33	17
188.8	10.29	10
200.6	12.25	6
210.0	12.75	8
219.5	12.60	5
230.5	12.94	5
241.7	13.37	6
249.8	13.19	7
263.2	13.53	3
268.9	13.47	3
276.9	13.6	1
289.9	13.4	1
371.2	<12.5	-
389.3	<13.9	-
402.3	13.4	1
418.1	13.4	1
428.6	13.20	2
452.0	12.22	4
471.9	11.60	4
480.0	11.16	6
489.3	10.45	9
500.9	10.67	7
511.8	10.47	8
518.1	10.03	6
530.4	10.05	23
538.5	10.13	14
549.7	10.06	5
560.8	9.53	16
569.9	9.17	23
581.1	8.93	6
591.0	8.58	14
600.5	8.48	15
609.0	8.89	10
620.1	9.56	18
630.2	8.90	12
639.5	8.56	5
651.3	8.56	7
660.1	8.54	5
666.9	8.40	3

RY Sgr
191033

717.3	7.5	1
726.2	8.0	1
739.7	7.79	9
749.7	7.34	10
758.4	7.38	6
769.8	7.53	3
778.9	7.30	12
789.0	7.24	7
801.3	7.54	10
807.3	7.58	12
817.3	7.24	9
829.7	7.18	11
829.5	7.28	15
852.3	7.30	5
860.3	7.09	30
869.7	7.18	28
881.5	7.24	10
890.7	7.16	23
898.5	6.94	22
911.6	6.83	12
920.0	7.00	30
928.8	7.10	10
941.5	6.66	18
950.9	6.80	17
958.2	6.85	17
970.6	6.57	16
980.5	6.66	26
990.1	6.80	11

2,442,000+

000.3	7.03	21


S APS
FIGURE 1
S APS
FIGURE 2
GU SGR
FIGURE 3
GU SGR
FIGURE 4

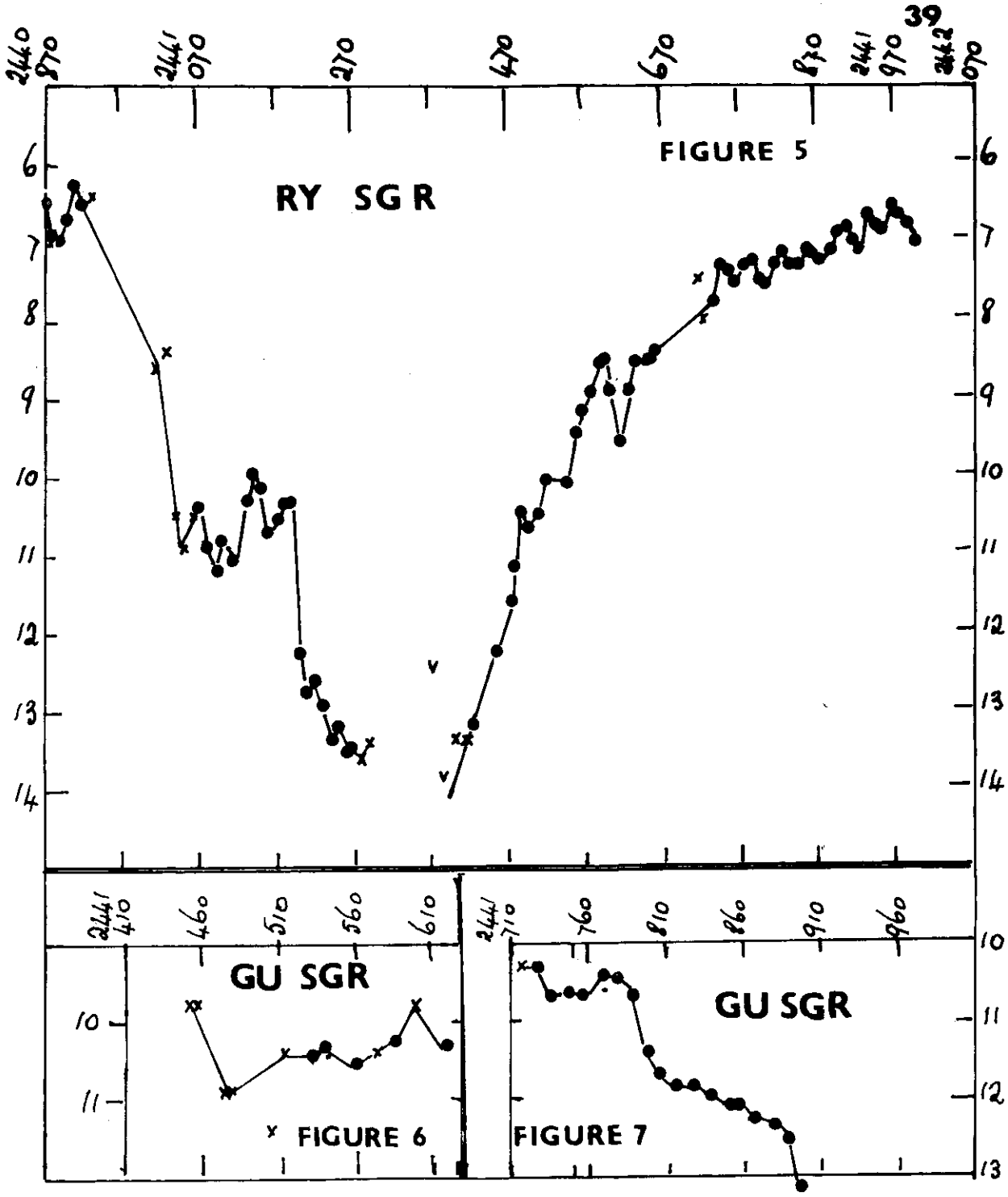
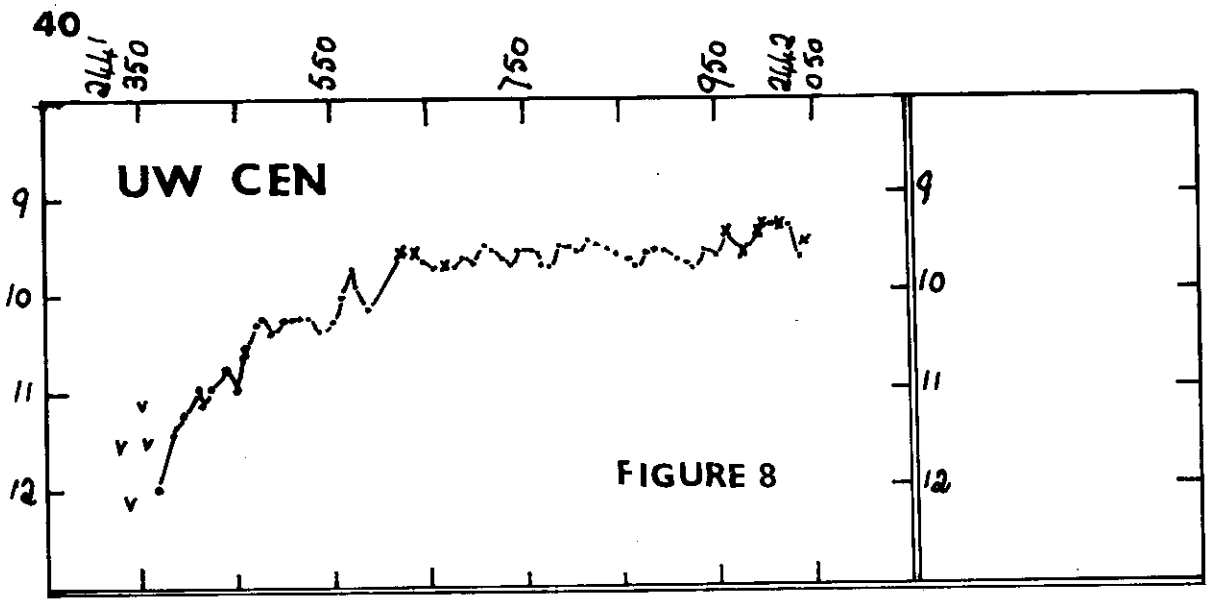


FIGURE 5

FIGURE 6

FIGURE 7



LIGHT CURVES OF SOME MIRA TYPE VARIABLES

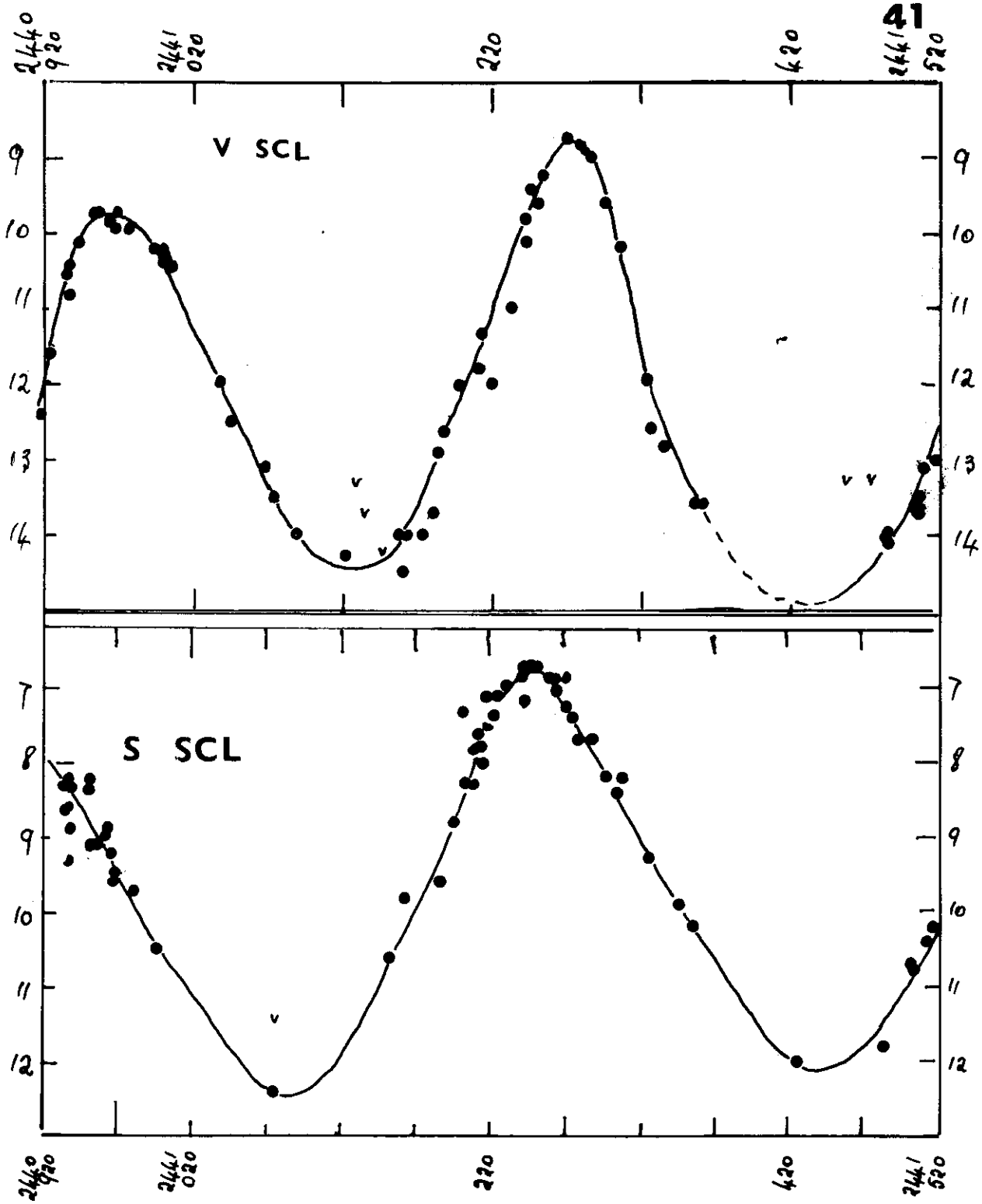
Frank M. Bateson

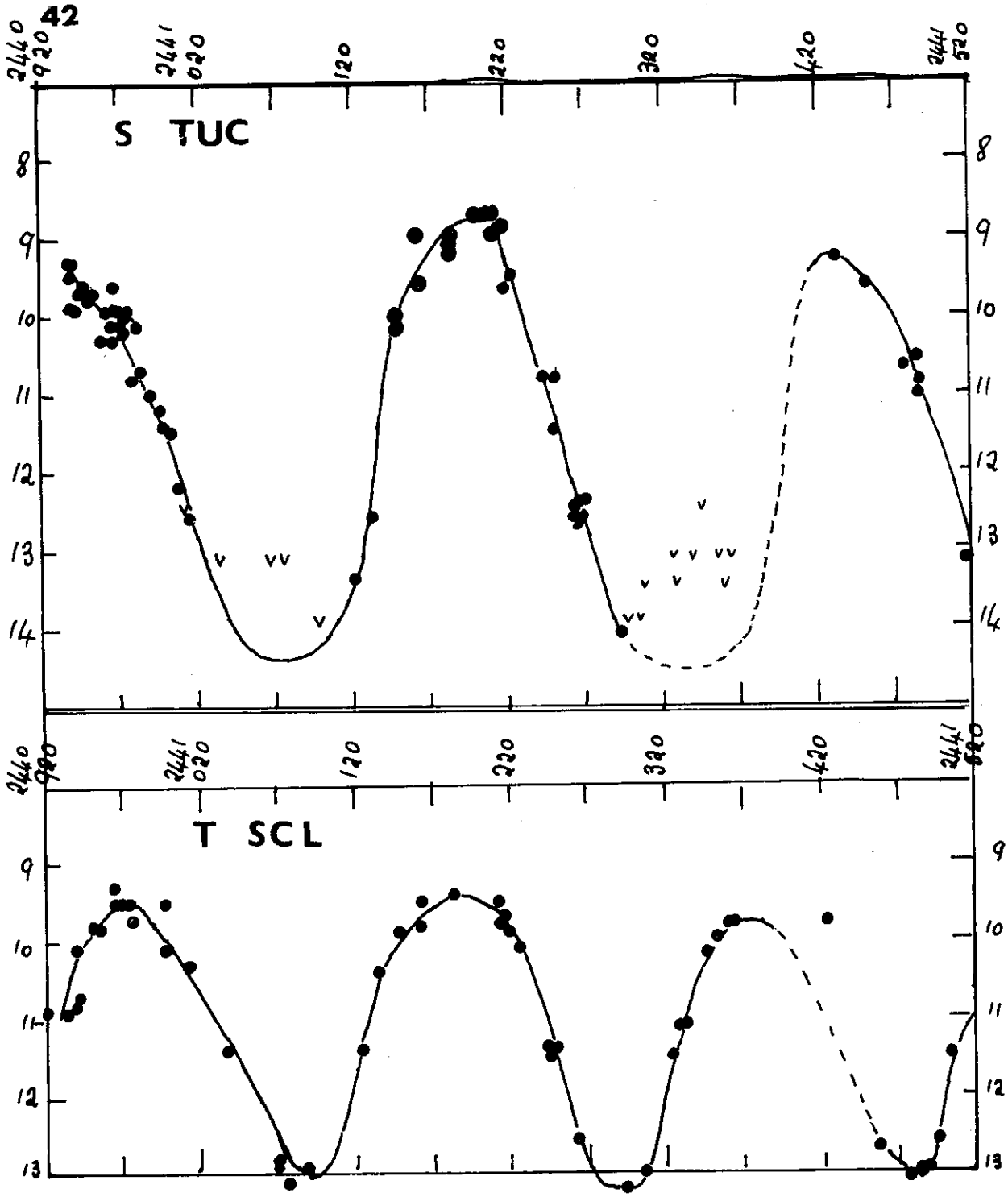
On pages 41 to 55 appear light curves for V Scl; S Scl; S Tuc; T Scl; T Phe; X Scl; U Tuc; U Scl; R Hor; X Hor; S Mic; R Gru; S PsA; R PsA; T Gru; S Gru; R Ind; T Tuc and V Phe.

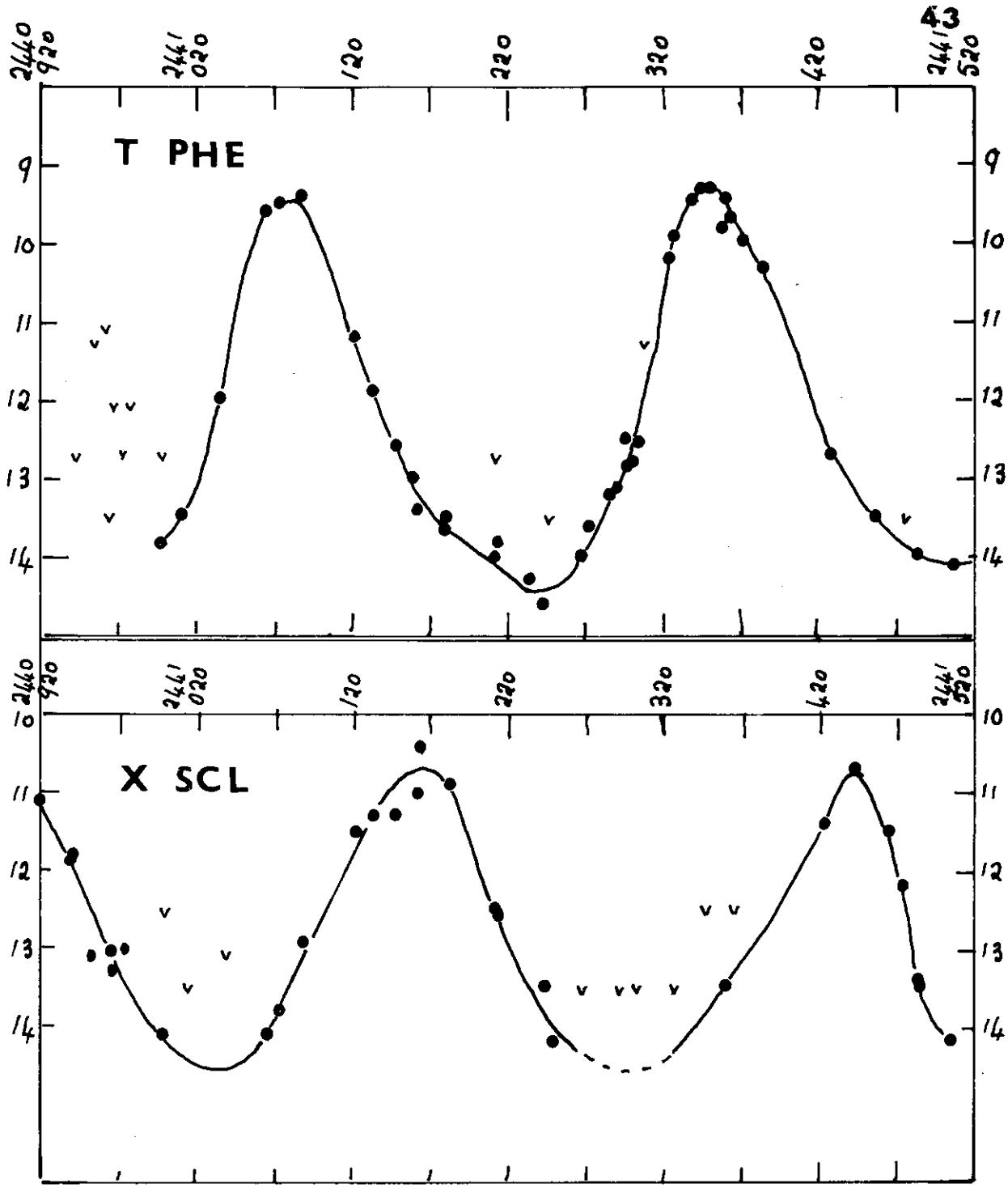
These continue the observations previously published in the Circulars of the Section. The intervals covered differ in accordance with the date of the last observation published for each star. The curves are from individual visual observations, and in drawing them allowance has been made for accidental and systematic deviations. For some stars the scatter of the observations is minimal; for others there is more scatter than is desirable. Observers will be able to check from their own records to see how their observations compare with the curves.

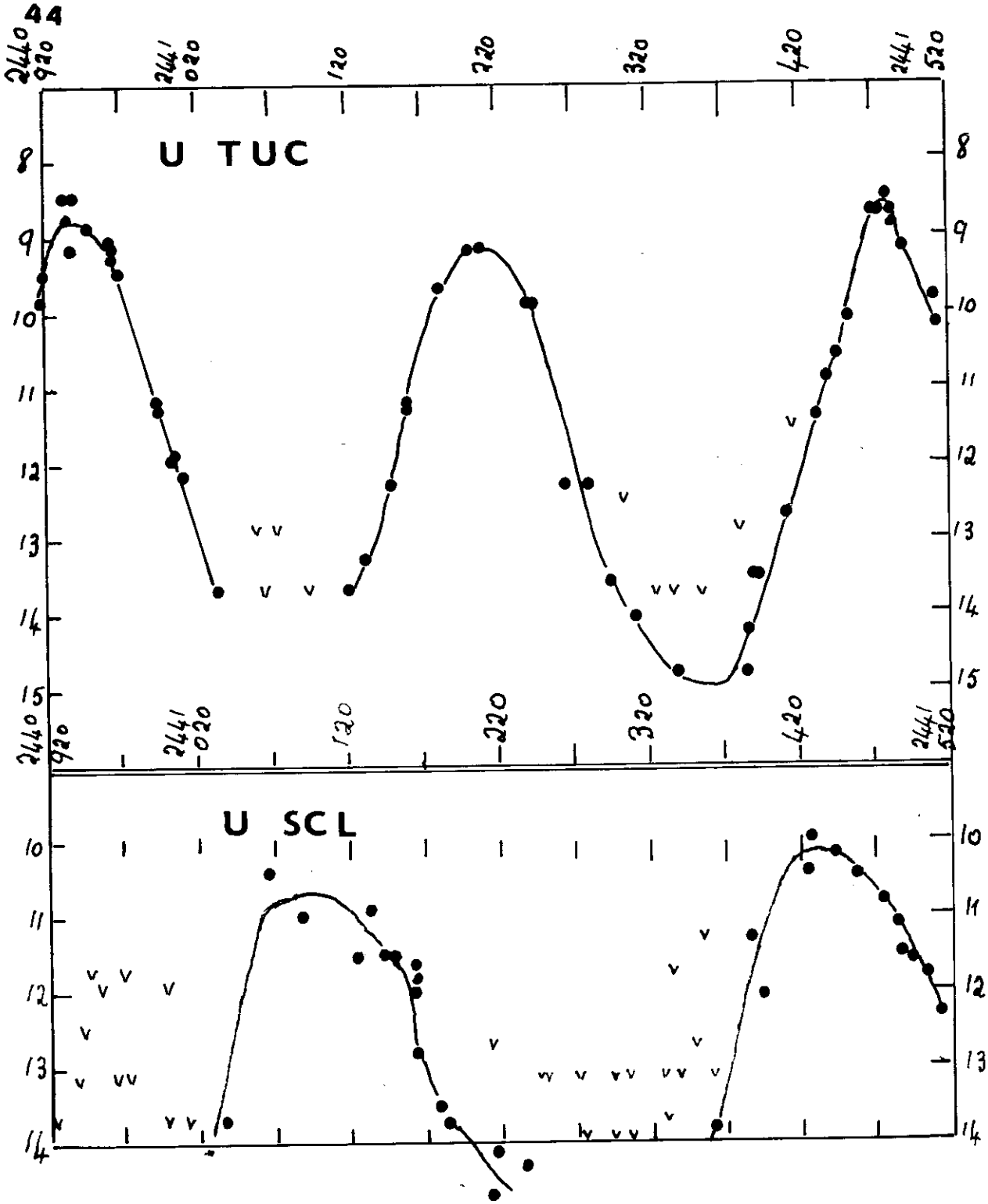
The next Publication contains many more light curves together with a Table of the observed dates of maxima and minima for the curves now published and for those in Publication No. 2. Predictions also appear in Publication No. 2.

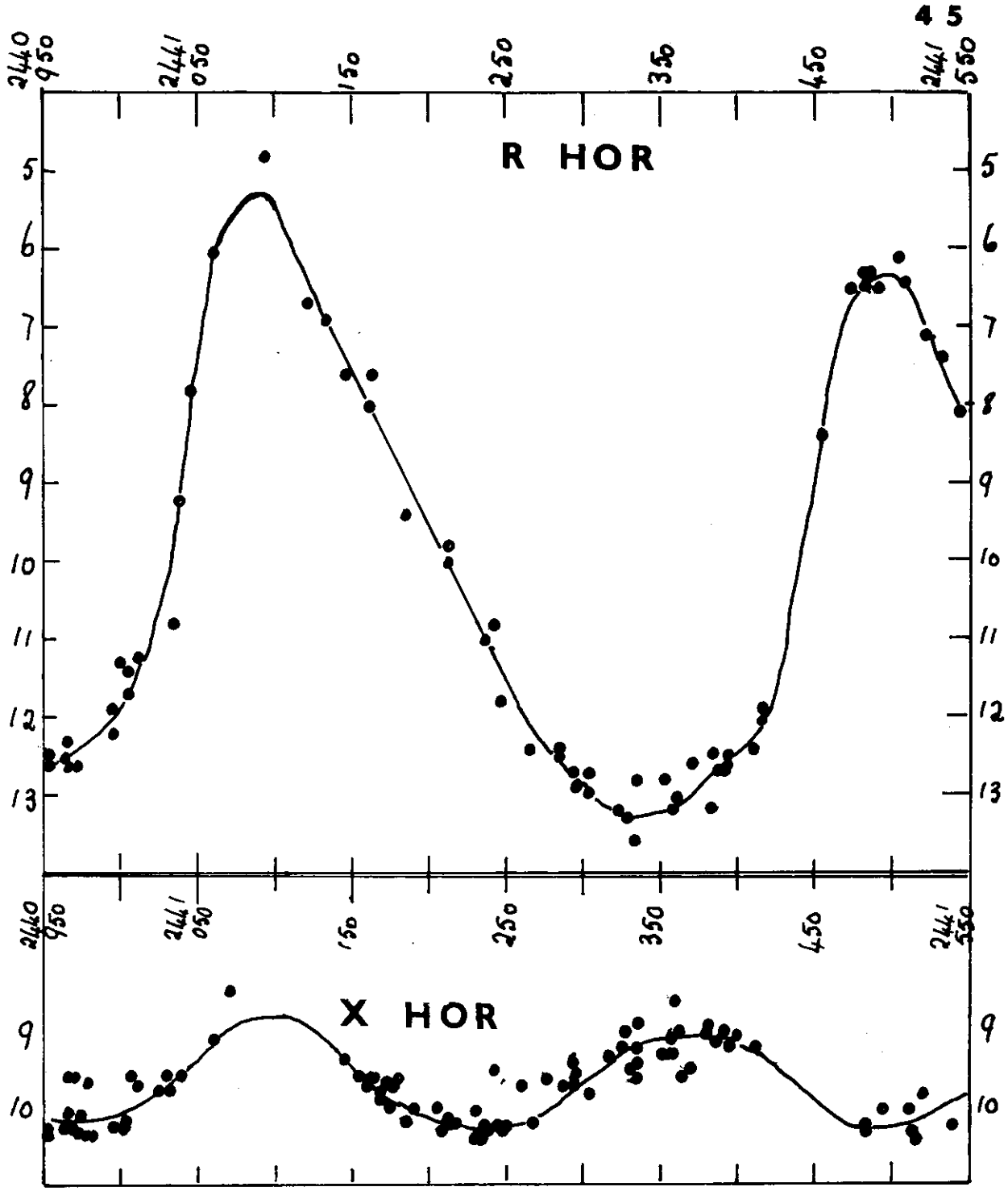
It is not intended to reproduce all subsequent curves on the large scale used in Publication No.1.

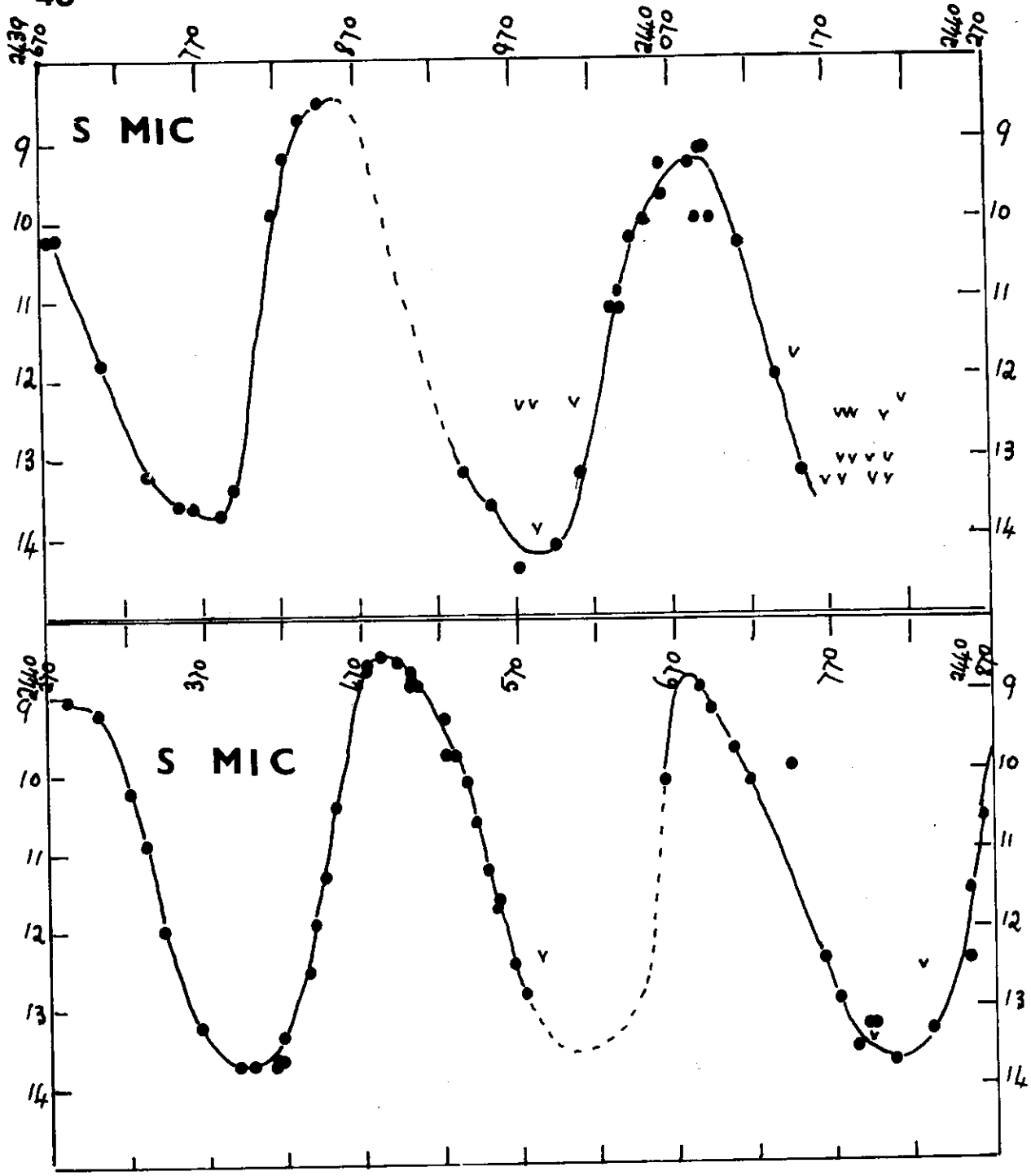

V SCL
S SCL
2440 920
2441 020
220
420
2441 520
9
10
11
12
13
14
7
8

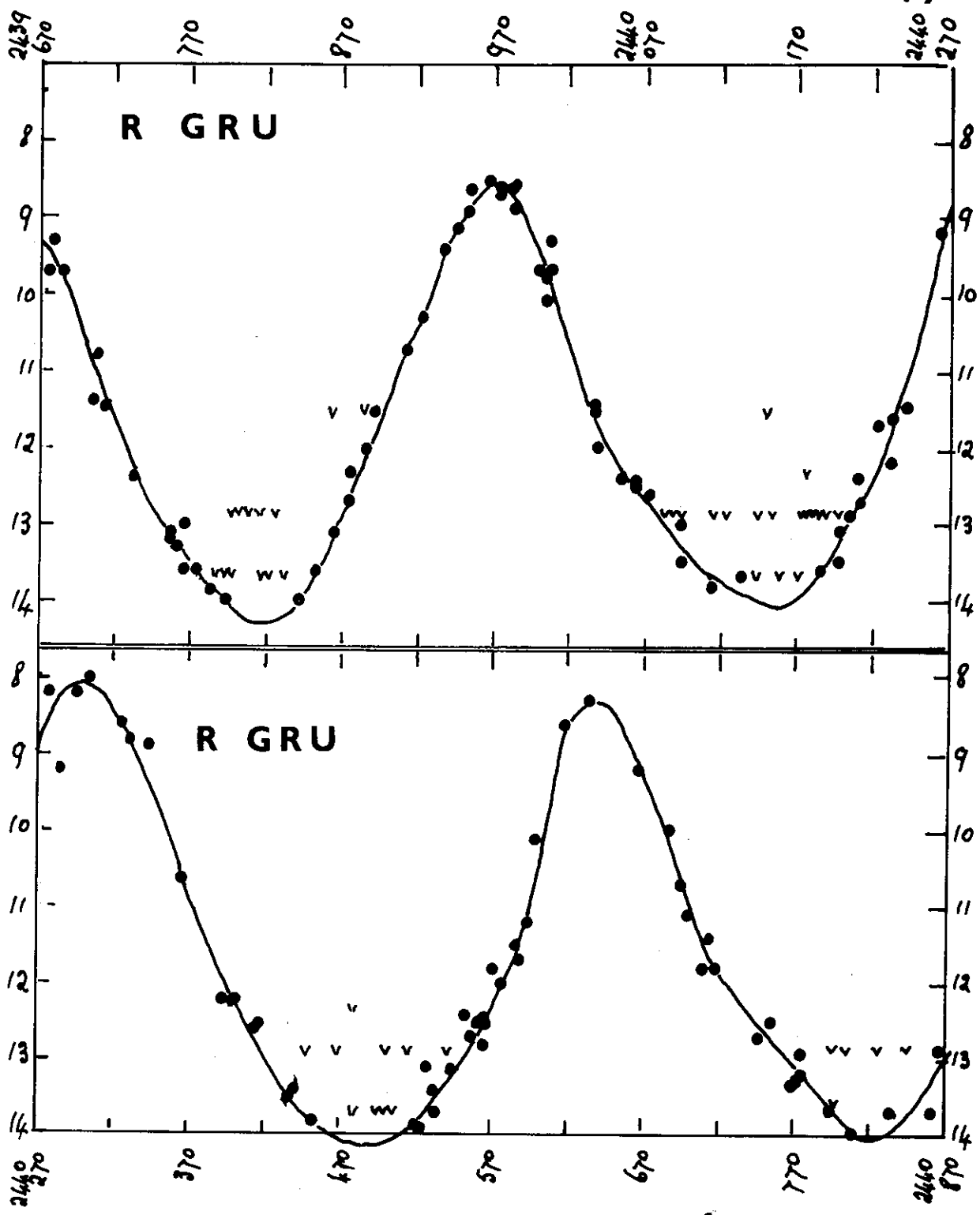

S TUC
T SCL
2440 920
2441 020
120
220
320
420
2441 520
8
9
10
11
12
13
14

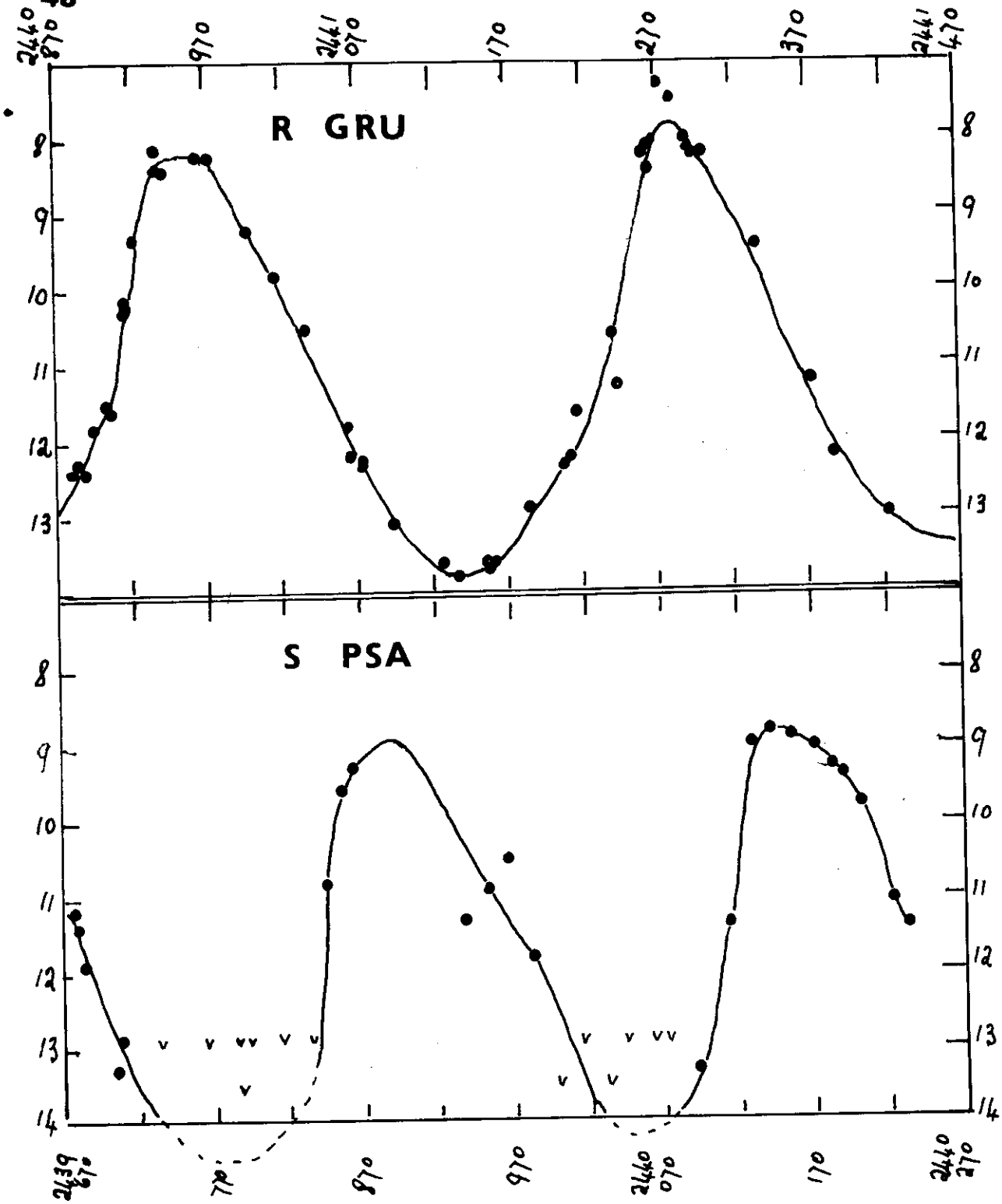

T PHE
X SCL
2440 920
2441 020
120
220
320
420
2441 520
9
10
11
12
13
14

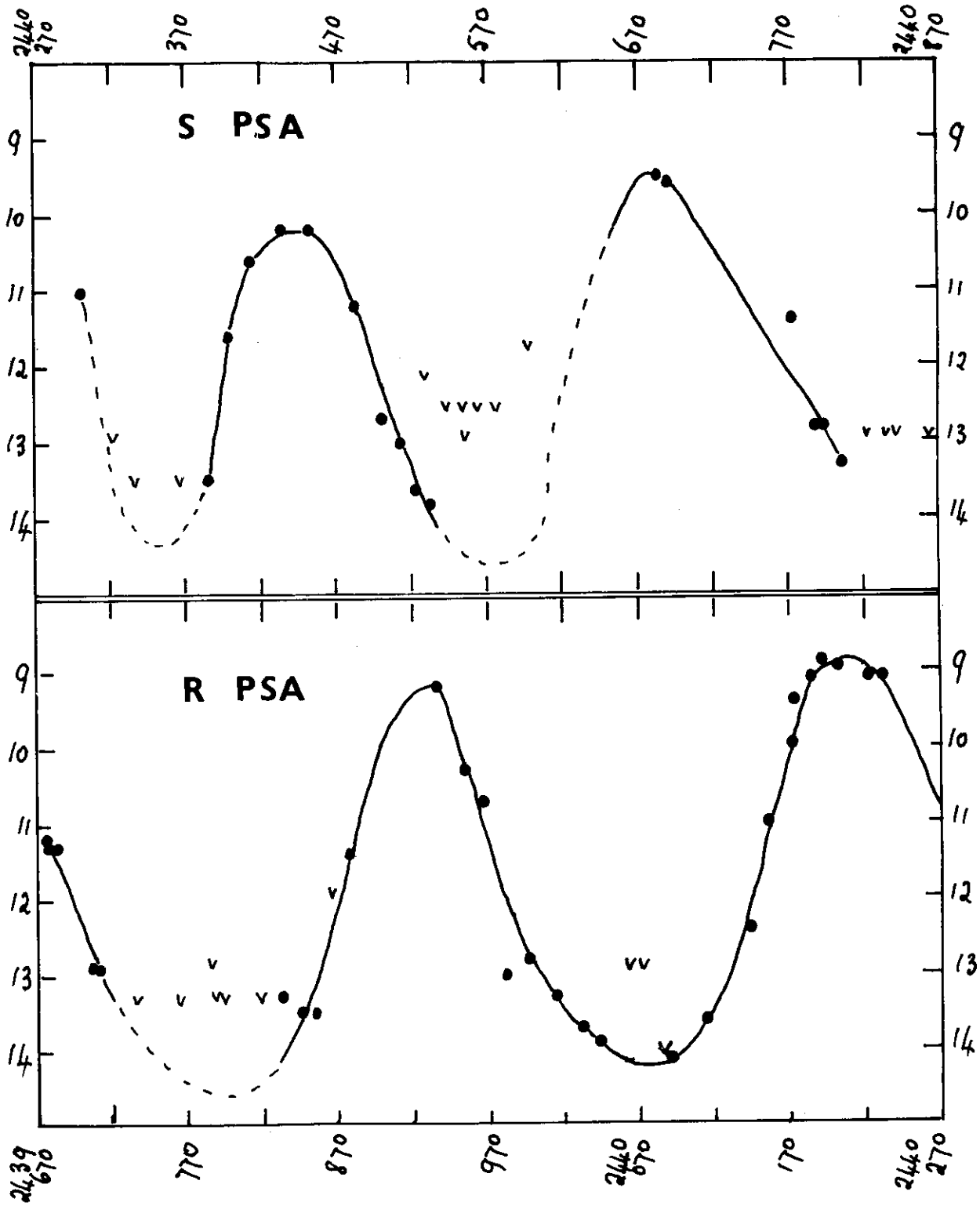

U TUC
U SCL
2440 920
2441 020
120
220
320
420
2441 520
8
9
10
11
12
13
14
15

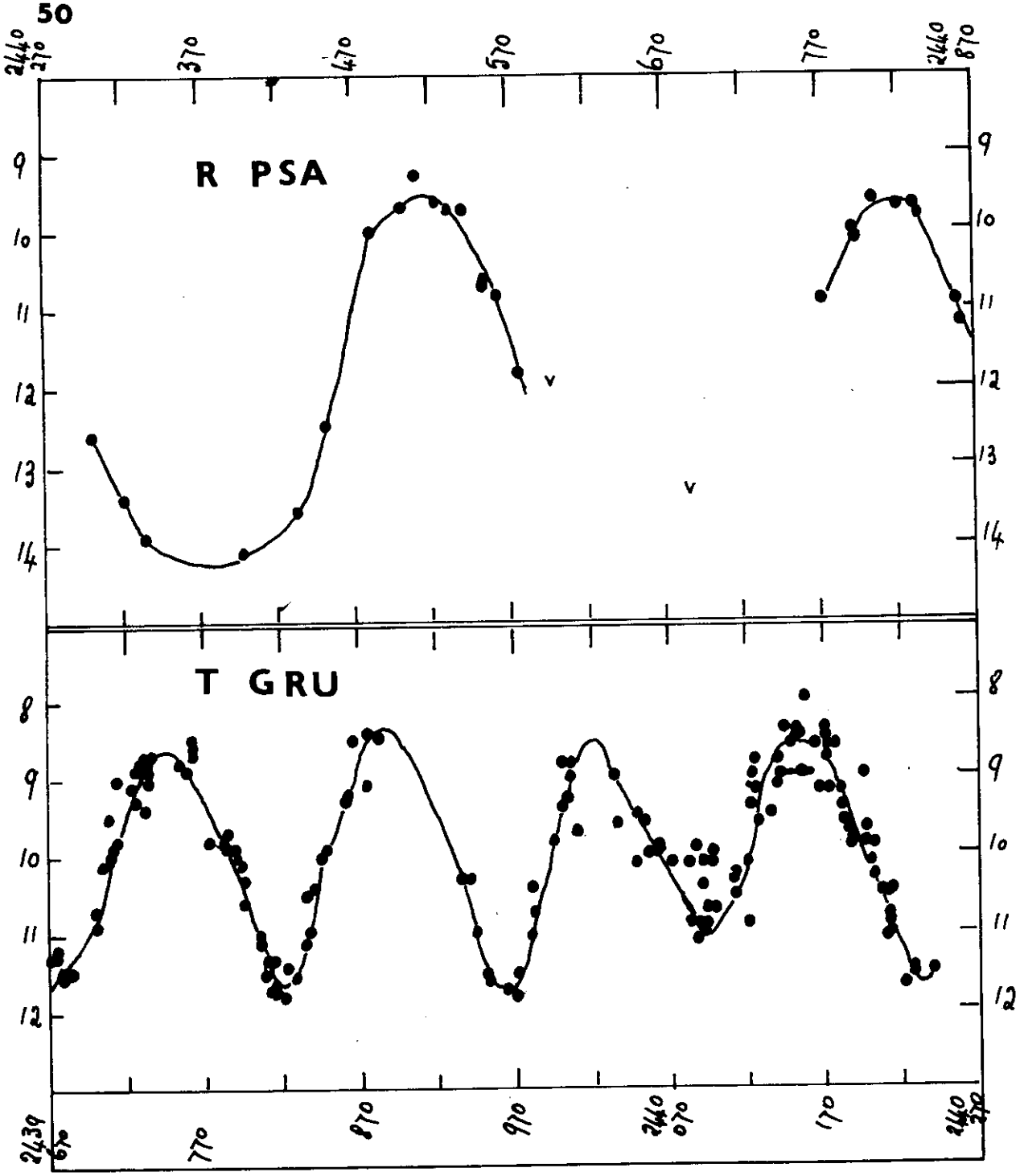

R HOR
X HOR
2440 950
2441 050
150
250
350
450
2441 550
4 5
5
6
7
8
9
10
11
12
13

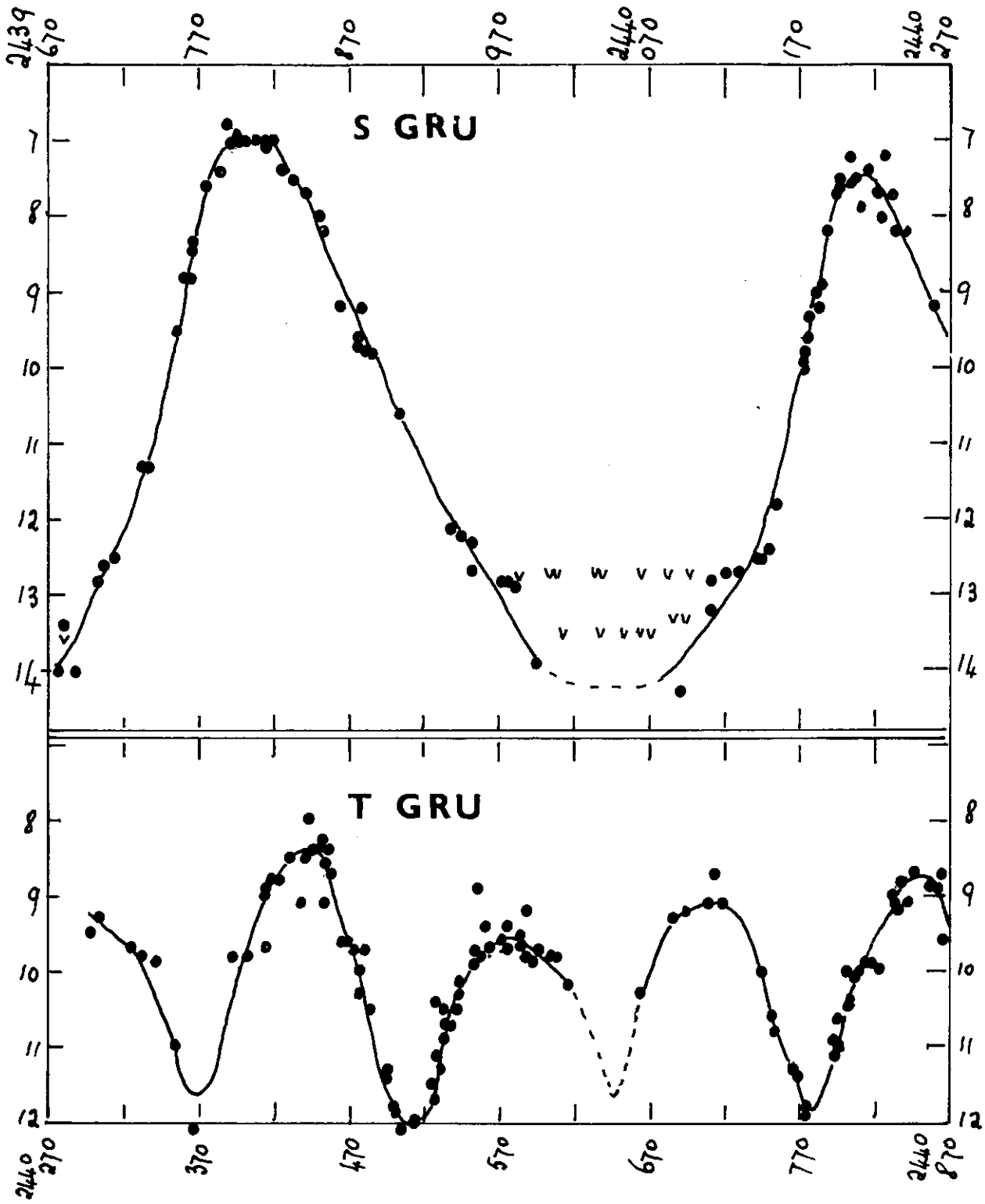

S MIC
S MIC

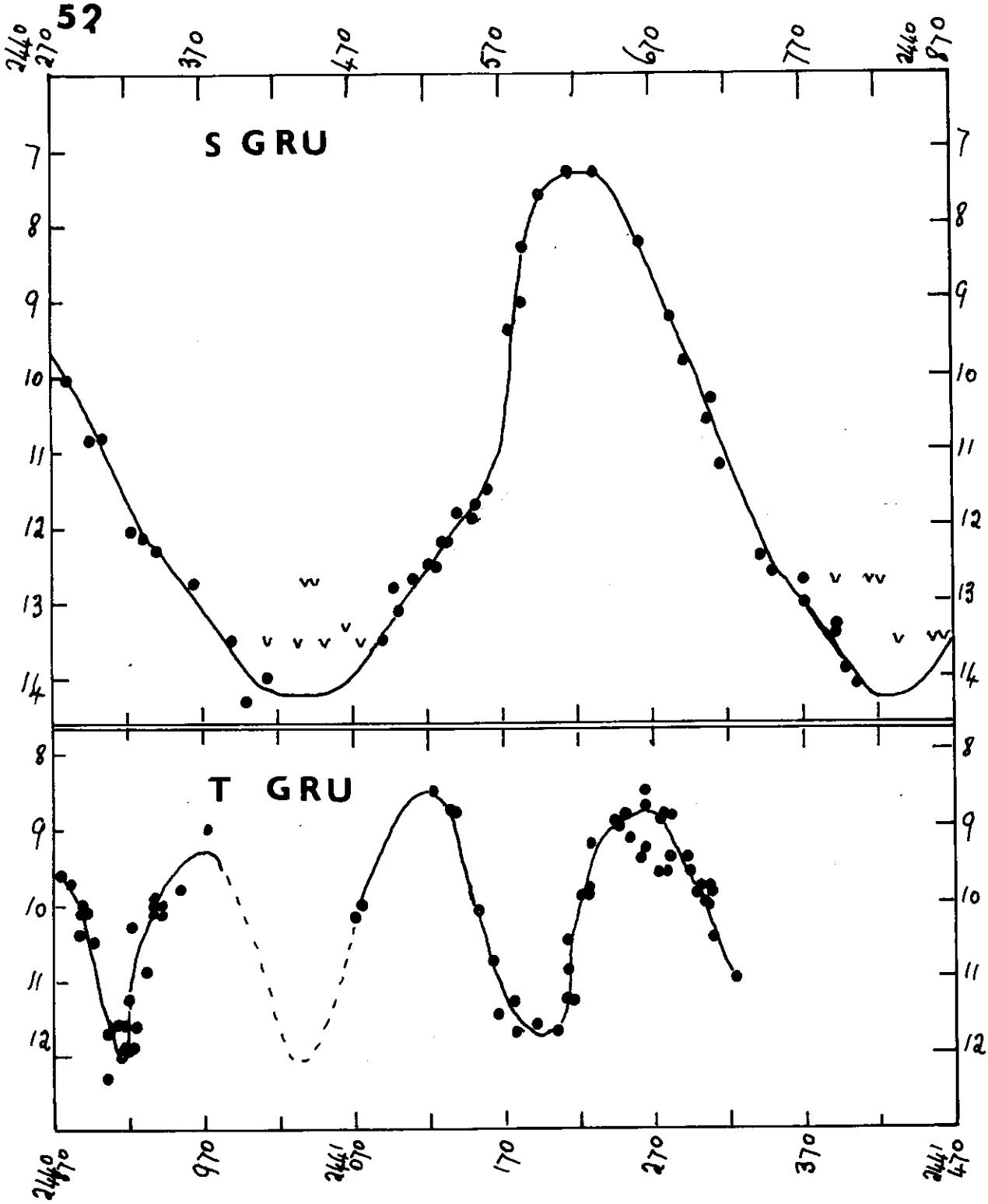

R GRU
R GRU
2439 670
770
870
970
2440 070
170
2440 270
2440 270
370
470
570
670
770
2440 870
8
9
10
11
12
13
14


R GRU
S PSA
2440 870
970
2441 070
170
270
370
2441 470
2439 670
770
870
970
2440 070
170
2440 270
8
9
10
11
12
13
14


S PSA
R PSA
2440 270
370
470
570
670
770
2440 870
9
10
11
12
13
14
2439 670
770
870
970
2440 670
170
2440 270


R PSA
T GRU
2440 270
370
470
570
670
770
2440 870
9
10
11
12
13
14
8
2439 670
770
870
970
2440 070
170
2440 270


S GRU
T GRU
2439 670
770
870
970
2440 070
170
2440 270
370
470
570
670
770
2440 870
7
8
9
10
11
12
13
14


S GRU
T GRU
2440 270
370
470
570
670
770
2440 870
7
8
9
10
11
12
13
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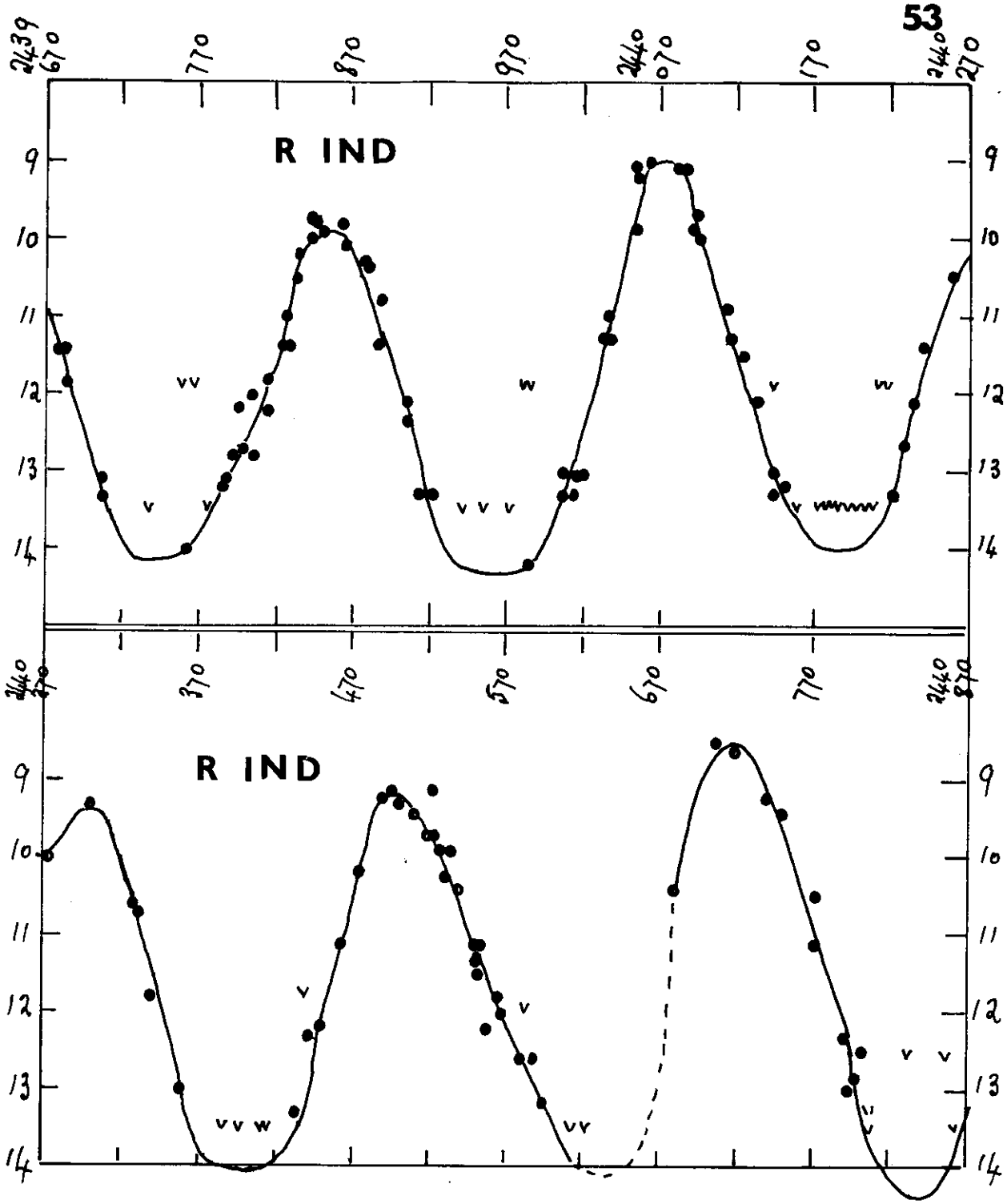
270
370
2441 470


R IND
R IND
2439 670
770
870
970
2440 070
170
2440 270
370
470
570
670
770
2440 870
9
10
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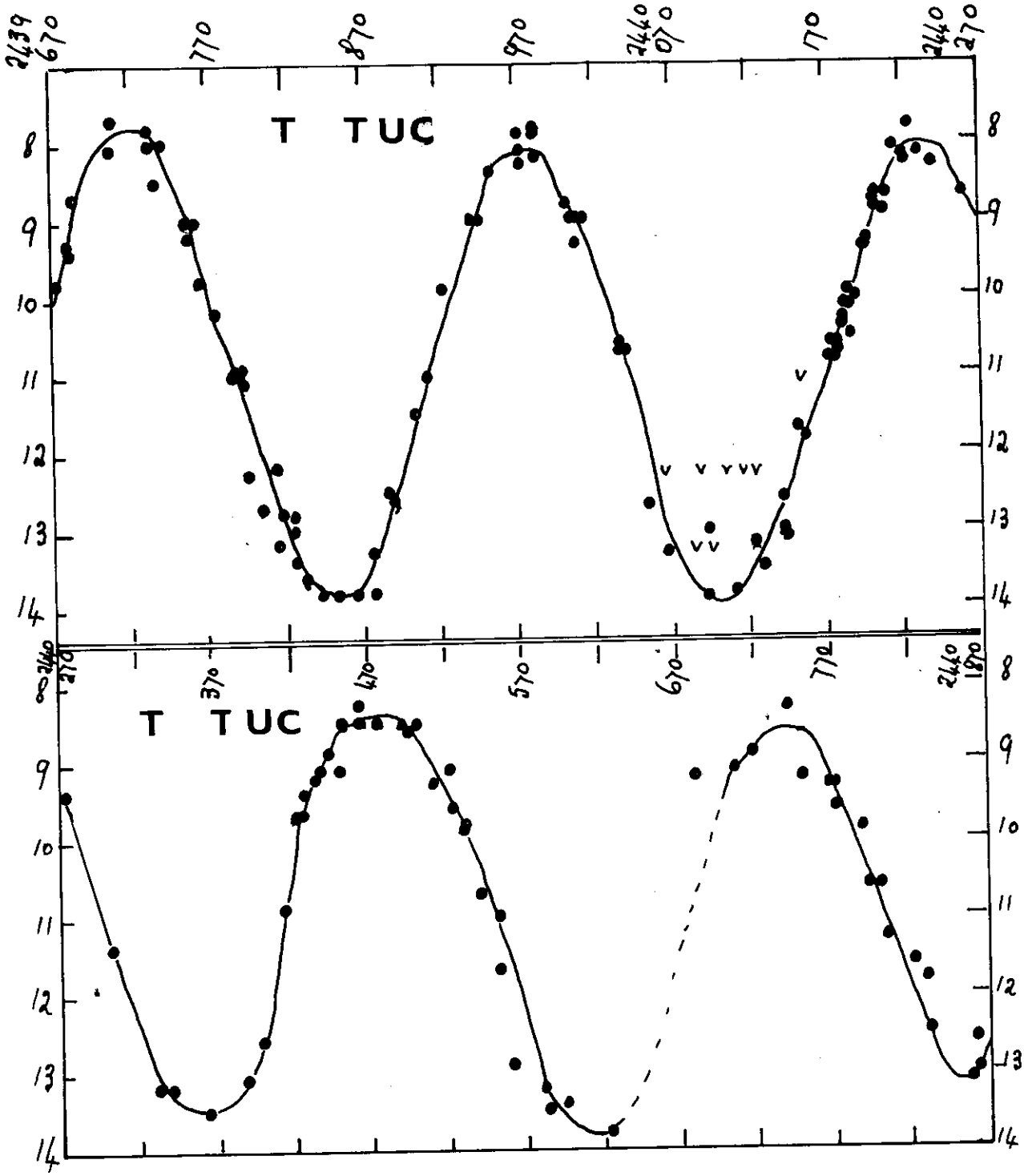
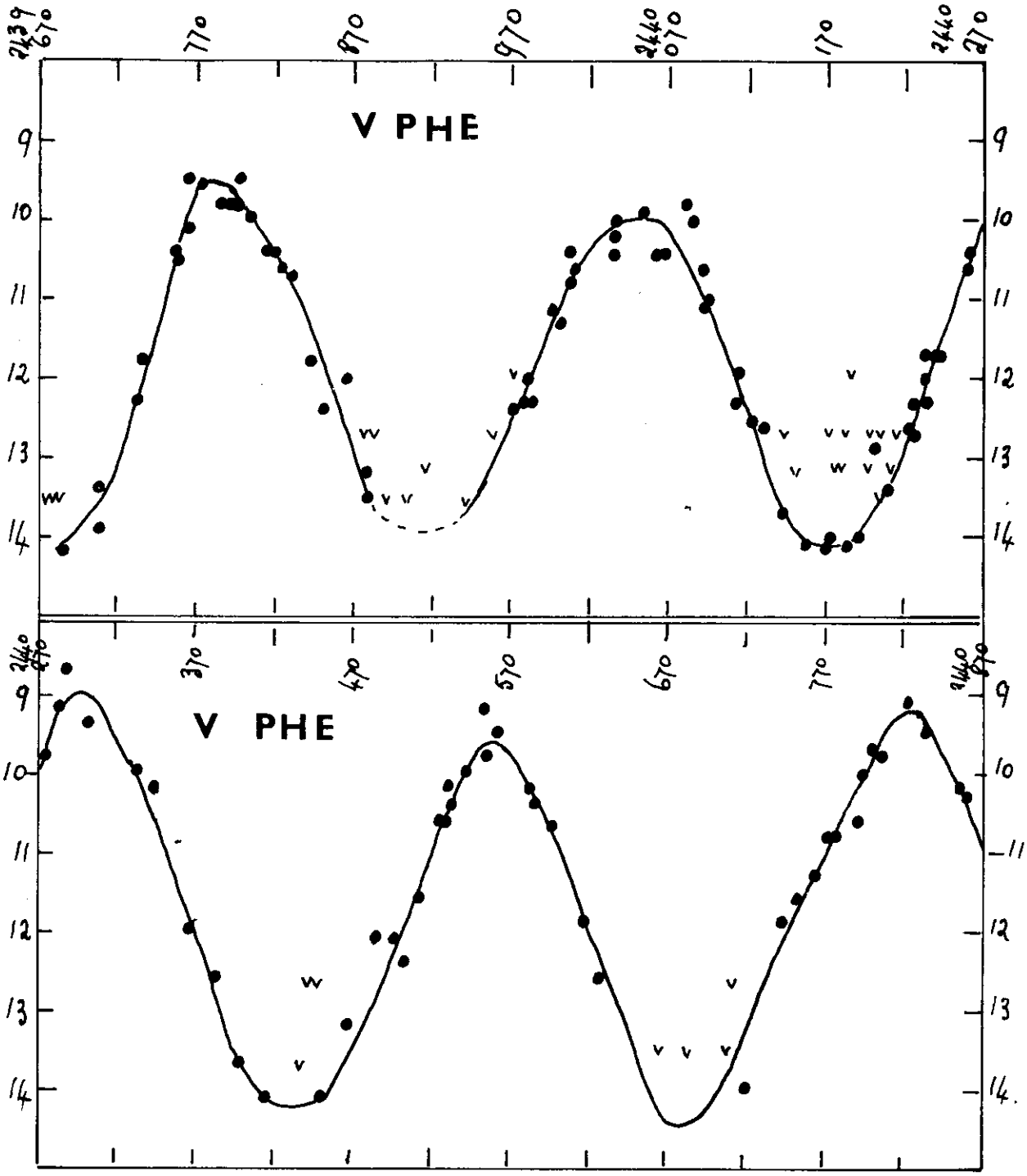
12
13
14


T TUC
T TUC


V PHE
V PHE