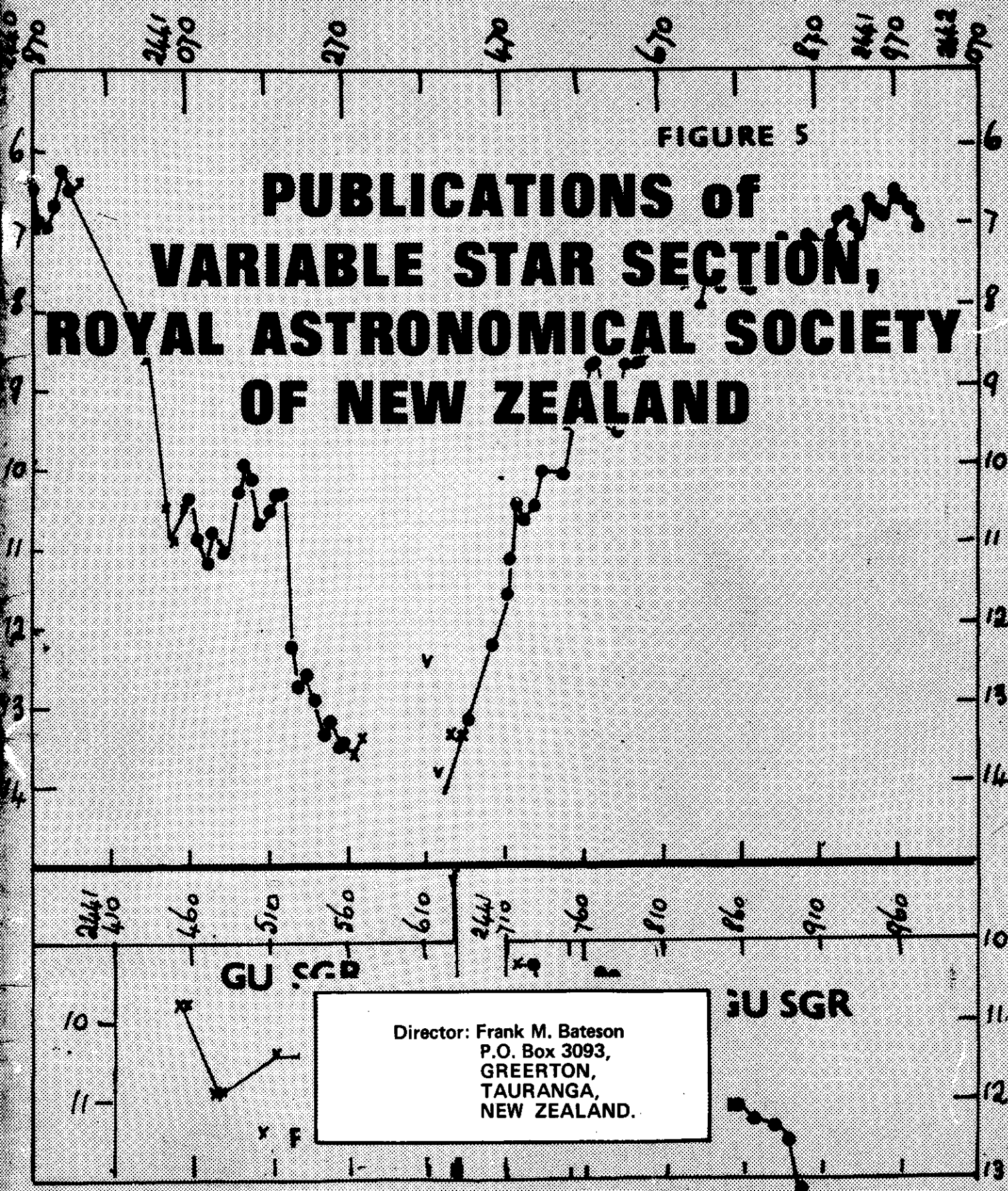




CONTENTS.

	<u>PAGE</u>
INDUCED SECONDARY AND TERTIARY PERIODS IN THE MIRA VARIABLE R Hor. F.M. Bateson & P.R. Wood	1
PHOTOELECTRIC UBV SEQUENCES FOR SOUTHERN DWARF NOVAE. N. Vogt	8
PHOTOELECTRIC LIGHT CURVES OF THE ECLIPSING BINARY XY LEONIS H.D. Kennedy & W.K. Wisniewski	17
THE STUDY OF SOUTHERN CEPHEID VARIABLES. II Mati Morel	29
A PHOTOELECTRIC PHOTOMETER FOR SMALL TELESCOPES W.H. Allen	38
REPORT OF SECTION FOR YEAR ENDED 1980 30th SEPTEMBER	51
NOTICES	56
NOTICE TO CONTRIBUTORS	INSIDE BACK COVER
PRICE LIST	OUTSIDE BACK COVER

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1980 December 24

INDUCED SECONDARY AND TERTIARY PERIODS IN THE MIRA VARIABLE R HOR

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SUMMARY: Visual observations covering an interval of 50 years have been used in a search for secondary periods in the Mira variable R Hor. No secondary period is obvious before JD2431500 but, near this date, a glitch occurred in the pulsation of R Hor which resulted in an abnormally short cycle (~ 350 days compared with a typical period ~ 400 days) and an abnormally faint maximum ($M_V \sim 8$ mag compared with a mean maximum magnitude $M_V \sim 6$ mag). Following the glitch (1) the mean primary period increased to $P = 408$ days from $P = 402$ days before the glitch (2) a distinct secondary period twice the length of the primary period and lasting ~ 20 years was clearly evident, and (3) the magnitude at minimum and the O-C curve show a tertiary modulation (lasting ~ 20 years) with a period approximately seven times that of the primary period. We conclude that the secondary period of length $2P$ does not correspond to a distinct mode of pulsation but is a result of the large amplitude of pulsation, and that the tertiary period is most likely produced by excitation of a non-radial pulsation mode.

INTRODUCTION

Although the variability of Miras is almost certainly the result of radial pulsation (non-radial oscillations, star spots on a rotating star and giant supergranules have also been proposed), there is some uncertainty as to the pulsation mode of the primary stellar oscillation. Wood¹ has shown that luminosities and effective temperatures of Miras yield a pulsation constant $Q \sim 0.04$ for masses $M \sim M_\odot$, this value of Q being the value obtained from theoretical first overtone pulsators. However, in a recent paper Hill and Willson⁽²⁾ find that a study of shock propagation in the outer layers of Miras yields a value of $Q \sim 0.1$, which would indicate pulsation in the fundamental mode.

The most unambiguous method of ascertaining the dominant mode of pulsation in a Mira would be to find secondary periodicities in some of these stars. Since period ratios are almost model independent for stars of a similar type (e.g. red giants) and since the ratio of fundamental period P_0 to first overtone period P_1 ($3 - 5$) is vastly different from the ratio of P_1 to the second overtone period P_2 ($1.2 - 1.5$), identification of a secondary period in a Mira and calculation of the ratio of the secondary to the primary period should lead to a good estimate of the mode of the primary (and secondary) oscillation.

In this study, ten day means covering 50 years of visual observations of the Mira variables R Hor and U Tuc were examined with the aim of finding secondary periods. In U Tuc no secondary period was found but in R Hor a total of three periods were found to occur simultaneously. In the following sections we present our results for R Hor.

METHOD OF ANALYSIS.

Visual observations obtained by members of the Variable Star Section, R.A.S.N.Z., were grouped into ten day means. Previous studies (3), (4), have shown that the errors in the resulting magnitudes are 0.2mag. or less. Light curves were plotted and examined for obvious periodicities. An O-C curve was initially constructed from the data by using observed dates of maximum.

However, as noted by Eggen (5) the light curves of Miras do not repeat well around maximum, probably due to the presence of a shock wave and associated Balmer emission around this phase; in the interval from phase $\phi = -0.25$ to minimum ($\phi = -0.5$), however, the light curve does seem to repeat reasonably well. Consequently, the observed dates O for the O-C curve were defined as the dates on which a given V magnitude roughly half way between maximum and minimum ($V = 10$ mag. in the case of R Hor) was reached on the declining part of the light curve. Because of the rapid rate of change of magnitude at this point, errors in O produced by errors in the observed magnitude are small. The O-C curve obtained in this way showed less scatter than the O-C curve obtained using dates of maximum.

In order to search for secondary periodicities the phase dispersion minimization (PDM) method(6) was used. In this method, the data is folded on itself with a selected period and put into a number of bins, each of which corresponds to a small phase element of the period selected. When this period corresponds to a period present in the star, the dispersion of the observations about the bin means is reduced to a minimum. The bin means then give the corresponding light curve directly.

RESULTS

The O-C curve of all 50 years of our data is shown in Figure 1, where the observed dates O correspond to visual magnitude $V=10$ mag. on the declining part of the light curve as described in the previous section. Several facts are immediately obvious from Figure 1.

- a Before cycle number -5, the O-C curve is relatively smooth.
- b Around cycle number 0, a glitch in the pulsation occurred which induced a distinct two-point oscillation in the O-C curve lasting until near cycle number 20. Such an oscillation could be produced by a secondary periodicity in R Hor of length twice the primary period of pulsation or by any secondary period with length $2P/n$, where n is a positive integer.
- c From cycles -16 to -5, the O-C curve in Figure 1 is represented by a straight line corresponding to a mean period of pulsation 402.1 ± 1.6 days, at the 95% confidence level. Following the glitch, in the interval from cycles 0 to 20, the mean period is increased to 407.9 ± 1.4 days.
- d There is some evidence for a tertiary oscillation with a length ~ 7 times the primary period being induced by the glitch and lasting until about cycle number 15.

The complete light curve of ten day means covering the interval from cycle numbers 0 to 20 (when the secondary and tertiary periods are apparent in the O-C curve) is shown in Figure 2. It can be seen that the maximum at cycle number 0 is unusually faint, giving direct evidence that some perturbation of the star occurred at this time. In order to ascertain which of the possible secondary periods $2P/n$ is causing the two-point oscillation in the O-C curve, the PDM technique was used to analyse all data between cycle numbers 0 and 20, when the two-point oscillation is apparent in the O-C curve. After pre-whitening the data by removal of the primary period, the only period of the form $2P/n$ found present corresponded to $n = 1$, i.e. the secondary oscillation was found to be of length $2P$.

Visual inspection of the light curve in Figure 2 does not show any clear evidence for the secondary period of length $2P$ between cycle numbers 0 and 13 when this secondary period is particularly prominent in the (O-C) curve. However, from cycles 13 to 20 there is a distinct oscillation in the magnitude at maximum indicating the presence of the secondary period although its presence in the O-C diagram is not as clear as in the previous interval. The explanation for this behaviour of the secondary period is that near cycle number 13, which corresponds to an unusually bright maximum, a secondary perturbation occurred which changed both the phase and amplitude of the secondary oscillation. Before cycle number 13, the secondary oscillation was small on successive maxima of the primary oscillation whereas after cycle 13 the visual displacement of the secondary oscillation was significant at the times of maxima of the primary oscillation. This is shown in Figure 3 which gives the mean ⁷ primary light curve and the secondary oscillation from cycle numbers 0 to 13 and 13 to 22, where observations have been ~~put~~ ⁷ put into bins of constant phase width. Clearly the shape and amplitude of the secondary oscillation are different in the two intervals.

Evidence for the tertiary period of length $7P$ induced by the glitch at epoch number 0 can be seen in the magnitudes of minima in Figure 2. This tertiary oscillation is apparent during the interval covering primary cycles numbers 0 to 20. Although there is much more scatter in the magnitudes of maximum (possibly due to variations in the strength of the shock wave and Balmer line emission), there is some very slight evidence that the maxima are brighter/fainter when the minima are brighter/fainter throughout the $7P$ oscillation. In such a situation, the tertiary period must be due to the superposition of a discrete oscillation of period $7P$ on the light curve of the star. The alternative explanation of the tertiary period is that it is produced by the beating of the principal period with a discrete oscillation whose period is $\frac{7}{8}P$ or $\frac{7}{8}P$. In this case, addition of the two beating periodicities⁸

would cause the magnitudes at maximum to be brighter/fainter when the magnitudes at minimum are fainter/brighter.

DISCUSSION

The existence of a secondary period of length twice the primary period of pulsation seems to be relatively common in cool variables of high central condensation. This phenomenon is one of the distinguishing features of the RV Tauri variables, which show alternate high and low maxima. A small number of Mira variables (e.g. R Cen, R Nor) also exhibit this feature distinctly, while $2P$ components of a smaller amplitude or occasional occurrence have also been reported (7,8).

Non-linear pulsation calculations indicate that the $2P$ oscillation is produced by a large amplitude of pulsation and does not result from a distinct mode of pulsation. Christy (9) was the first to find oscillations with alternating high and low maxima in a complete theoretical model. Other calculations (10, 11) which consider only the outer layers of a star being driven by pulsation of the interior with period P also show the $2P$ oscillation; thus the $2P$ oscillation is a surface phenomenon and does not involve eigenmodes of the complete star. In R Hor, a $2P$ oscillation seems to have been induced by the glitch at epoch number 0:

a If the tertiary period represents the period of an independent oscillation rather than a beating phenomenon, then this period of length $7P$ could not be due to radial oscillations.

If radial modes only are considered, the 7P oscillation would (at best) have to correspond to the fundamental mode, which would mean (from theoretical period ratios) that the $\frac{7}{8}$ primary mode of oscillation is roughly the fifth overtone. This is unlikely for stars of the relatively large amplitude exhibited by the Miras. However, theoretical considerations (e.g. Ledoux 12) show that for stars with a radiative region such as that found interior to the convective envelope of a Mira there exists an infinite series of oscillatory non-radial gravity (g^+) modes with periods longer than those of the radial modes. For simple polytropic models, g^+ modes with periods of length ~ 7 times that of the fundamental of first overtone radial pulsation period are readily found. Absence of evidence for the presence of g^+ modes under normal circumstances indicates that these modes have negative growth rates. In R Hor, however, a g^+ mode could have been induced by the glitch in the star near cycle number 0.

b If the tertiary period represents the result of beating between the primary period and another oscillation induced in R Hor, then this oscillation must have a period of length either $\frac{7P}{6}$ or $\frac{7P}{8}$.

If the induced oscillation is a radial mode, then the period ratio obtained from the beat period in R Hor would be consistent with theoretical period ratios only if the primary period of pulsation is the third or fourth overtone, which again we think unlikely given the large pulsation amplitude. In order to produce a beat period of the length found in R Hor, we must ascribe the induced oscillation to a non-radial p mode whose order (number of radial modes) is the same as (or lower than) that of the primary radial pulsation mode. Ando (13) has calculated periods of non-radial p modes in late-type giant stars (models S1 and S2 are most appropriate) and the (ℓ, σ) diagrams indicate a change in period of $\sim 5\%$ for a unit change in the spherical harmonic number ℓ of a mode of given order. The models of Ando thus predict that the primary radial mode, when beating with the non-radial p mode of the same order but with $\ell = 2$ or 3, would produce the observed beat period of 7P. It is interesting to note that many semi-regular variables show modulations of their light curves with periods predominantly in the range 6-12 times the length of the primary period (14). The primary mode of oscillation of the semi-regulars (if radial) is a higher overtone than that of the Miras (15) so that it may be possible to interpret the observed period ratios in these stars in terms of beating between successive radial overtone modes. However, beating between a radial mode and a non-radial p mode is also a possibility.

The other feature associated with the glitch in R Hor is the temporary change in period of the primary pulsation. Small period changes are well known in Mira variables (16) (17, 18, 8); in R Hor, the size of the change (2%) is typical of that found in other Miras. A possible explanation is a change in the number of convection cells in the envelope.

To conclude, we note that both interpretations of the tertiary period seem to require the presence of non-radial pulsation. Unfortunately, without detailed theoretical models, we are unable to distinguish between the two alternative explanations of the tertiary period. We are also unable to determine the mode of the primary oscillation from the length of the tertiary period (or from the length of the secondary period). As far as we are aware no calculations of g^+ modes in red giant stars have been made and we also note that the p mode calculations (13) were made on models that are not good representations of Miras.

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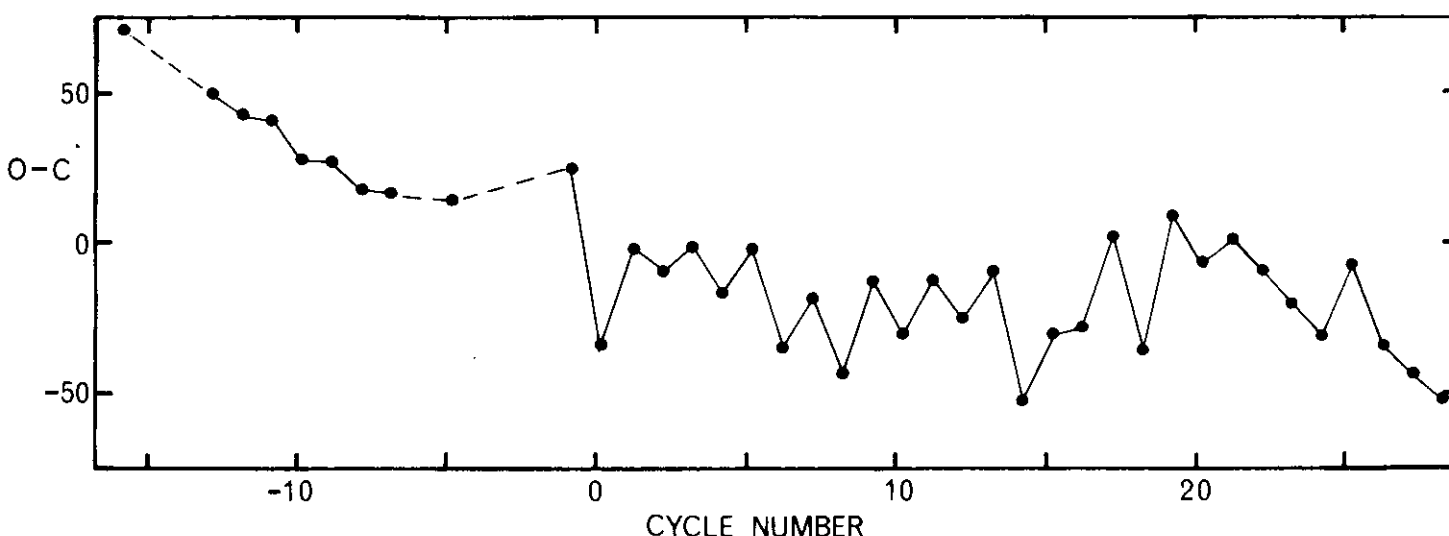


Figure 1. O-C plotted against cycle number for R Hor. A constant period of 408.16 day is used to compute C and cycle number zero corresponds to the faint maximum on JD 2431754.

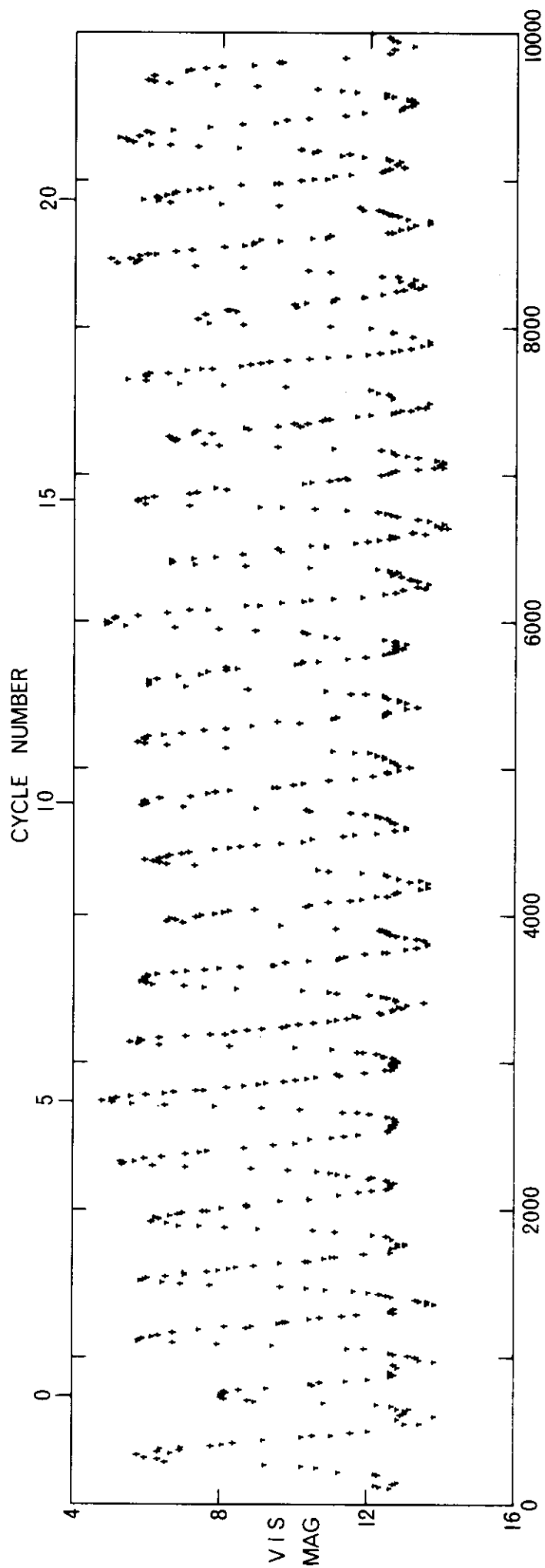


Figure 2. Light curve of R Hor constructed from ten day means. The cycle number of the maxima is indicated along the top axis.

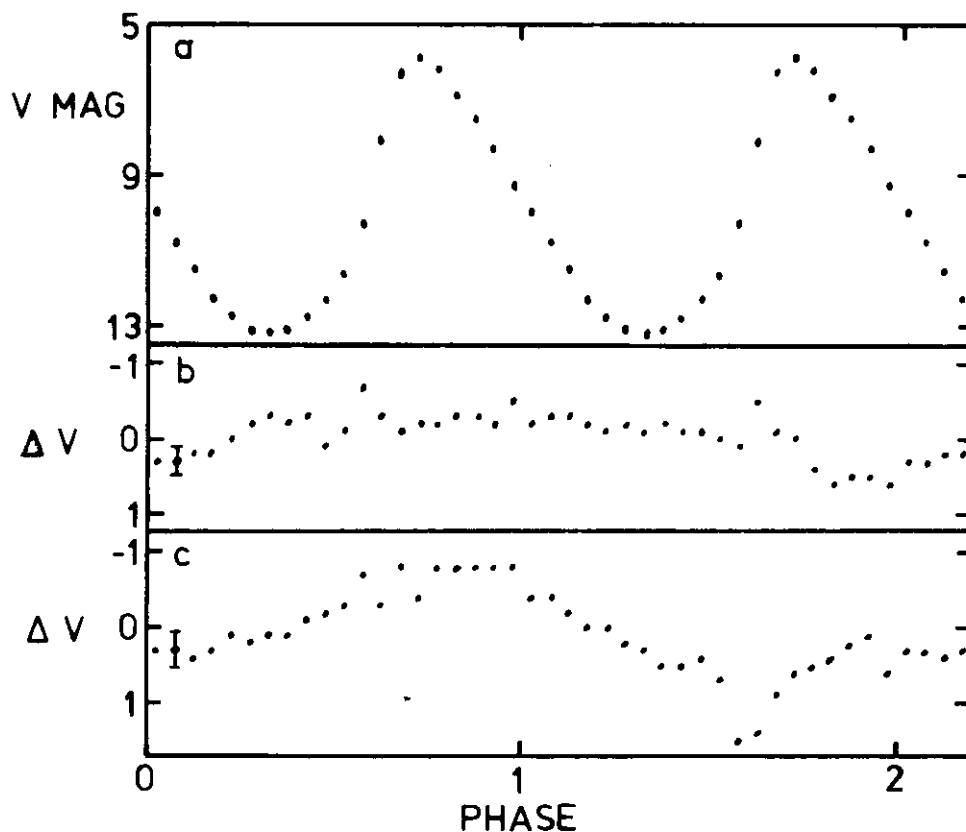


Figure 3. (a) The mean primary light curve for numbers 0 to 22 repeated over two cycles of the primary oscillation, (b) The mean light curve ($\Delta V = V - V_{\text{primary}}$) of the secondary period of length $2P$ for cycle numbers 0 to 13, and (c) the mean light curve of the secondary period of length $2P$ for cycle numbers 13 to 22.

The mean standard deviation of the phase bin means are shown in the lower two figures, but the mean standard deviation of the bin means of the upper curve (0.12 mag) is too small to be shown.

PHOTOELECTRIC UBV SEQUENCES FOR SOUTHERN DWARF NOVAE

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SUMMARY: Photoelectric UBV photometry of a total of 125 stars in 32 fields of southern dwarf novae (including one recurrent nova) is given, with limiting magnitudes up to 16^m . Finding charts are added for 25 fields.

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The present study continues the photoelectric photometry of scale stars in dwarf nova fields which was initiated by Vogt (1) = paper 1, for a first set of 17 southern dwarf novae. Further UBV photoelectric observations were carried out between October 1977 and September 1979 at the European Southern Observatory, La Silla, Chile, using the ESO 1m and 50 cm telescopes, as well as the 61 cm telescope of the Bochum University. I refer to paper 1 for details on the observing and reduction procedures, standard stars and error analysis. Table 1 gives the results of the photoelectric photometry of all 25 fields for which two or more sequence stars are available. N refers to the total number of independent observations. As in paper 1, the identifications by letters correspond to those of Bateson et al., "Charts for Southern Variables" (references see paper 1). Identification by numbers refer to additional scale stars selected by the author. Finding charts for all stars of Table 1 are given in Figure 1 a - d, based on ESO or Palomar Sky Survey prints. One of these fields contains the recurrent nova VY Aqr, all other fields correspond to confirmed or suspected dwarf novae. For seven additional dwarf novae only one star per field was measured, serving as comparison star for the variable. Table 2 contains the photoelectric results of these stars, including their identification due to published finding charts or approximate position relative to the variable. The AAVSO charts mentioned in Table 2 refer to the most recent Atlas edition (2). No finding charts are given for these fields.

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ERRATUM.

There is a typing error in paper 1: Please read "11.20" instead of "12.20" for V of star 1 in the field of MU Cen.

FIGURES 1 a -d: Identification charts of the photoelectric sequences. North is top; east is left. The bar corresponds to the size of one minute of arc. If known the variable is marked by a circle.

Table 1

field		star	V	B-V	U-B	N
0006-12	WW Cet	A	12.51	1.20	1.16	3
		B	13.12	0.78	0.34	4
		C	13.68	0.53	-0.05	2
		D	13.45	0.58	-0.06	3
		F	13.39	0.56	-0.08	1
		G	14.38	0.89	0.5	1
		1	10.95	0.64	0.12	13
0111-18	WX Cet	1	10.59	0.61	0.05	3
		2	11.88	0.93	0.65	3
		3	13.16	0.61	-0.01	2
		4	11.86	0.68	0.22	2
		5	13.91	0.79	0.53	2
0445-76	TU Men	C	10.90	0.43	0.13	1
		D	10.97	0.51	-0.02	1
		E	10.95	0.36	0.11	2
		M	12.23	0.63	0.07	1
		N	12.91	0.68	0.11	1
		Q	13.18	1.01	0.7	1
0501-04	AQ Eri	B	10.67	0.67	0.26	1
		C	12.96	0.50	0.09	1
		D	10.98	1.26	1.38	2
		1	15.28	0.68	0.2	1
0631+00	CW Mon	1	9.22	0.22	0.19	5
		2	11.78	0.65	0.16	1
		3	12.56	1.30	1.14	1
		4	12.78	0.61	0.05	1
		5	13.58	0.84	0.2	1
		6	13.89	1.61	0.9:	1
		7	11.39	0.51	-0.08	1
0652-09	EQ Mon	1	12.82	0.36	0.26	1
		2	13.87	0.61	0.17	1
		3	15.45	1.12	0.8:	3
0741-12	UY Pup	1	12.32	1.17	0.90	1
		2	14.09	0.93	0.44	1
		3	13.58	0.12	0.16	1
		4	12.92	0.35	0.18	1
		5	11.29	0.22	0.14	8
0945-23	AG Hya	1	12.04	0.57	0.06	1
		2	12.16	0.60	0.09	1
		3	12.74	1.23	1.19	1
		4	13.16	0.70	0.25	2

= HD 228725

field		star	V	B-V	U-B	N
1004-69	OY Car	D	12.01	0.28	0.24	8
		E	11.72	0.72	0.28	1
		L	12.47	1.28	1.3	1
		N	13.36	1.28	1.2:	1
1140-03	TW Vir	1	8.86	1.04	0.80	1
		2	10.41	0.53	0.04	1
1619-04	V 699 Oph	1	11.74	0.57	0.20	1
		2	16.5	1.2	0.7:	1
1702-25	V 2051 Oph	1	10.33	0.52	0.11	7
		2	11.87	0.78	0.28	3
		3	13.52	1.93	1.4:	2
		4	10.95	0.61	0.16	1
		5	13.79	1.64	1.9:	2
		6	14.13	1.86	1.1:	2
1719-35	V 478 Sco	A	13.22	0.83	0.28	1
		D	12.12	1.45	1.34	1
		E	13.19	0.56	0.39	1
		F	12.40	1.43	1.05	1
		G	13.51	0.63	0.36	1
		K	14.04	0.80	0.45	1
		1	11.59	0.71	0.21	3
1725-62	FV Ara	A	8.37	1.27	1.39	2
		C	11.29	0.16	0.16	5
		G	13.38	0.55	0.21	2
		H	13.33	1.31	1.4:	2
		K	14.04	0.55	0.07	1
		M	13.75	1.06	0.92	2
1730-47	BF Ara	1	14.09	0.65	0.23	3
		2	15.5	1.02	0.7	2
		3	15.2	0.83	0.5	1
		4	15.4	1.4	1.3:	1
		5	16.0	0.6	-	1
		6	11.45	0.62	0.09	2
		7	13.37	1.40	1.8:	1
		8	13.42	0.82	0.11	1
		9	12.99	0.73	0.14	1
1805-14	UZ Ser	1	11.81	1.21	0.97	1
		2	12.31	0.27	0.22	7
1911-00	FO Aql	1	10.87	0.57	0.14	8
		2	10.85	0.48	0.06	1
		3	16.2	0.9	0.7:	1
1920-10	DH Aql	1	12.67	0.53	0.16	1
		2	11.57	0.52	0.22	1
		3	10.82	0.30	0.17	1

field		star	V	B-V	U-B	N
1951-09	UU Aql	1	12.39	0.76	0.31	1
		2	11.00	0.49	-0.01	3
2021-52	KK Tel	1	11.04	0.69	0.27	5
		2	11.90	0.98	0.61	2
		3	13.82	0.84	0.41	4
		4	14.67	0.76	0.16	2
		5	15.07	0.59	-0.1:	1
		6	16.5	0.6	0.0:	1
2025-56	TT Ind	1	11.42	1.00	0.87	11
		2	14.56	0.49	0.13	1
		3	14.98	0.84	0.7	1
		4	15.44	0.70	0.6:	2
		5	15.08	0.64	0.1	1
		6	13.48	1.03	0.96	2
		7	12.99	0.75	0.20	2
2026-45	TU Ind	1	11.47	0.68	0.30	1
		2	12.38	0.60	0.04	1
		3	13.52	0.93	0.37	1
		4	13.78	0.60	0.3:	2
2106-09	VY Aqr	1	10.97	0.55	0.07	5
		2	9.71	1.09	0.91	2
		3	10.91	1.28	1.25	2
		4	12.01	1.12	0.98	2
		5	13.79	0.76	0.21	2
		6	13.7	1.0	0.4	2
2116-14	CV Aqr	1	11.10	0.53	0.06	5
		2	12.79	0.56	0.13	2
		3	13.22	0.83	0.32	1
		4	16.2	1.5	-	1
2125-03	VZ Aqr	B	10.02	1.03	0.81	2
		D	12.93	0.52	0.01	3
		E	12.29	0.75	0.32	1
		1	15.53	0.45	-0.09	1

Table 2

field	V	B-V	U-B	N	Identification
0418-13 AH Eri	12.57	0.62	0.11	1	"d" in RASNZ chart 311
0547-05 CN Ori	9.82	0.48	0.00	2	"99" in AAVSO chart 054705 e
0725+06 SV CMi	11.99	0.37	0.00	4	approximately 2'.2 east and 0'.3 south of the variable, between "a" and "127" on AAVSO chart 072506 e
0855+18 SY Cnc	10.96	0.72	0.30	2	"109" on AAVSO chart 085518 e
1147-23 SW Crt	12.84	0.70	0.17	1	"a" on chart of Dorodnaya and Kholopov (1977)
1640+25 AH Her	12.63	0.49	-0.02	1	"123" on AAVSO chart 164025 e
1753-29 V 735 Sgr	11.68	0.32	-0.01	3	approximately 1'.8 east and 0'.6 south of the variable

REFERENCE:

Dorodnaya, E.A., Kholopov, P.N., 1977, Per. Zvezdy, Suppl., 3, 274

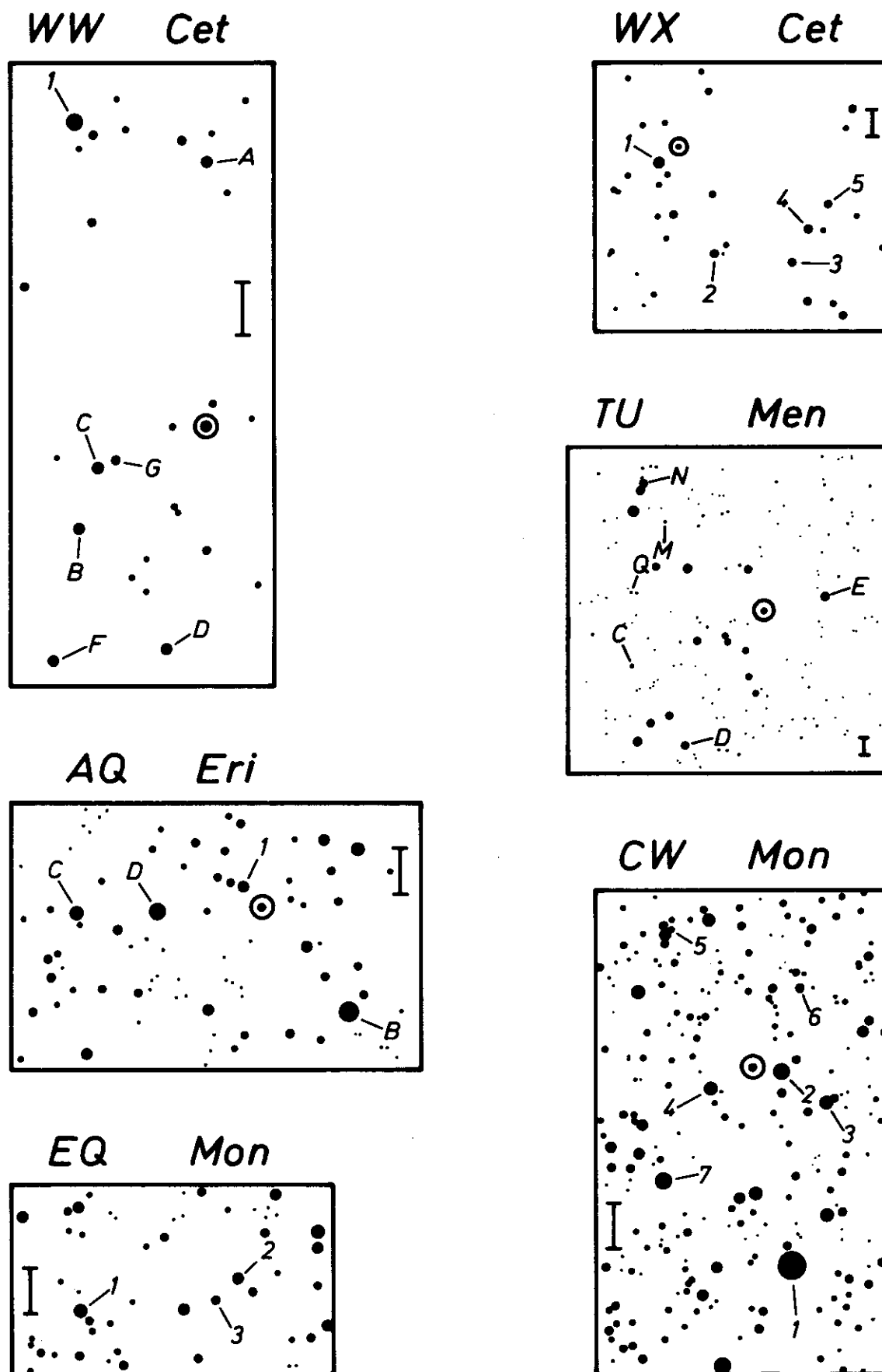


Figure 1a. Identification charts of the photoelectric sequences. North is top; east is left. The bar corresponds to the size of one minute of arc. If known, the variable is marked by a circle.

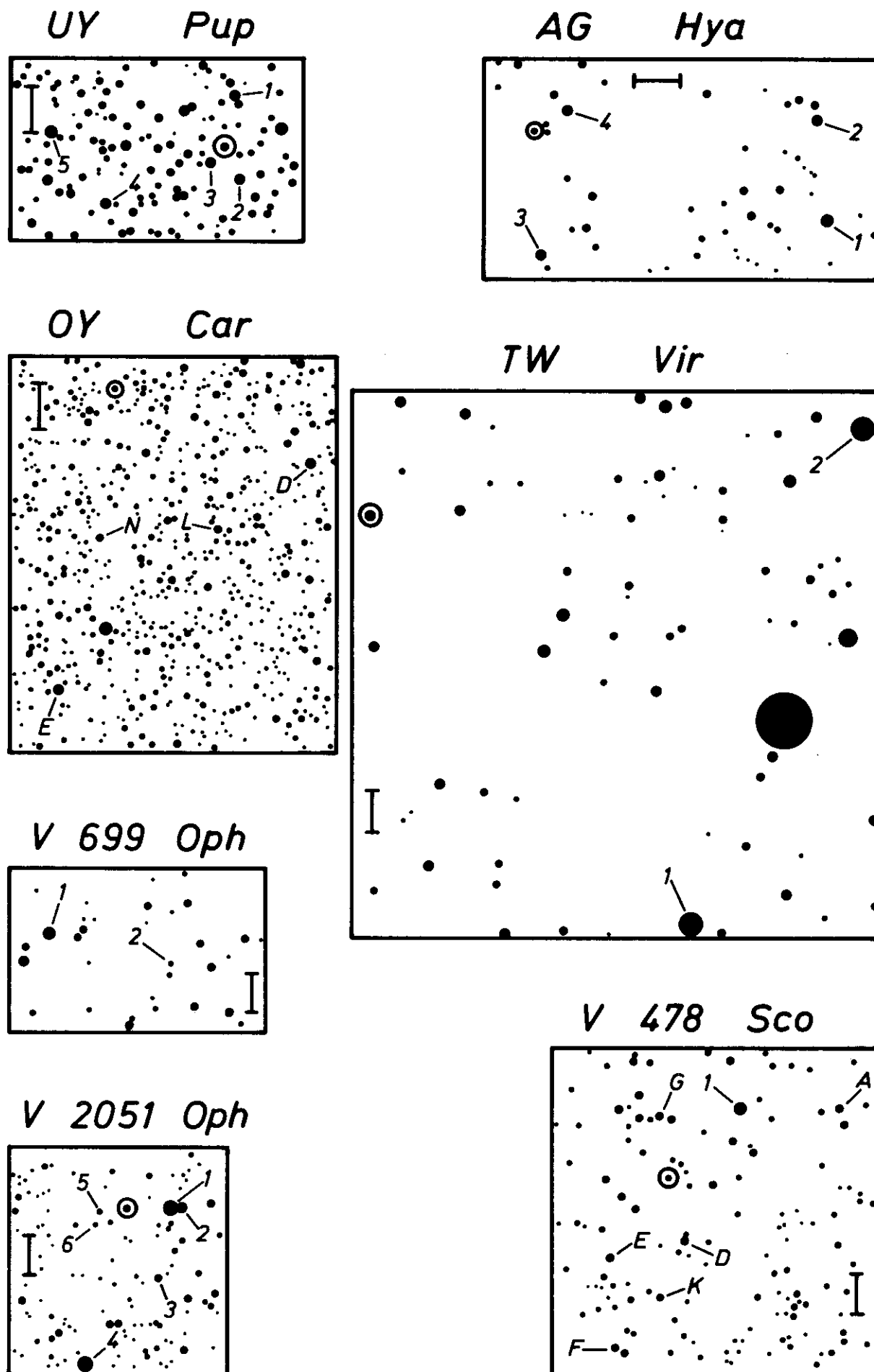


Figure 1b: Identification charts of the photoelectric sequences. North is top; east is left. The bar corresponds to the size of one minute of arc. If known, the variable is marked by a circle.

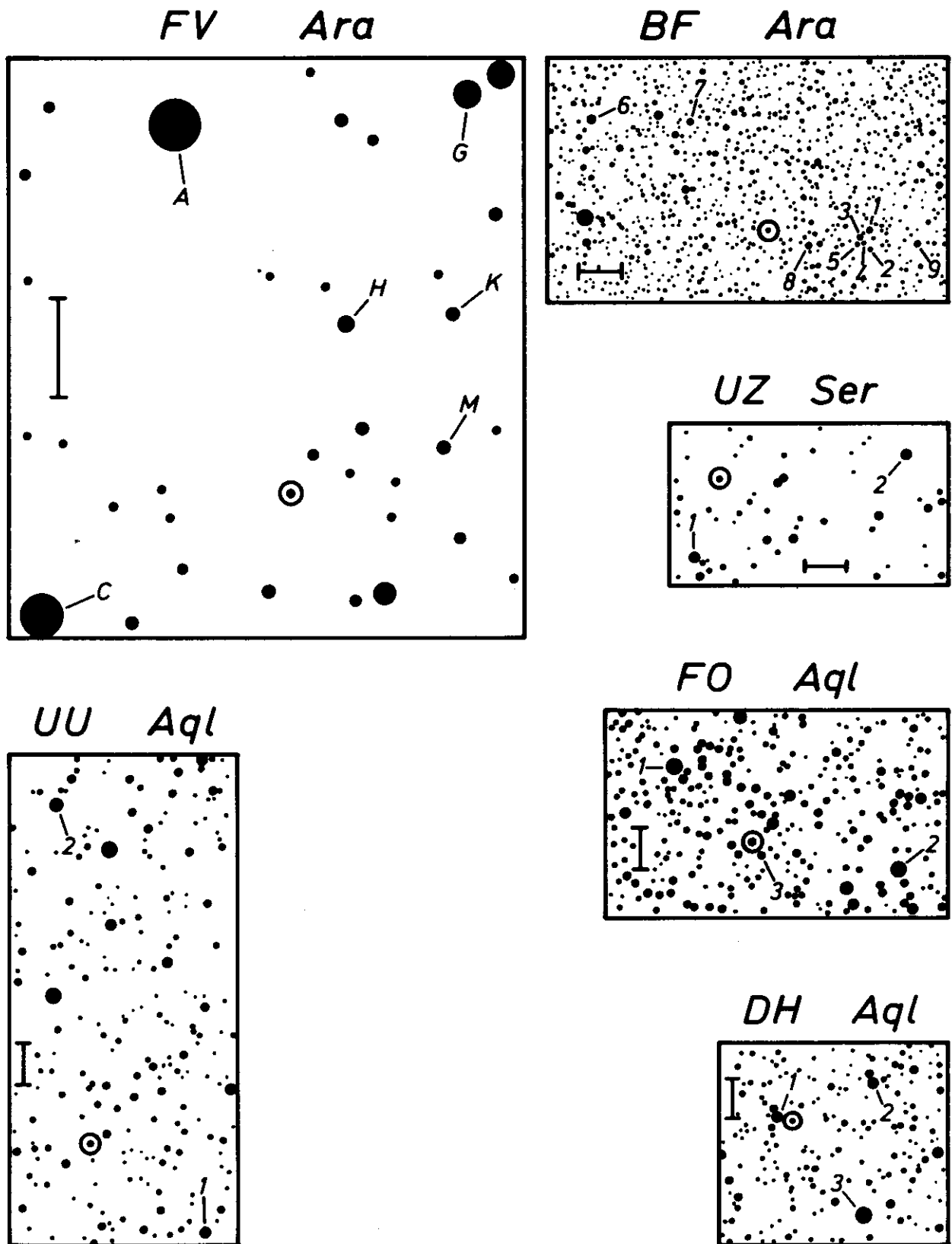


Figure 1c: Identification charts of the photoelectric sequences. North is top; east is left. The bar corresponds to the size of one minute of arc. If known, the variable is marked by a circle.

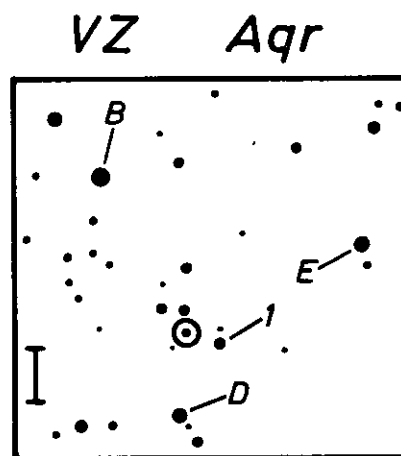
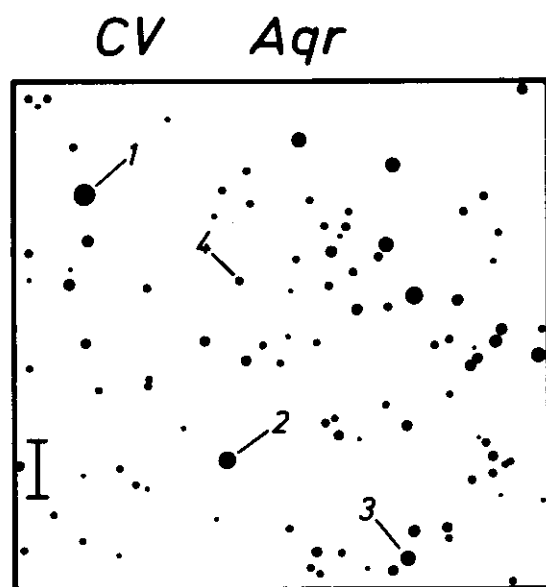
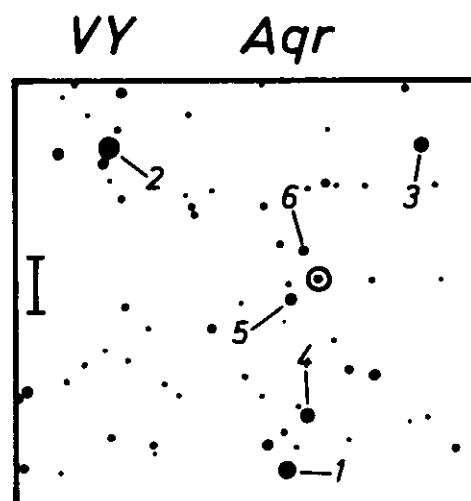
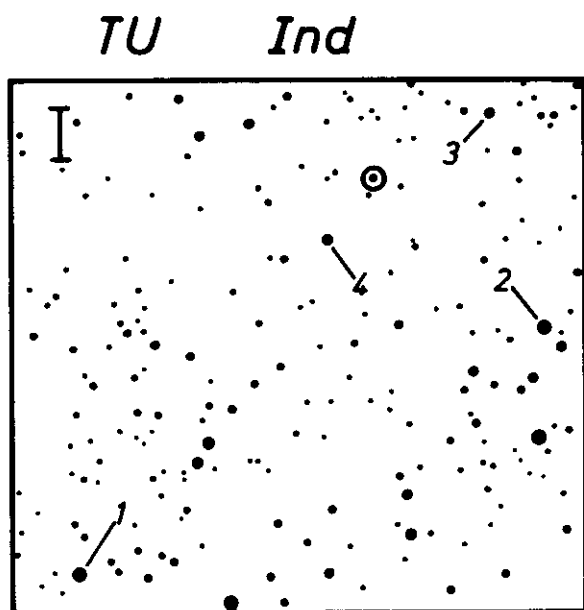
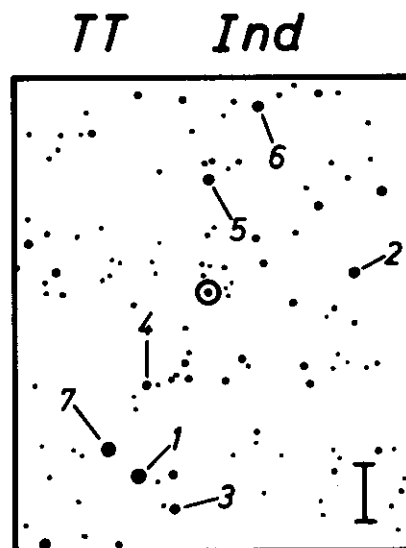
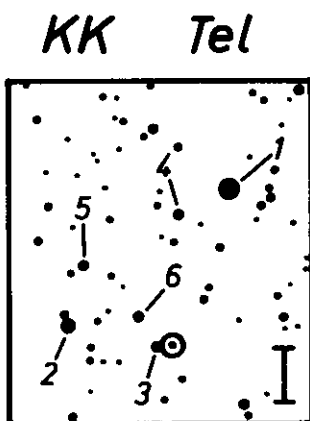


Figure 1d: Identification charts of the photoelectric sequences. North is top; east is left. The bar corresponds to the size of one minute of arc. If known, the variable is marked by a circle.

PHOTOELECTRIC LIGHT CURVES OF THE ECLIPSING BINARY XY LEONIS

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SUMMARY: A total of 214 photoelectric observations of XY Leo in yellow, blue and ultraviolet light obtained in 1978 and 1979 is presented. Analysis of these observations indicates that this binary can be dynamically active over a time scale of the order of one month. (O-C) values appear variable within a one year period and confirm departure from an earlier proposed third body (O-C) sinusoid. There are indications of excess loss of light in ultraviolet at secondary minimum.

INTRODUCTION:

Hoffmeister (1) discovered the variability of the short period eclipsing binary XY Leo ((BD +18°2307)). Although this system has been under observation for almost 50 years, certain pertinent features still remain unexplained.

Observations of minima have been reported (2,3,4). The system was classified as of spectral type G5 (5) from prism plates. It was classified as a W UMa type binary from radial velocity curves (6). Koch (7) presented a yellow light and a differential (B-V) colour curve as well as a limited photometric solution. He stated the possibility of the presence of third light as a result of the system orbiting a third star, or alternatively, the system having an intrinsically variable period. Photographic observations (8) confirmed period variability. This period variability was interpreted (9) as periodical and a sinusoidal (O-C) time relationship was proposed. Additional primary and secondary minima were obtained (10). These were used to test the hypothesis whether the period changes could be explained as a light time orbit caused by a third mass belonging to the system. It was concluded that this third component (if present) could be a white dwarf. As an alternative it was indicated that there is the possibility of sudden period changes ("jumps") as observed in other W UMa systems. The system was observed (11) about one month after the authors and it was concluded that XY Leo constitutes an overcontact system with an intrinsically variable period; rejecting the third stellar body hypothesis. They (11) confirmed departure from the (O-C) sinusoid as previously observed (12).

The O-C values obtained by the authors indicate a similar departure.

OBSERVATIONS

XY Leo was observed during two nights in February 1978, in order to detect possible changes in period and to obtain an additional light curve at shorter wavelengths/ During the night of February 3, observing conditions were perfect. The following night, observations were interrupted by high level cloud. However, due to the fact that the system has a very short period of 0.2841 (6h 49m), it was possible to observe one complete revolution during the first night.

A total of 32 points in each of the three colours of the UBV system (13) was obtained with the University of Arizona's 101cm reflector at the Catalina Observatory, elevation some 2835m above sea level.

The photomultiplier was equipped with a RCA 1P21 tube, refrigerated with dry ice. The photometer carried its own standard source, being a photoelectrically controlled tungsten light source. The current from the photomultiplier was fed into an integrating, direct current amplifier; the output of which was registered by a printer while simultaneously being punched onto paper tape.

The diaphragm used was 46 arcsec. in diameter. All integrations were of 15 sec duration. The telescope automatically scanned between star and sky, the sky-offset was preprogrammed.

The observations of XY Leo were made differentially with respect to the comparison star BD +18°2306. A number of standard stars was observed during the night. No corrections for differential extinction were made.

One observation was obtained from the following sequence of deflections: variable-sky-variable-sky-variable-standard source-dark current, followed by: comparison-sky-comparison-sky-comparison-standard source-dark current. Information relating to the variable, comparison and check stars are listed in Table 1. The observations, along with heliocentric Julian Dates and phases are listed in Table II. The probable error for a single observation is estimated to be ± 0.005 mag.

The magnitude differences are given as variable minus comparison star. The phases were computed from the light ephemeris as stated by Koch:

$$J.D. \text{ Hel. Min. I} = 2,435,195.66306 + 0.2841091 E.$$

The yellow, blue and ultraviolet light curves are shown in Fig. 1. Zero point corrections of -0.131, +0.183 and +0.581 mag. were applied in yellow, blue and ultraviolet respectively in order to make magnitude differences equal to zero at maximum light.

Koch and Shanus (11) observed XY Leo about a month after we obtained our observational data in February 1978. They observed one primary and two secondary minima. Their results are included in Table IV.

One of us, (HDK), made further observations at Midway Observatory, in order to obtain data relating to the depth of secondary minimum in ultraviolet light.

The instrument used at Midway was the 38cm reflector, equipped with photometer. The photometer incorporates an EMI 9502B tube, refrigerated with dry ice. The current from the photomultiplier tube is fed into an integrating, direct current amplifier, the output of which is displayed simultaneously on a chart recorder and digital voltmeter. The chart recorder serves as a continuous monitor of sky conditions and sequence of observations. The digital voltmeter is connected to a microprocessor controlled printer. The mean value of three deflections, each integrated over 10 seconds through a 30 arcsec diaphragm, is taken as a single observation. The same amplifier sensitivity gains were used on all nights for the variable and comparison star. The observational procedure was similar to that at Catalina. Only the U-filter was used; this filter approximates the U of the UBV system (13). At Midway, XY Leo was observed on four nights in March, four nights in April and one night in May 1979. During this observation run, primary minimum was observed five times and secondary minimum four times. These additional observations, given as variable minus comparison star, along with Heliocentric Julian dates and phases are listed in Table III.

For four of the primary minima and three of the secondary minima, sufficient data were obtained to determine epoch of minimum light, using the Hertzprung (14) method as modified by Kwee and van Woerden (15).

The likely error for a single observation is estimated to be ± 0.01 mag.

TABLE I

Star	BD No.	R.A. (1975)	Dec. (1975)	SP.
XY Leonis	+ 18 ⁰ 2307	10 h 00 m 16 s	+ 17 ⁰ 31'04"	G4
Comparison star	+ 18 ⁰ 2306	10 h 00 m 02 s	+ 17 ⁰ 44'06"	--
Check star	+ 18 ⁰ 2308	10 h 00 m 21 s	+ 17 ⁰ 54'04"	--

EPOCHS OF PRIMARY AND SECONDARY MINIMA.

Including the results (11), primary and secondary minimum were each observed eight times. All times of minimum light and (O-C) values are listed in Table IV. (O-C) for primary minimum, as derived from our 1978 observations, equals $+0^d.1125$. For secondary minimum equals $+0.1094$. The large discrepancy of 0.0031 between the above (O-C) values most likely results from the fact that both values are based on only one revolution of the system.

About one month later, Koch and Shanus determined an (O-C) of $+0^d.1088$, a value being about $0^d.002$ less positive than our average (O-C) value of $+0^d.1110$.

The 1979 results indicate an average (O-C) of $+0^d.1036$ which is about $0^d.005$ less positive than Koch and Shanus' value, indicating a continuing trend of decreasing (O-C) values of the order of $\sim 0^d.004$ per 1000 revolutions. Although the above values are of approximate nature, they indicate continuing dynamic activity of the system.

The above analysis of observational data is based on Koch's (7) original ephemeris.

A more recent ephemeris (10) is:

$$\text{J.D. Hel. Min. I} = 2,435,484.0222 + 0.28410282 \text{ E.}$$

Using the above values, all (O-C) values for Min. I as listed in Table IV, were computed again and are presented in Table V.

In Figure 3 the values for (O-C) thus obtained were plotted against the "third body" (O-C) sinusoid (10).

A departure of -0.01 from the sinusoid was reported (11). Our observations confirm similar departures of a slightly lesser amplitude, ($\sim 0^d.008$). Figure 3 illustrates the earlier mentioned dynamical activity of XY Leo.

DEPTHS OF MINIMA.

The depths of primary minima in yellow, blue and ultraviolet are $0^m.43$, $0^m.47$ and $0^m.51$ respectively. For the secondary minima the values are $0^m.35$, $0^m.39$ and $0^m.51$. Due to the fact that the light curves are based on one night's observations only, the above values have, at best, an accuracy of the order of $\pm 0^m.01$. This brings them into agreement with Koch's (7) values. Koch states the depth of secondary eclipse in blue as being too great to provide agreement with his solution for yellow light. The light curve in ultraviolet appears to indicate minima of practically equal depth, indicating excess loss of light in ultraviolet at secondary minimum.

The 1979 observations (HDK) were made specifically to investigate a possible tendency toward equality of depths of minima with decreasing wavelength. These observations are listed in Table III. The phases were calculated from the following ephemeris:

$$\text{J.D. Hel. Min. I} = 2,443,957.9754 + 0.2841091 \text{ E.}$$

All light curve points between phases 0.85 and 0.15 (Min. I) and 0.35 and 0.65 (Min. II) are shown in Fig. 2. The noise envelope for both minima is approximately 0.1 deep. The observations could indicate equal depths of minima in ultraviolet light. Secondary minimum appears slightly wider than primary minimum. No attempt will be made to explain the above, other than to state that Koch (7) mentioned the possibility of an extensive luminous shell enveloping the eclipsing pair.

Lack of observational data prohibits the study of possible widening of minima with decreasing wavelength.

It is doubtful, however, whether the equality of minima in UV can be attributed entirely to observational noise. The possibility of the presence of an extended atmosphere may as yet prove to be worthwhile investigating.

ACKNOWLEDGEMENTS.

One of us, (HDK) wishes to express his appreciation to Dr. G.V. Coyne, Director, Catalina Observatory, for the allotment of time of the 101 cm telescope; to Dr. W.K. Wisniewski, Lunar and Planetary Laboratory, University of Arizona, for his valuable assistance with regard to the reduction of the observations, and to Dr. T. Gehrels, University of Arizona.

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XY Leo. (O-C) Min. I computed for ephemeris (10)

TABLE V.

Min.	Color	Obs.	(O) 2,443,000+	(C) 2,443,000+	(O-C)	E
I	V	K/W	543.7533	543.7351	+ 0.0182	28,369
I	V	K/S	572.7288	572.7136	+ 0.0152	28,471
I	U	K	957.9749	957.9570	+ 0.0179	29,827
I	U	K	959.9649	959.9457	+ 0.0192	29,834
I	U	K	982.9761	982.9581	+ 0.0180	29,915
I	U	K	984.9672	984.9468	+ 0.0204	29,922

J.D. Hel. 2,443,543+	Phase	Δm_V	J.D. Hel. 2,443,543+	Phase	Δm_B
.7194	0.277	-0.004	.7180	0.272	-0.304
.7235	0.291	-0.075	.7261	0.300	-0.382
.7356	0.334	-0.182	.7343	0.329	-0.501
.7498	0.384	-0.293	.7484	0.374	-0.653
.7588	0.416	-0.250	.7572	0.410	-0.607
.7668	0.444	-0.176	.7651	0.438	-0.543
.7892	0.523	+0.004	.7877	0.517	-0.325
.7983	0.555	+0.059	.7969	0.550	-0.249
.8045	0.576	+0.084	.8032	0.572	-0.244
.8097	0.595	+0.106	.8084	0.590	-0.208
.8201	0.631	+0.131	.8188	0.627	-0.186
.8251	0.649	+0.123	.8238	0.644	-0.189
.8301	0.666	+0.124	.8288	0.662	-0.186
.8349	0.683	+0.110	.8337	0.679	-0.210
.8481	0.730	+0.063	.8462	0.723	-0.240
.8548	0.753	+0.027	.8533	0.748	-0.290
.8623	0.780	-0.014	.8608	0.775	-0.331
.8804	0.844	-0.118	.8755	0.826	-0.443
.8856	0.863	-0.206	.8842	0.857	-0.550
.8919	0.884	-0.217	.8905	0.879	-0.551
.9083	0.942	-0.127	.9069	0.937	-0.477
.9163	0.970	-0.065	.9143	0.903	-0.429
.9307	0.021	+0.048	.9294	0.998	-0.283
.9367	0.040	+0.079	.9348	0.035	-0.254
.9415	0.059	+0.095	.9402	0.054	-0.222
.9465	0.076	+0.107	.9452	0.072	-0.211
.9580	0.117	+0.131	.9563	0.111	-0.183
.9633	0.135	+0.126	.9620	0.131	-0.178
.9710	0.162	+0.132	.9691	0.156	-0.181
.9855	0.213	+0.088	.9838	0.267	-0.214
.9911	0.233	+0.071	.9897	0.228	-0.232
.9968	0.253	+0.032	.9949	0.247	-0.320

TABLE II (continued)

J.D. Hel. 2,443,543+	Phase	Δm_U	J.D. Hel. 2,443,543+	Phase	Δm_U
.7209	0.282	-0.741	.8570	0.761	-0.757
.7297	0.313	-0.824	.8640	0.786	-0.802
.7373	0.340	-0.958	.8802	0.843	-0.979
.7515	0.390	-1.089	.8936	0.890	-1.100
.7605	0.422	-0.998	.9108	0.951	-0.915
.7688	0.451	-0.882	.9324	0.027	-0.657
.7909	0.529	-0.686	.9379	0.046	-0.644
.7999	0.560	-0.647	.9430	0.064	-0.676
.8058	0.581	-0.600	.9480	0.081	-0.641
.8110	0.599	-0.591	.9594	0.122	-0.589
.8215	0.636	-0.592	.9651	0.142	-0.564
.8265	0.654	-0.581	.9726	0.168	-0.593
.8315	0.671	-0.600	.9869	0.218	-0.606
.8363	0.688	-0.641	.9926	0.238	-0.630
.8498	0.736	-0.703	.9981	0.258	-0.679

TABLE III

XY Leo. Observations at Midway Observatory in 1979

J.D. Hel. 2,443,900+	Phase	Δm_U	J.D. Hel. 2,443,900+	Phase	Δm_U
57.9550	0.9282	0.7878	59.9639	0.9991	1.0632
.9583	0.9398	0.8839	.9677	0.0124	1.0740
.9612	0.9500	0.9296	.9713	0.0251	1.0514
.9635	0.9581	0.9797	.9753	0.0392	1.0119
.9659	0.9666	1.0290	.9790	0.0522	0.9250
.9702	0.9817	1.0896	.9824	0.0642	0.8653
.9777	0.0081	1.0443	.9857	0.0758	0.8137
.9810	0.0197	1.0205	.9894	0.0888	0.7560
.9870	0.0408	0.9518	60.0025	0.1349	0.6375
.9911	0.0553	0.9038	.9317	0.4055	0.7760
.9945	0.0672	0.8335	.9358	0.4199	0.7972
58.0087	0.1172	0.6667	.9382	0.4284	0.8088
.9558	0.4508	0.9520	.9453	0.4534	1.0278
.9583	0.4596	0.9680	.9489	0.4660	1.0655
.9607	0.4680	1.0231	.9520	0.4770	1.1025
.9636	0.4782	1.0432	.9555	0.4893	1.1080
.9663	0.4877	1.0381	.9587	0.5005	1.1034
.9693	0.4983	1.0108	.9622	0.5129	1.0897
.9735	0.5131	1.0150	.9658	0.5255	1.0686
.9774	0.5268	0.9743	.9693	0.5379	1.0199
.9849	0.5532	0.9148	.9737	0.5533	0.9605
.9903	0.5722	0.8403	.9770	0.5650	0.8842
59.0032	0.6176	0.7543	.9812	0.5797	0.8142
.9380	0.9079	0.6706	.9956	0.6304	0.7349
.9403	0.9160	0.7231	61.0052	0.6642	0.5341
.9443	0.9301	0.8057	82.9487	0.9004	0.7620
.9472	0.9403	0.8843	.9520	0.9120	0.8023
.9553	0.9688	1.0068	.9594	0.9380	0.8946
.9578	0.9776	1.0661	.9642	0.9549	0.9205
.9606	0.9875	1.0542	.9667	0.9637	0.9562

TABLE III (continued)

J.D. Hel. 2,443,900+	Phase	Δm_U	J.D. Hel. 2,443,900+	Phase	Δm_U
82.9760	0.9965	1.0596	84.9977	0.1124	0.7683
.9797	0.0095	1.0644	86.9506	0.9862	1.0325
.9819	0.0172	1.0426	.9521	0.9915	1.0445
.9858	0.0310	0.9949	.9575	0.0105	1.0816
.9905	0.0475	0.8954	.9596	0.0179	1.0514
.9944	0.0612	0.8253	87.9346	0.4496	0.8561
.9985	0.0757	0.8100	.9367	0.4570	0.9002
83.0064	0.1035	0.7197	.9386	0.4637	0.9199
.0081	0.1095	0.7074	.9420	0.4757	0.9380
.0108	0.1190	0.7017	.9454	0.4876	0.9558
.0131	0.1271	0.6940	.9470	0.4933	0.9631
84.9328	0.8840	0.6675	.9488	0.4996	0.9892
.9345	0.8900	0.6962	.9522	0.5116	1.0064
.9365	0.8970	0.7273	.9536	0.5165	0.9758
.9489	0.9406	0.8740	.9574	0.5299	0.9672
.9505	0.9463	0.9061	.9591	0.5359	0.9271
.9532	0.9558	0.9287	.9606	0.5411	0.9186
.9608	0.9825	1.0046	.9669	0.5633	0.8521
.9626	0.9889	1.0010	.9707	0.5767	0.8489
.9645	0.9955	1.0082	.9749	0.5915	0.8133
.9673	0.0054	1.0019	.9768	0.5982	0.8202
.9693	0.0124	0.9957	95.9080	0.5142	1.0291
.9710	0.0184	0.9904	.9096	0.5198	1.0222
.9731	0.0258	0.9940	.9110	0.5400	1.0223
.9758	0.0353	0.9975	.9189	0.5526	0.9389
.9778	0.0424	0.9814	.9217	0.5624	0.9091
.9797	0.0490	0.9696	.9298	0.5909	0.8288
.9889	0.0814	0.8348	.9314	0.5966	0.8033
.9926	0.0945	0.7719	.9340	0.6057	0.7778
.9946	0.1015	0.7700	.9435	0.6392	0.7526

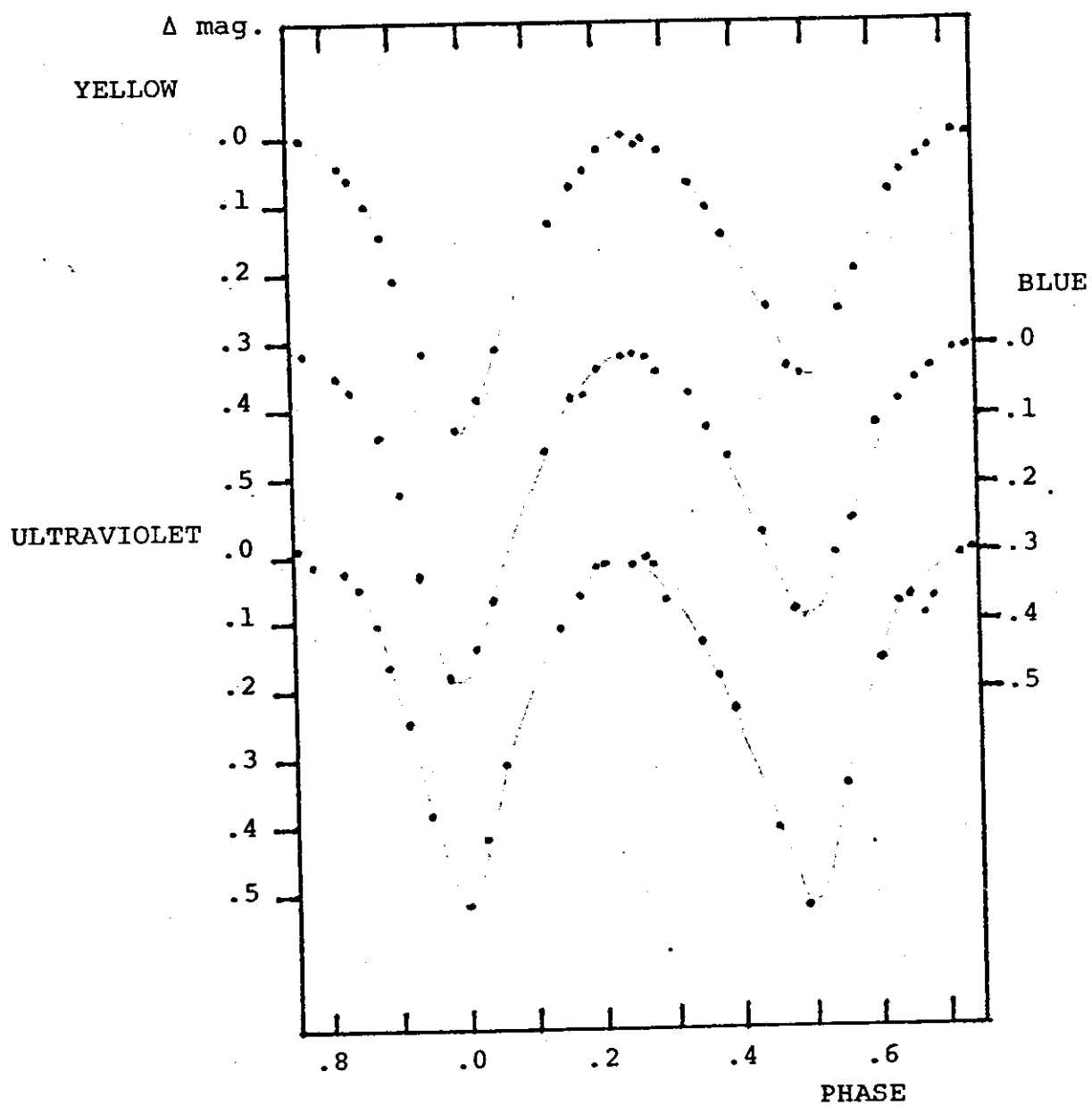
TABLE IV
XY Leo-----Observed Minima

Min.	Color	Obs.	(O) 2,443,000+	(C) 2,443,000+	(O-C)	E
I	V	K/W	543.7533	543.6407	+ 0.1126	29,383
I	B	K/W	543.7532	543.6407	+ 0.1125	29,383
I	U	K/W	543.7531	543.6407	+ 0.1124	29,383
II	V	K/W	543.8922	543.7828	+ 0.1094	29,383
II	B	K/W	543.8921	543.7828	+ 0.1093	29,383
II	U	K/W	543.8923	543.7828	+ 0.1095	29,383
II	V	K/S	567.7564	567.6480	+ 0.1084	29,467
					+ 0.1088	
I	V	K/S	572.7288	572.6199	+ 0.1089	29,485
II	V	K/S	612.6462	612.5372	+ 0.1090	29,625
I	U	K	957.9749	957.8718	+ 0.1031	30,841
II	U	K	958.9684	958.8662	+ 0.1022	30,844
					+ 0.1036	
I	U	K	959.9649	959.8606	+ 0.1043	30,848
II	U	K	960.9588	960.8550	+ 0.1038	30,851
I	U	K	982.9761	982.8734	+ 0.1027	30,929
I	U	K	984.9672	984.8622	+ 0.1050	30,936
II	U	K	987.9494	987.8453	+ 0.1041	30,946

K/W Kennedy & Wisniewski

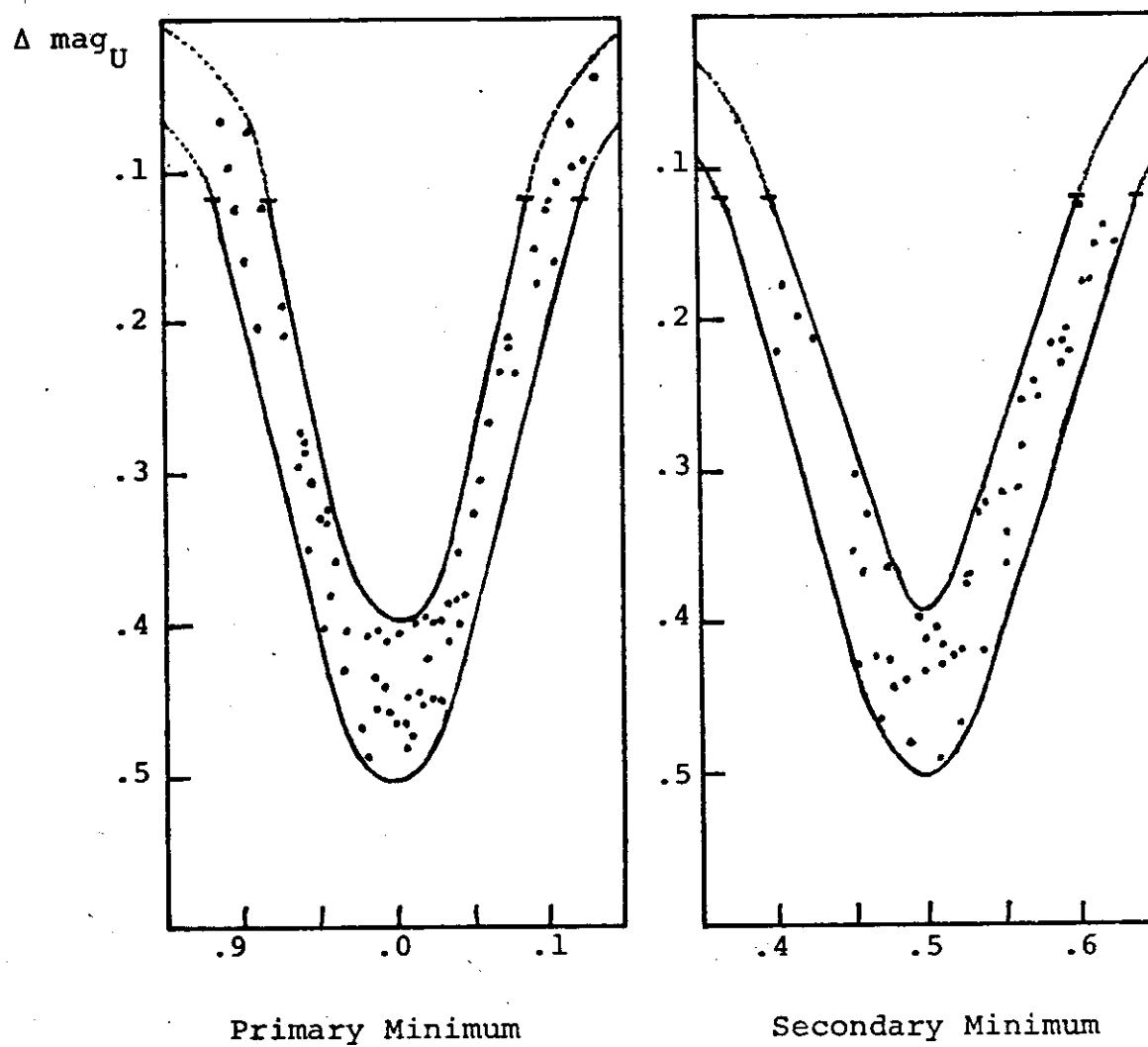
K/S Koch & Shanus

K Kennedy



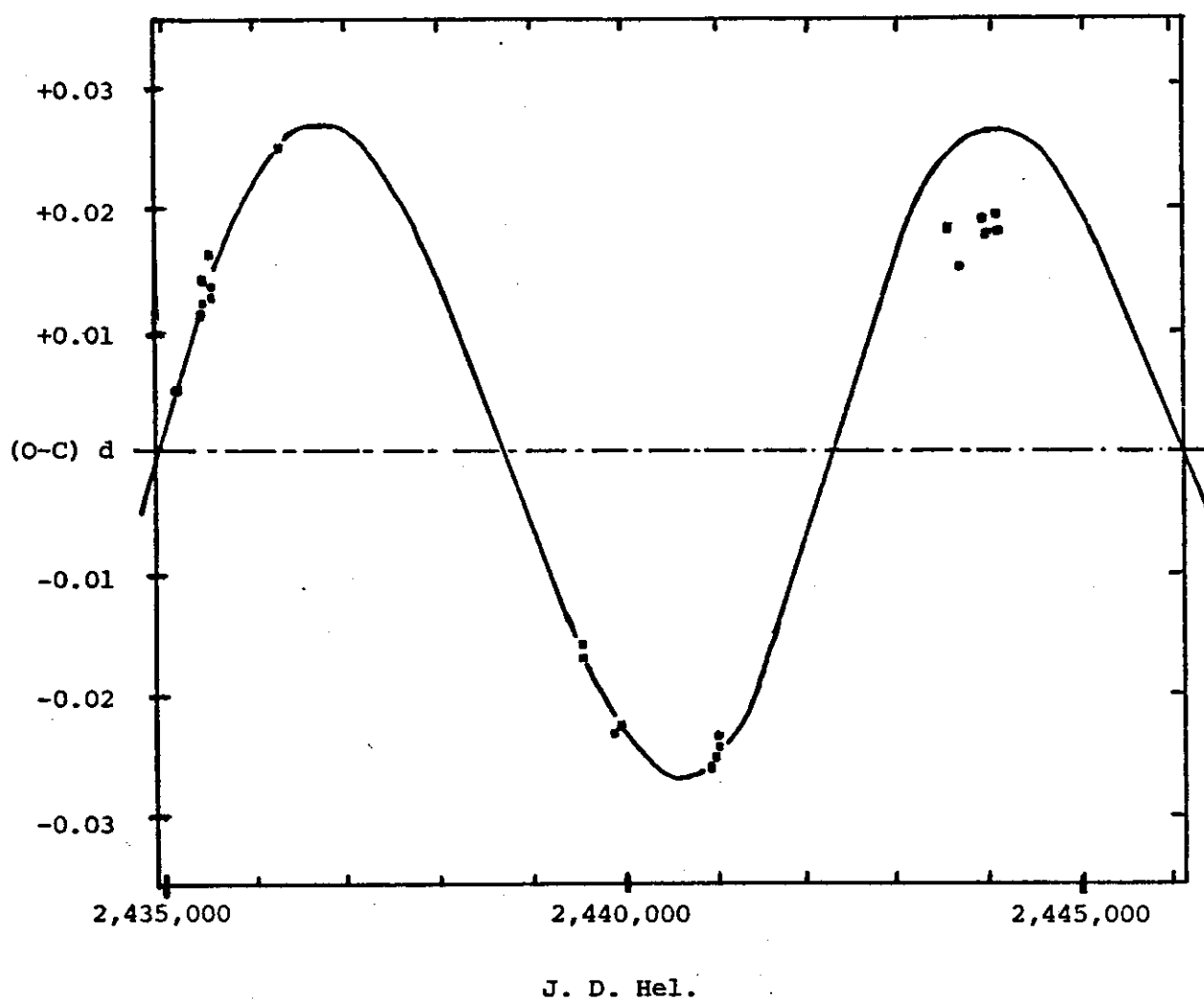
THE LIGHT CURVES OF XY LEONIS

Fig. 1



THE MINIMA OF XY LEONIS

Fig. 2



(O-C) VALUES, XY LEONIS

Fig. 3

THE STUDY OF SOUTHERN CEPHEID VARIABLES. II

Mati Morel
Variable Star Section, R.A.S.N.Z.

SUMMARY: Comparison sequences in V are presented for eight variables of the Delta Cep type, namely RZ Vel, SV Vel, SW Vel, VY Car, WZ Car, XZ Car, FR Car and SY Nor, all of which are suited to the Classical Cepheid Programme (1). Each star is provided with a chart, showing a wide range of comparison stars compiled from data in the UBV system published by other authors.

...

INTRODUCTION

Morel (2) described some preliminary observations of U Car, and indicated how a sequence of reliable photoelectric magnitudes in the UBV system could be constructed by a search of the literature. This has now been extended to the stars listed in Table 1. The charts with this paper give the usual information for each star.

GENERAL NOTES ON THE PROGRAMME STARS.

083343 RZ Vel. Chart 552. This star has the brightest mean magnitude of the eight stars. The field overlaps, and is due north of Chart 366 (3).

084047 SW Vel. Chart 553. Also shown on chart 366 (3). Chart 553 is on the enlarged scale of $20''=1\text{mm}$, allowing additional comparison stars to be inserted.

104055 SV Vel & 104057^{VY Car} Chart 554. These two stars lie in a field that has been extensively measured by UBV photometry, but, alas, the immediate vicinities of the variables are inadequately served. It has been necessary to include some Cape photovisual magnitudes from the SAO Catalogue. These are on the International System, and have been underlined to identify them.

105160 WZ Car. Chart 555. This star is shown on Chart 452 (4). The new chart shows the immediate surroundings in greater detail, with additional comparison stars.

110060 XZ Car. Chart 556. Same remarks as for WZ Car.

111059 FR Car. Chart 557. The range in V of this star is rather small, compared with the others, and the period is at the short end of the scale. It does, however, have a good range of comparison stars.

154654 SY Nor. Chart 558. Same remarks as for FR Car.

CONCLUSIONS

The above variables are all suited to regular observation by visual observers with smaller telescopes, or binoculars. Observations should be forwarded to Headquarters monthly, as is done for other variables. At the end of the observing season for each star, all observations of that star should also be sent to the Section's Cepheid Recorder, T.A. Cragg, C/o Anglo-Australian Observatory, Private Bag No. 4, Coonabarabran, N.S.W. 2857, Australia.

REFERENCES

- (1) Cragg, Thomas A., 1971. Circ. 179, V.S.S., R.A.S.N.Z.
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- (3) Bateson, F.M., Morel, M. & Winnett, R. 1977. "Charts for Southern Variables" Series 9. Published by F.M. Bateson, Tauranga, N.Z.
- (4) Bateson, F.M., Morel, M., Summer, B. & Winnett, R. 1979. "Charts for Southern Variables" Series 11. Publ. by F.M. Bateson, Tauranga, N.Z.

TABLE 1.

SOURCE OF MAGNITUDES FOR COMPARISON STARS FOR EIGHT CEPHEIDS.

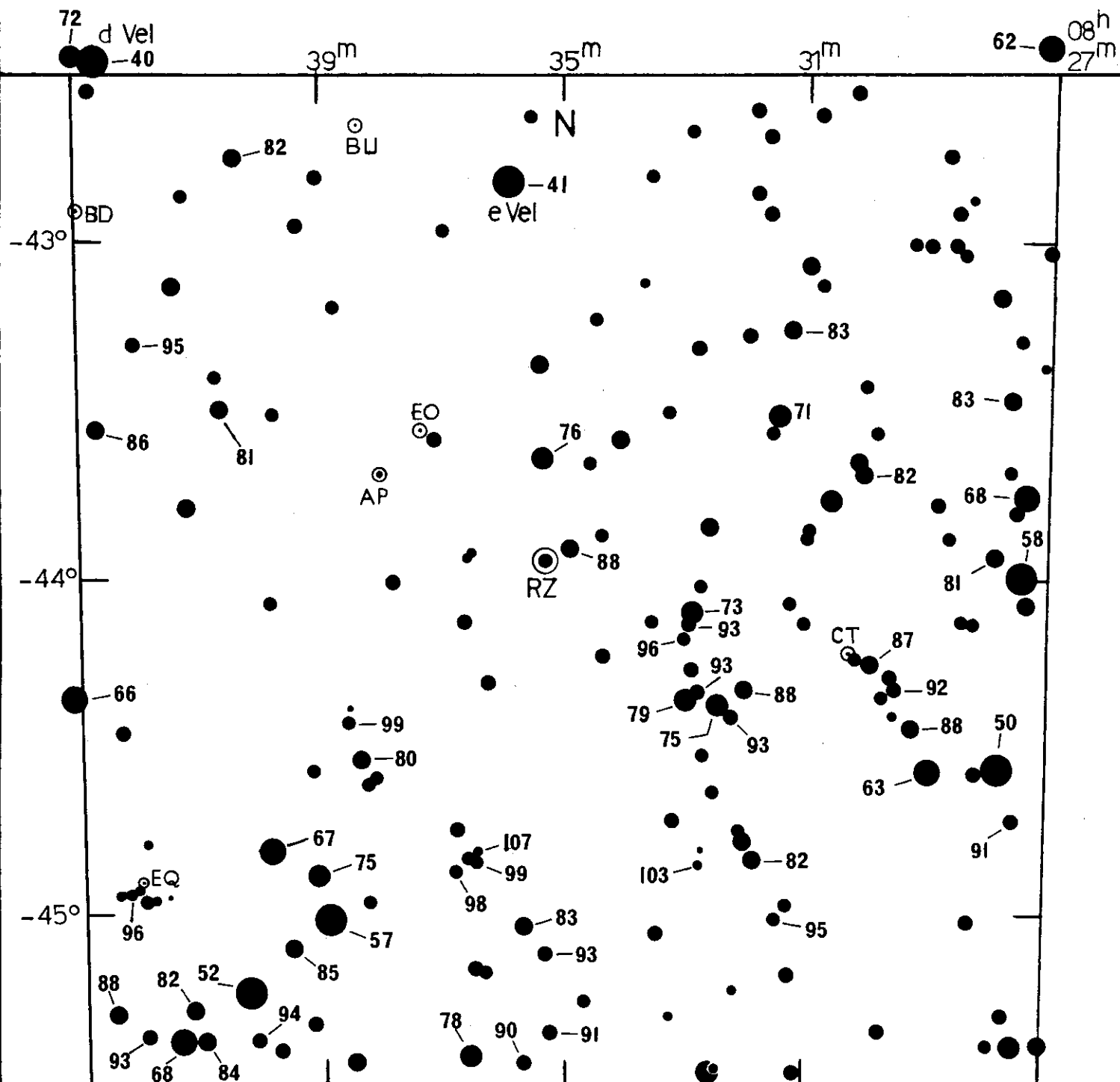
<u>STAR</u>	<u>REFERENCES FOR MAGNITUDES.</u>
083343 RZ Vel	2, 3, 5, 8, 11, 12, 15, 17, 20, 23.
084047 SW Vel	5, 12, 18, 23.
104055 SV Vel	(3, 5, 9, 10, 13, 15, 16, 18, 21, 23 + SAO.
104057 VY Car	(24
105160 WZ Car	2, 3, 5, 16, 25.
110060 XZ Car	3, 5, 13, 15, 16, 23, 25.
111059 FR Car	1, 3, 4, 5, 8, 9, 13, 15, 16, 19, 21.
154654 SY Nor	1, 2, 3, 6, 7, 14, 15, 16, 22, 23.

REFERENCES TO TABLE 1.

1. Bok, B.J. & Bok, P. 1969. Astr. J., 74, 1125.
2. Bok, B.J., Bok, P. & Miller, E.W. 1972. Astr. J. 77, 733.
- 3/ Buscombe, W. 1977. "MK Spectral Classifications" 3rd General Cat., Northwestern Univ., Evanston.
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6. Drilling, J.S. 1968. Astr. J. 73, 590..
- 7/ Drilling, J.S. 1972. Astr. J. 77, 463.
8. Feast, M.W. et al. 1961. Mon. Not. R. astr. Soc. 122, 239.
9. Feinstein, A. 1969. Mon. Not. R. astr. Soc. 143, 273.
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11. Goy, J. 1973. Astr. Astrophys. Suppl. 12, 277.
12. Guenier, S. 1974. Astr. Astrophys. Suppl. 16, 269.
13. Humphries, R.M. 1973. Astr. Astrophys. Suppl. 9, 85.
14. Humphries, R.M. 1974. Astr. Astrophys. Suppl. 19, 243.
15. Humphries, R.M. 1978. Astrophys. J. Suppl. 38, 309.
16. Kennedy, P.M., & Buscombe, W. 1974. "MK Spectral Classifications since Jaschek's La Plata Catalogue". Northwestern Univ., Evanston.
17. Lesh, J.R. 1971. Astr. Astrophys. Suppl. 5, 129
18. Mermilliod, J.C. 1976. Astr. Astrophys. Suppl. 24, 159 (NGC 3293)
19. Miller, E.W. 1972. Astr. J. 77, 216.
20. Moffat, A.F.J. & Vogt, N. 1975. Astr. Astrophys. Suppl. 20, 85.
21. Moffat, A.F.J. & Vogt, N. 1975. Astr. Astrophys. Suppl. 20, 125.
22. Muzzio, J.C. & McCarthy, C.C. 1973. Astr. J. 78, 924.
23. Nicolat, B. 1978. "Catalogue of Homogeneous Data in UBV Photoelectric Photometry", Centre de Donnees Stellaires, Strasbourg.
24. Van den Bergh, S. & Herbst, W. 1975. Astr. J. 80, 212.
25. Wramdemark, S. 1975. Astr. Astrophys. Suppl. 23, 231.

Cf. 6.44 - 7.64 V. 20^d 3969. G8.

SCALE: 60" = 1mm



FMB 1.7.80

EPOCH; 1950

553

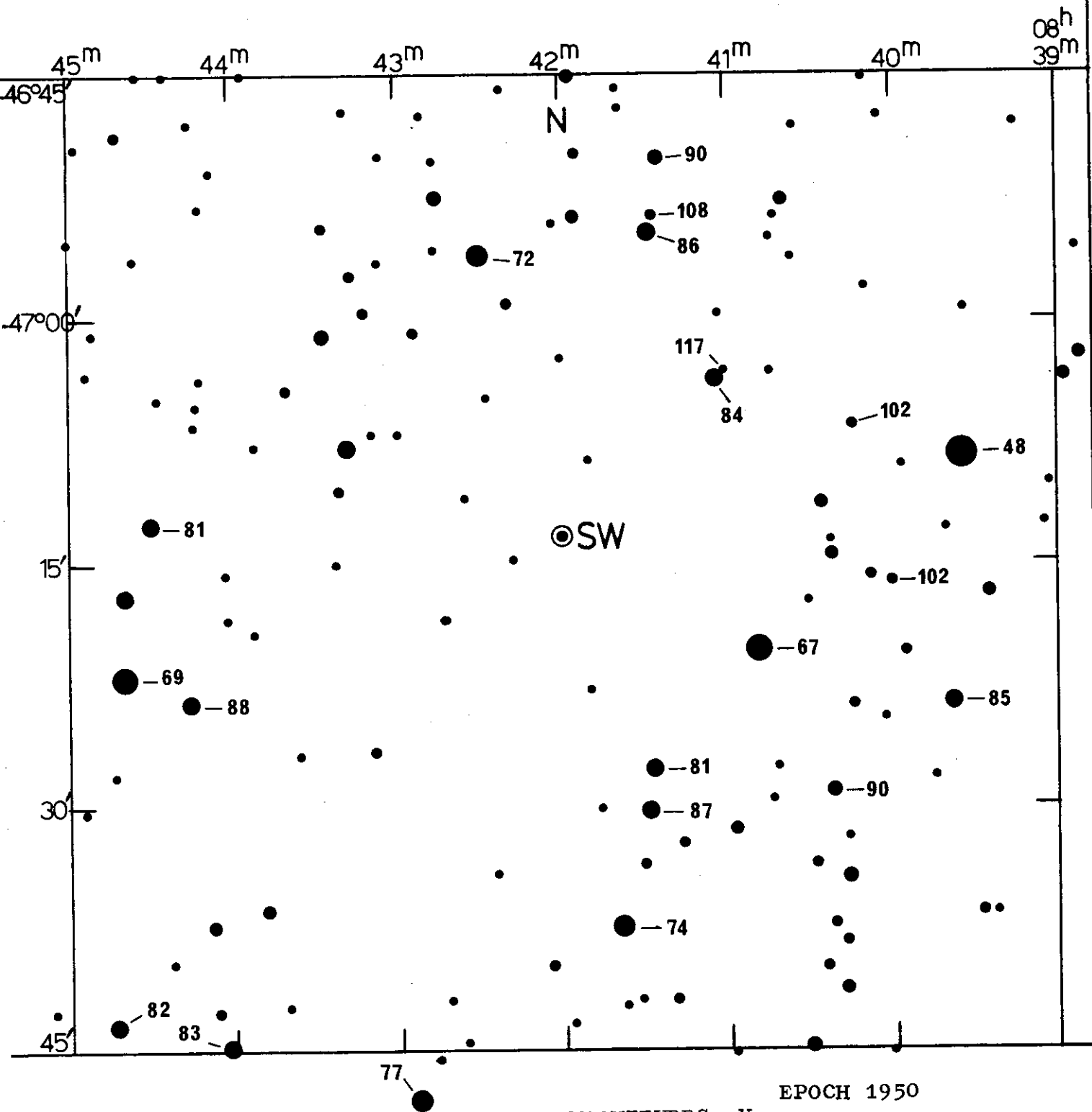
084047 SW VELORUM

(1950): 08h 42m 00s -47° 13.3'

(2000): 08 43 38 -47 24.0

C δ . 7.44 - 8.96V 23.^d4744. K2.

SCALE: 20" = 1mm



MAGNITUDES: V.

F.M.B. 1.7.80

Plotted by M.M. from SAO & CoD.

SCALE: 20" = 1mm



110060 XZ CARINAE

(1950): 11h 02m 09s -60° 42.6'

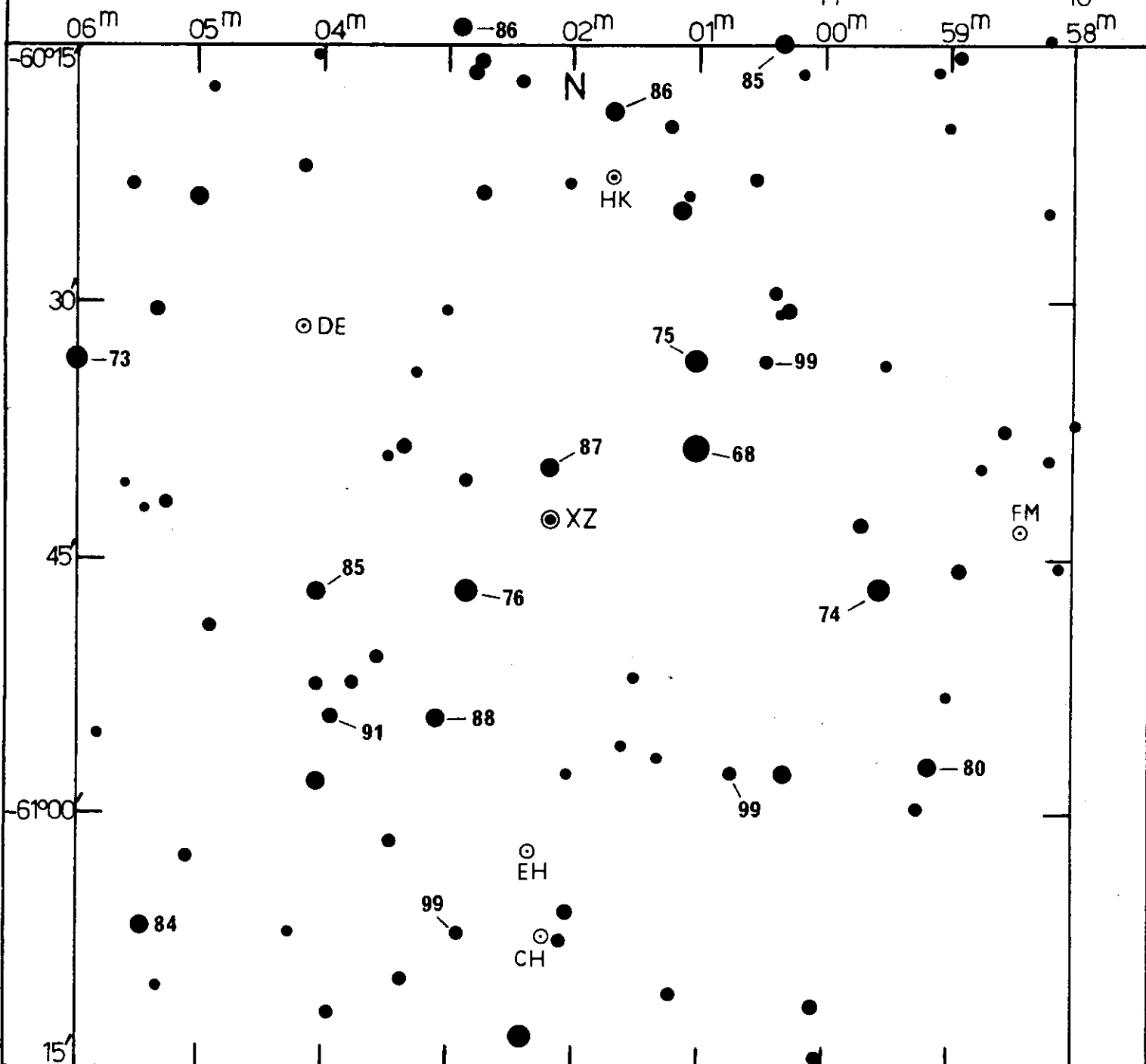
(2000): 11 04 12 -60 58.7

C δ . 8.05 - 9.13V. 16.64^d99. K5.

ALSO SHOWN:

CH; DE; EH; FM; HK Car.

SCALE: 20" = 1mm

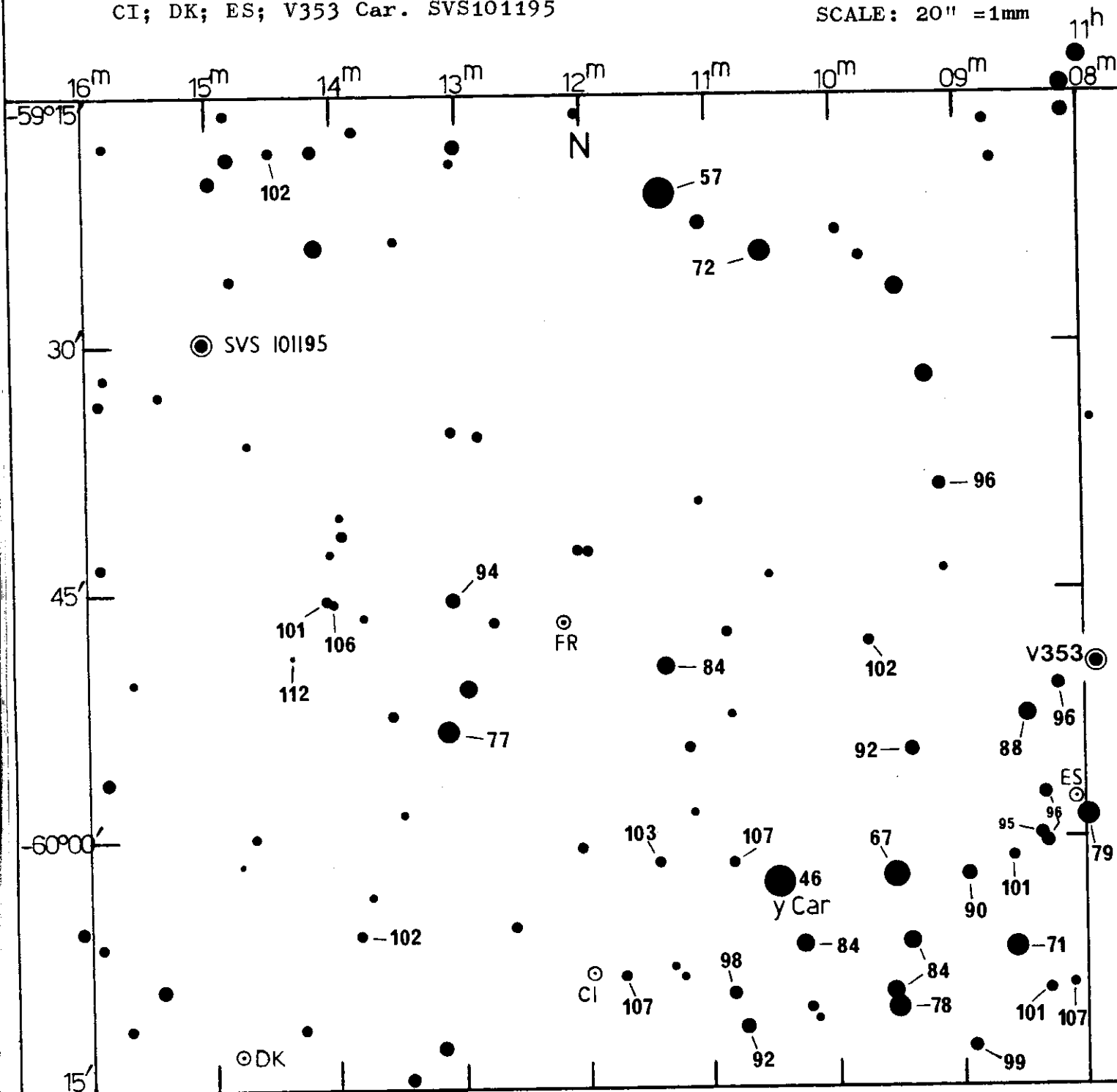


Plotted by M.M. from SAO & CoD.
MAGNITUDES: V.

EPOCH: 1950
F.M.B. 1.7.00

$$C_d^r = 9.35 - 10.04V. 10^{d.7173} \text{ G5.}$$

SCALE: 20'' = 1mm



F.M.B. 1.7.80

558

154654 SY NORMAE

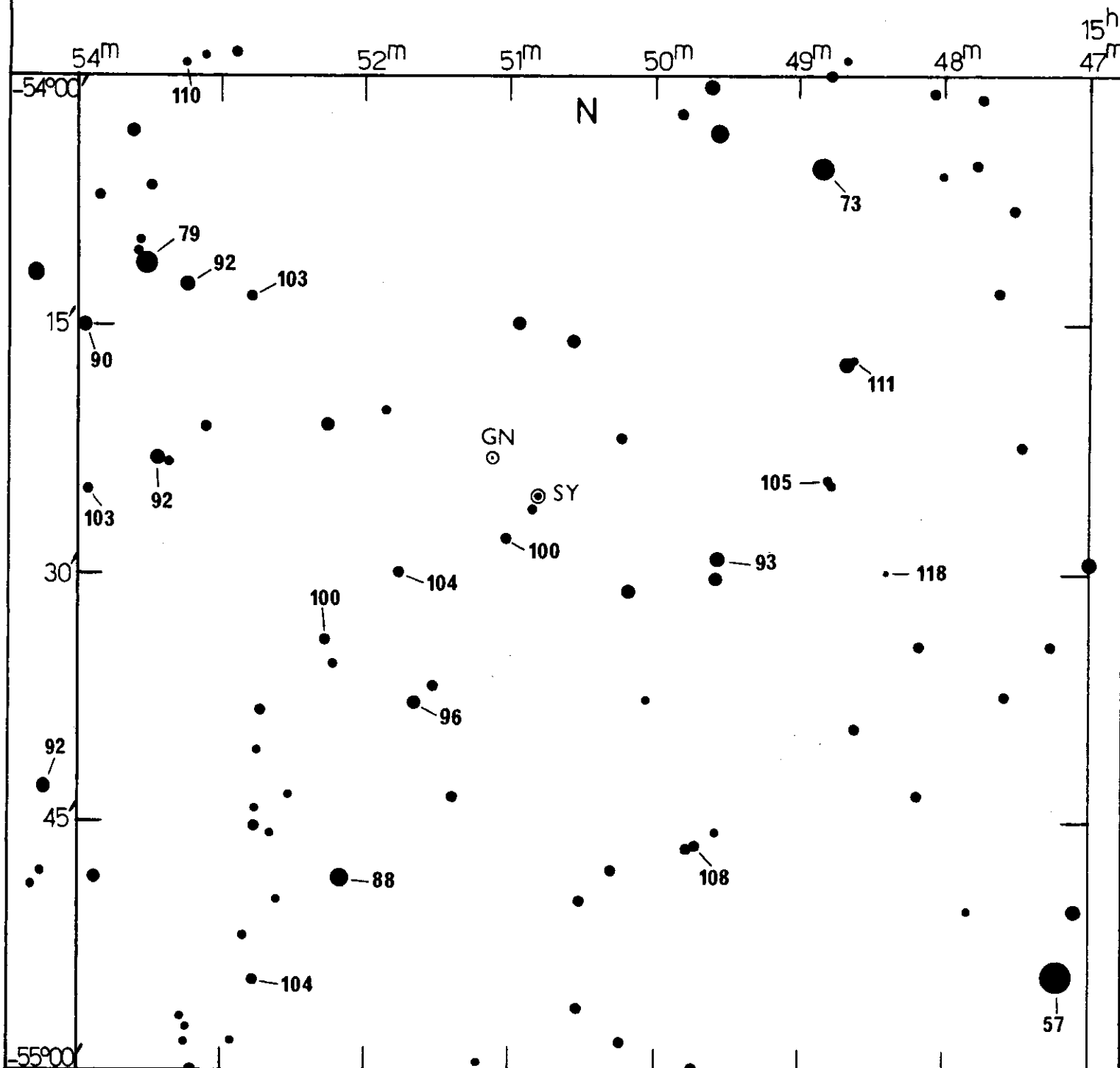
(1950): 15h 50m 49s -54° 25.3

(2000): 15 54 40 -54 34.4

C_D. 8.96 - 9.88V. 12.^d6452.

ALSO SHOWN: GN Nor.

SCALE: 20" = 1mm



Plotted by M.M. from SAO & CoD.
MAGNITUDES: V

EPOCH: 1950
F.M.B. 1. 7.80

A PHOTOELECTRIC PHOTOMETER FOR SMALL TELESCOPES

W.H. Allen

Beverly Begg Observatory, Dunedin, N.Z.

SUMMARY: The requirements for a photoelectric photometer suitable for use with small telescopes are discussed. Details of the design for such an instrument are given together with a summary of its operation and use.

...

INTRODUCTION:

I have for many years been involved with photoelectric photometry at the Beverly Begg Observatory, in Dunedin, New Zealand, where we have a 30 cm Cassegrain telescope, automated photoelectric photometer and a high speed data logging system. I have felt, however, that there is a real need to develop a compact and portable photometer that could be fitted to a small telescope to enable useful photoelectric work to be done at small observatories or in the backyard at home.

Having just purchased a Celestron 8 telescope, I decided to use this instrument as a basis from which to start the design parameters for the photometer.

The following design parameters were adopted:

- (i) The photometer head had to be small enough to pass between the forks giving access to the polar regions. (A friend of mine once remarked, that it is no use having the most southerly photoelectric system in the world without being able to observe the southern polar sky!).
- (ii) The diaphragm size is to be chosen within the limits of the tracking accuracy of the C8 siderial drive.
- (iii) To minimise the disturbance to the telescope once set up on a star, to automate the filter wheel, and data read out system.
- (iv) To mount in the photometer head, all the necessary control and data output electronics. This will reduce the number of auxillary cables between the photometer head and the output instrumentation.

OPTICAL AND MECHANICAL DESIGN.

To meet the design criteria detailed in (i) the photometer head has to be very compact. To achieve this the photometer has a 90°, two axis, flip mirror, which eliminates the need for the two flip mirrors in a conventional photometer head, and a drum filter wheel on which are mounted the Johnson U, B and V filters.

The shell of the photometer head, shown in Fig. 1, is constructed from aluminium rectangular hollow section. The various sections are fabricated with aluminium flanges and can be bolted together in three sections.

Light from the telescope passes into the photometer head as shown and strikes a movable aluminised glass mirror. (This and the other optical components were obtained from the Edmund Scientific Company). The mirror is mounted on a machined brass holder, that can move the mirror in two directions. In the first position it directs the light past the illuminated crosshairs and into the wide angle 18 mm Erfle eyepiece, and in the other position, 180° away, into the photoelectric measuring section.

The mirror is so arranged to rotate through 90° , the plane of rotation being parallel and on the aluminium surface.

This allows the optical axis to be axial in both directions which simplifies the setting up of the instrument. The adjusting screws shown enable precise optical alignment.

The flip mirror section of the instrument is made symmetrical to enable the telescope focal plane to be either placed at the crosshairs or on the diaphragm plate. This enables the crosshairs to be set up in a position which exactly represents the position of the diaphragm, and reduces the need for a second diaphragm viewing telescope used in conventional photometer heads.

The tracking accuracy of any small telescope with mass produced siderial gears is limited for long duration photometric observations because of the difficulty of keeping the star in the diaphragm. For the Celestron 8 telescope I have found from experiment that the minimum size of diaphragm is 80 seconds of arc. This enables a three colour observation to be made without the star moving out of the diaphragm.

After the light passes through the diaphragm it passes through a fabry lens. The purpose of this lens is to image the spot of light on the photomultiplier photocathode in such a way that movement of the star image does not cause a varying output from the photomultiplier due to varying sensitivities of the photocathode surface. The star light evenly illuminates the telescope objective which is imaged by the fabry lens as a spot of light on the photocathode. Since the telescope objective, fabry lens and photocathode are fixed relatively in the photometer head, any movement of the star image in the focal plane will not cause the spot of light on the photocathode to move. The dimensions and focal length of the fabry lens were chosen from the formula described in an article in Sky & Telescope by John Africano and Robert Quigley (Vol. 54, No.1, July 1977, page 60) a full description of the operation of a fabry lens is given in this reference.

The parallel light now passes through the Johnson U, B or V filter which are mounted on the inside circumference of the drum. The drum is driven by a 12 V geared electric motor and is automatically stopped at each filter position by a microswitch which opens the 12 V supply to the motor. A d.c. motor will run on after its supply is removed, which, would in turn, not place the filter in the centre of the light beam. It is essential that the light passes through the filter in the same place each time to ensure a consistency in measurements due to small variations in filter transparency. To stop this overshoot regenerative braking is used which stops the d.c. motor instantly.

The drum filter wheel is controlled remotely from a hand held control unit shown in the photographs. The crosshairs are illuminated by a red light emitting diode, which is adjusted in brightness also from the hand held control unit.

The drum filter wheel is moved by a geared d.c. motor, the gearing of which is chosen to give a two second filter change period for each of the four positions. However, due to the design of the drum filter, which requires twice as many holes as filter positions, it takes eight seconds to reset the start of the sequence, (no filter, V, B and U filters). This delay is not a problem as it provides a method of indexing the drum thus enabling the observer to know exactly which filter is being used at the start at each cycle. It also eliminates the need for expensive read out systems to show the filter position as all one has to do is listen for the long run of the motor which when stopped indicates the start of the sequence. With practice the observer gets readily tuned to this 8 second motor run.

ELECTRICAL DESIGN

The filter drum is driven by a 12 V d.c. geared electric motor and stopped at any one position by a microswitch opening at each filter position. To prevent overshoot of the motor, a regenerative braking resistor is switched by the microswitch across the motor terminals (see Fig. 2). Shorting the motor terminals would have achieved more effective braking but this did not allow re-starting the motor without physically opening the microswitch contacts. This was impractical and did not meet the objective of remote operation. A compromise was reached, and a resistor was chosen which provided reasonable braking, and at the same time set up enough voltage across the motor to slowly turn it when the microswitch contacts were by passed. Once the microswitch was opened by the motor, the motor was driven at full voltage and hence speed until the next filter position when the microswitch was again opened, and the motor stopped. This system works well once set up, and accurately positions the filter in the optical axis of the photometer head.

Light from the star falls on to the photocathode of the photomultiplier after passing through the fabry lens and filter. The photons of light after striking the photocathode cause emission of electrons direct proportion to the incident photons.

These electrons are accelerated and strike a series of dynodes in the tube causing the cascade emission of secondary electrons which are in turn collected by the anode and measured as a very weak electric current.

This electric current is also directly proportional to the number of incident photons from the star, and when measured is a direct measurement of the brightness. The light from the star is converted by the telescope and photometric measuring system to an intensity measurement.

There are many ways of amplifying the very weak anode current from the photomultiplier to get a direct measurement on either an instrument or chart recorder.

I have chosen to convert this current into a frequency directly proportional to the anode current which is then directly measured on a frequency counter. The pulses are measured for a period, typically 10 seconds, and recorded as an intensity measurement. A full description of the operation of this current to frequency converter is given in Appendix 1.

SETTING UP THE INSTRUMENT

Because no diaphragm inspection eyepiece is used in this instrument, it has to be accurately aligned so that when a star is positioned on the crosshairs of the field eyepiece it will also be positioned in the centre of the diaphragm when the mirror is flipped over to the other position.

This was done in two stages, by the use of the flip mirror adjustment screws. Firstly the photomultiplier tube was removed and the optical axis aligned by viewing the spot of light through a hole in the end of the housing. The spot of light is moved by adjusting the flip mirror position so that the optical and mechanical axes were axial. This aligned the optical axis in one plane and to align it in the other plane the photomultiplier tube was moved in or out. This latter alignment does not need to be as precise because of the rectangular photocathode in the EMI 9660A tube used in this instrument.

At this stage of the process one can physically measure the spot size by direct measurement using a transparent viewing screen. Ideally the size of this spot should be about 75% of the photocathode size to prevent the spot from partially missing the photocathode. If this happens the sensitivity of the photoelectric measuring system will reduce due to lost photons.

Adjustment of the optical axis in the other direction is made by setting a star in the diaphragm, and adjusting the flip mirror to centre the star on the crosshairs. Again the star can only be positioned in one plane by this method and movement of the crosshairs in the other plane enabled the star to be centered on both crosshairs. In practice it has been found that once the instrument is set up it is very easy to position the star in the diaphragm without actually viewing it.

OPERATION.

The object to be measured is first located in the field eyepiece and moved into the centre of the crosshairs. The flip mirror is then rotated through 90° and the star will now be in the centre of the diaphragm, and the photoelectric observation can now commence. However, if one wishes to check this, it can be done remotely by moving the telescope right ascension and declination slow motions and observing the change in output on the frequency counter.

This is best done by setting the frequency counter sampling time to a one second period. When the star moves out of or near the edge of the diaphragm there will be a sharp drop off in counts. With experience one can accurately position the star in the centre of the diaphragm without viewing it. If there are verniers on the right ascension and declination circles then direct positioning can be made by reference to the vernier positions.

When filter wheel position is remotely changed, it will be indexed in a regular manner (no filter, V, B and U filters). An observation sheet can be drawn up to record the observations, and an example of this is shown in Fig. 3.

It is essential to keep accurate records of the photoelectric observations, as this type of observing produces a lot of raw data. One should note down the name of the object being observed, the time, the sky conditions, the phase of the Moon and the photometric counts for the sky, comparison and star, in each of the three Johnson columns. It is essential to do this in a logical way, if these results are to be analysed correctly later.

REDUCTION

Light from the star is converted by the telescope, and photoelectric measuring system to an intensity measurement. This intensity measurement is recorded on the frequency counter as an accumulated number of counts over a ten second integration period. This measurement is directly related to the intensity of the star, and can be converted to a stellar magnitude directly, or differentially by comparison with a standard star whose brightness is accurately known. This latter technique, using differential photometry, is more suitable to use as there are less variables to determine in the measuring system.

During the photoelectric observation it is essential to record the sky brightness as it changes considerably from night to night due to changes in observing conditions.

USES OF THE PHOTOMETER

The photometer and Celestron 8 telescope is very compact and is regularly used in my backyard to observe variable stars. Because of the photometric systems small size it does not take long to set up and does not require a permanent observatory. It does, however, require an accurately aligned pier to enable accurate tracking. This pier and adjustment screws are shown in the photograph.

I also use this instrument at the Mt. John University Observatory as a sky monitoring photometer when I observe flare stars with the main 61 cm instrument. I observe the flare star with the 61cm photometric equipment and observe a nearby comparison star with the 20cm guide refractor on which is mounted my small photometer (See photographs).

This dual channel photometric system enables long observing runs to be made and eliminates the necessity to continually check the sky brightness.

ACKNOWLEDGEMENTS.

I would like to thank the University of Otago Physics Department for the loan of equipment essential for the operation of the photometer, and Dr. Thomas, Messrs. Rowe, Talley and Storer for assistance and guidance during this project. I would also like to thank the University of Canterbury for making available telescope time at Mt. John University Observatory.

APPENDIX 1.

A CURRENT TO FREQUENCY CONVERTER FOR PHOTOELECTRIC PHOTOMETERS.

In a photoelectric photometer the very small electric current produced by the photomultiplier tube has to be amplified to enable it to be measured. This current which is directly proportional to the incident photons, is of the order of nano-amps, and is a direct measurement of the brightness of the object observed.

There are many ways of measuring this current, and the method described below, using a current to frequency converter was developed for the compact photometer for the Celestron 8 telescope.

OPERATION OF CURRENT TO FREQUENCY CONVERTER.

The circuit diagram is shown in Appendix Fig. 1, and the current to frequency converter operates as follows:

Sections A, B and C of the 74C14 CMOS Schmitt trigger function as an oscillator with positive feedback.

Transistor Q1 acts as a switch in the feedback path of the oscillator and charges capacitor C1. Capacitor C1 is discharged by the PM tube mode current at a rate proportional to the light intensity entering the tube. As soon as the input voltage level of section A falls below the trigger threshold, Q1 is turned ON and the oscillator cycle separates.

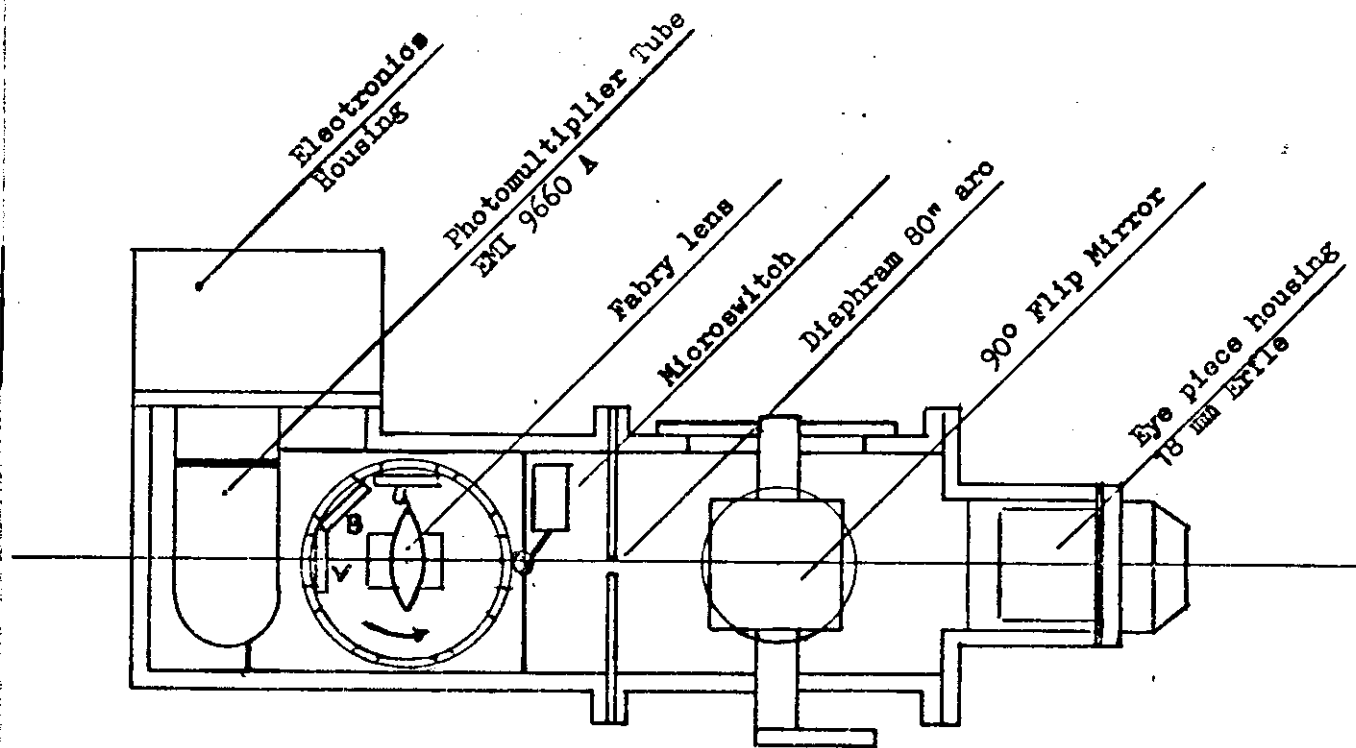
Sections D, E. and F of the 74C14 are buffer/drivers for the output transistor, Q2, which is an emitter follower stage with a low value load resistor, R2, used to impedance match a length of co-axial cable connecting the current to frequency converter to the digital counter.

CONSTRUCTION

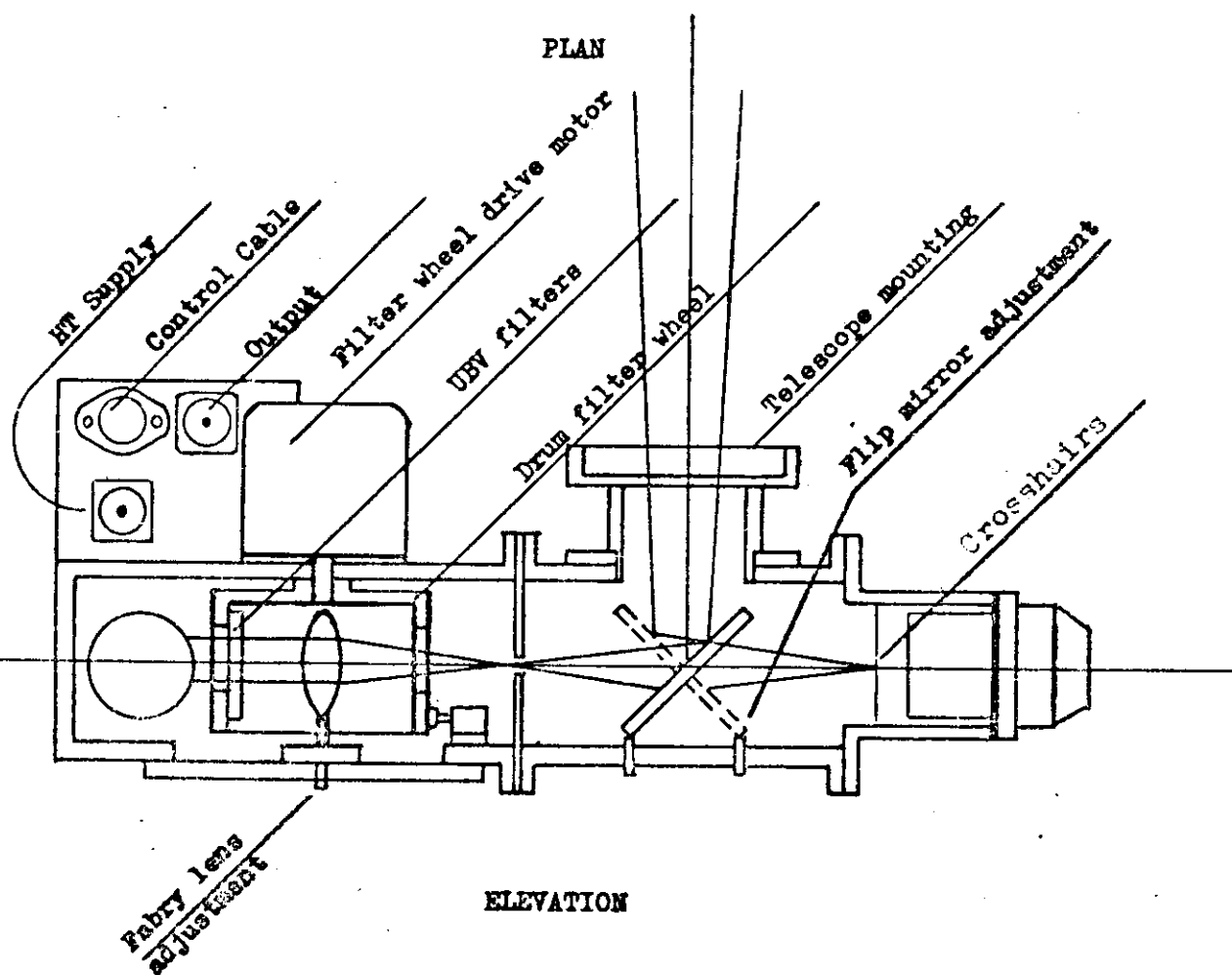
The artwork master for the converter is shown in Appendix Fig.2, while the assembly diagram is shown in Appendix Fig. 3.

The P C board should be filled with components in the standard way and special care should be directed to the positioning of the 10pF capacitor. This capacitor which is the anode current measuring capacitor should be a low temperature coefficient type or a polyester 250 V.w. type.

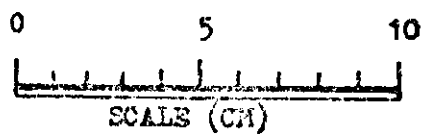
For stable operation of the system the earth rail should be bonded to the photometer frame.



PLAN



ELEVATION



PHOTOELECTRIC PHOTOMETER
FOR A CELESTRON 8 TELESCOPE

FIGURE 1.

Fig. 1
VNA 1072/1

Celestron 8 Telescope
20 cm .f10

High tension power supply

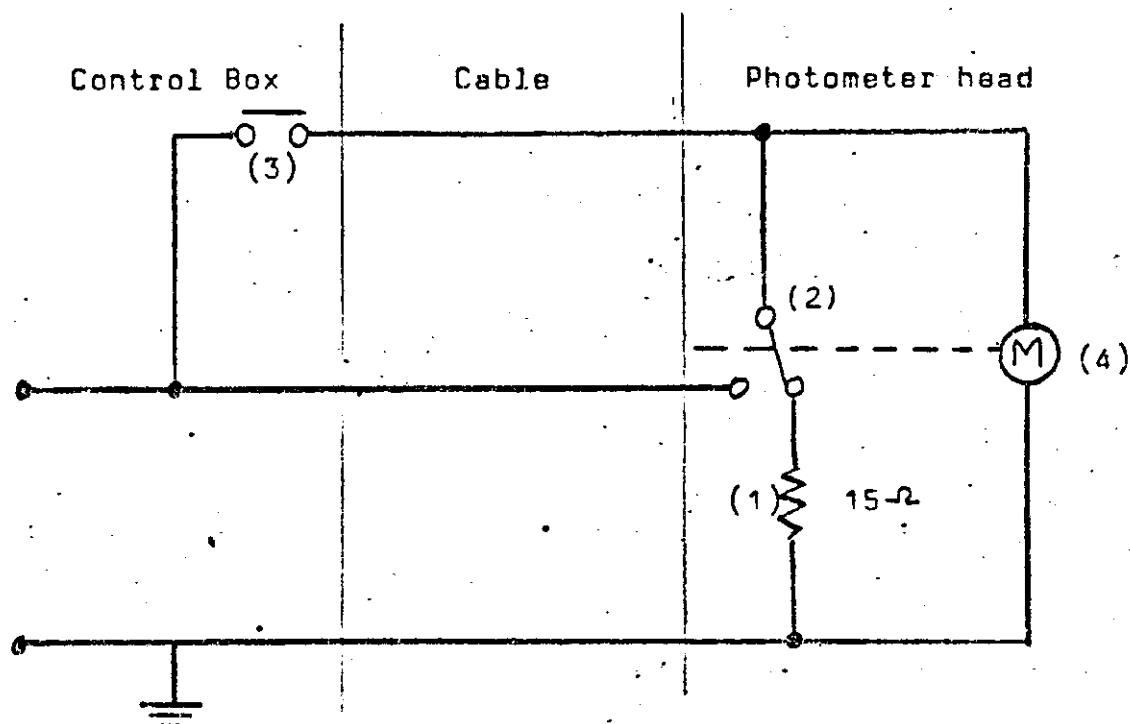
Photometer Head

Current to frequency
converter

Hand held control unit for filter
changing and cross-hair
illumination

Output digital
frequency meter

MOTOR CONTROL CIRCUIT



- | | |
|--------------------------|---------------------------------|
| 1. Breaking resistor | 3. Filter wheel changing switch |
| 2. Motor control switch. | 4. Filter wheel driving motor. |

Fig 2

PHOTOMULTIPLIER TUBE DATA.

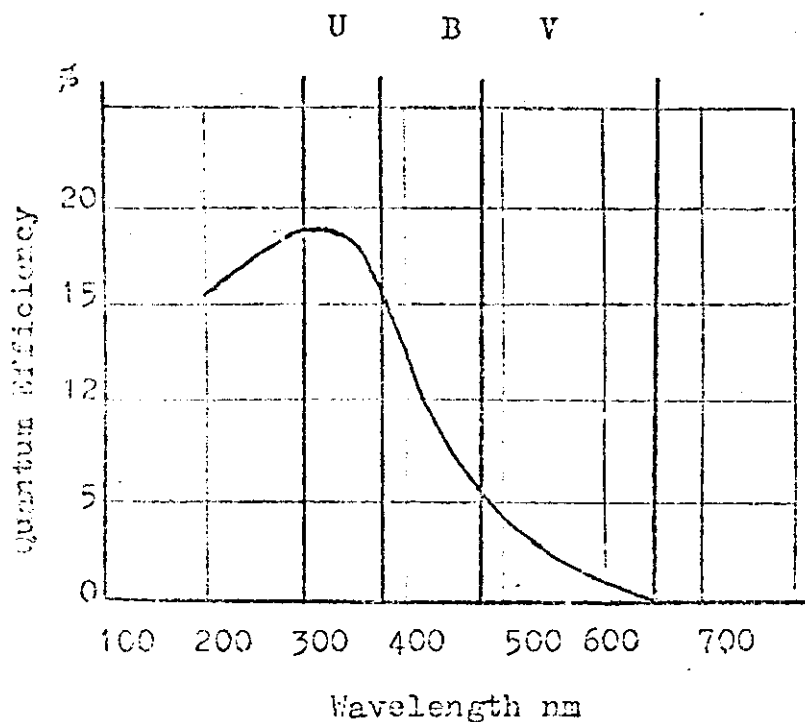
TYPE	EMI 9660A
CATHODE	S ₂
SPECTRAL RESPONSE	180 - 650 nm
NUMBER OF DYNODES	9
MAXIMUM OPERATING VOLTAGE	1200 V
DYNODE CHAIN RESISTORS	200 K Ω (Electrocil).

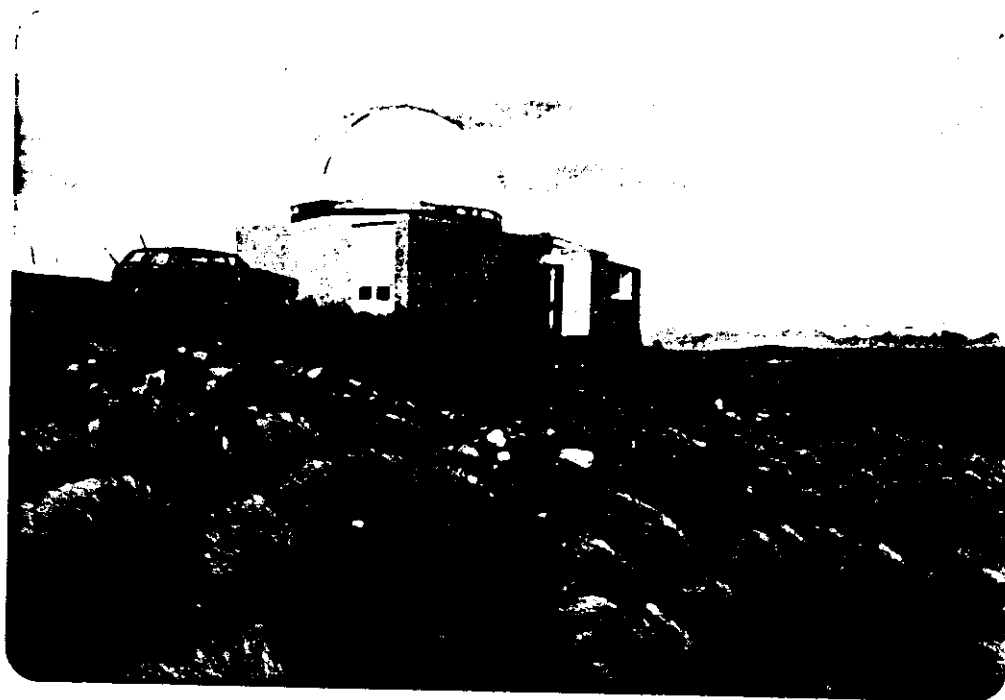
FILTER DATA

<u>FILTER</u>	<u>BANDWIDTH (nm)</u>
V	470 $\rightarrow$ (650)
B	370 - 470
U	300 - 380

PHOTOMULTIPLIER TUBE RESPONSE.

EMI 9660A.

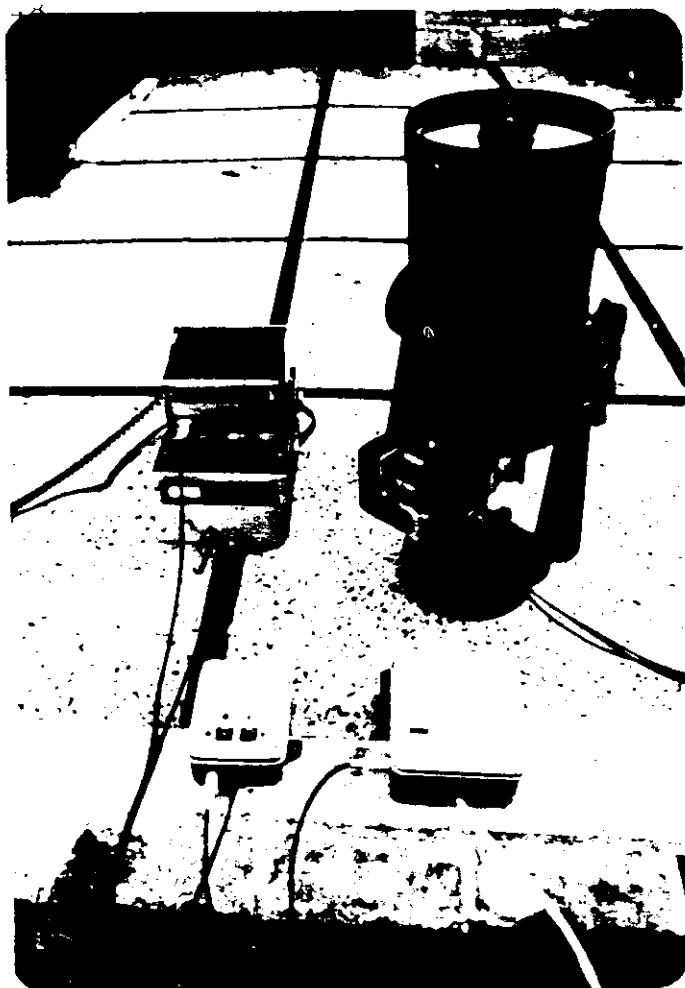




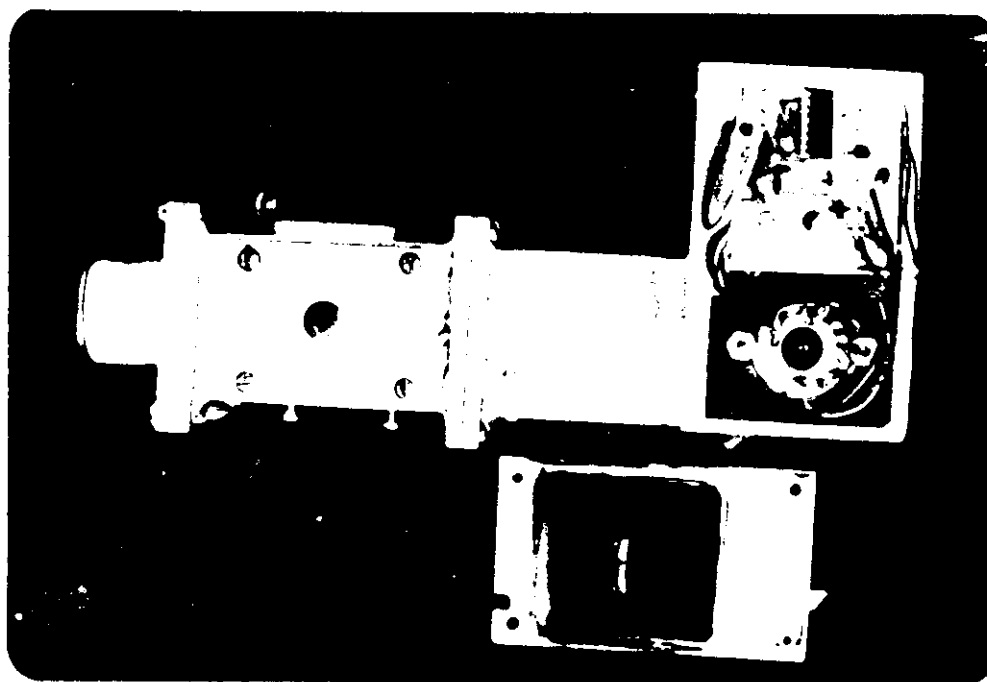
MOUNT JOHN UNIVERSITY OBSERVATORY, 24" BOLLER AND CHIVENS TELESCOPE

DUAL CHANNEL PHOTOMETRIC
EQUIPMENT, WITH PHOTOELECTRIC
PHOTOMETERS MOUNTED ON THE
8" AND 24" TELESCOPES.
INSTRUMENTATION FOR EACH IS
SHOWN ON THE LEFT AND RIGHT
RESPECTIVELY.



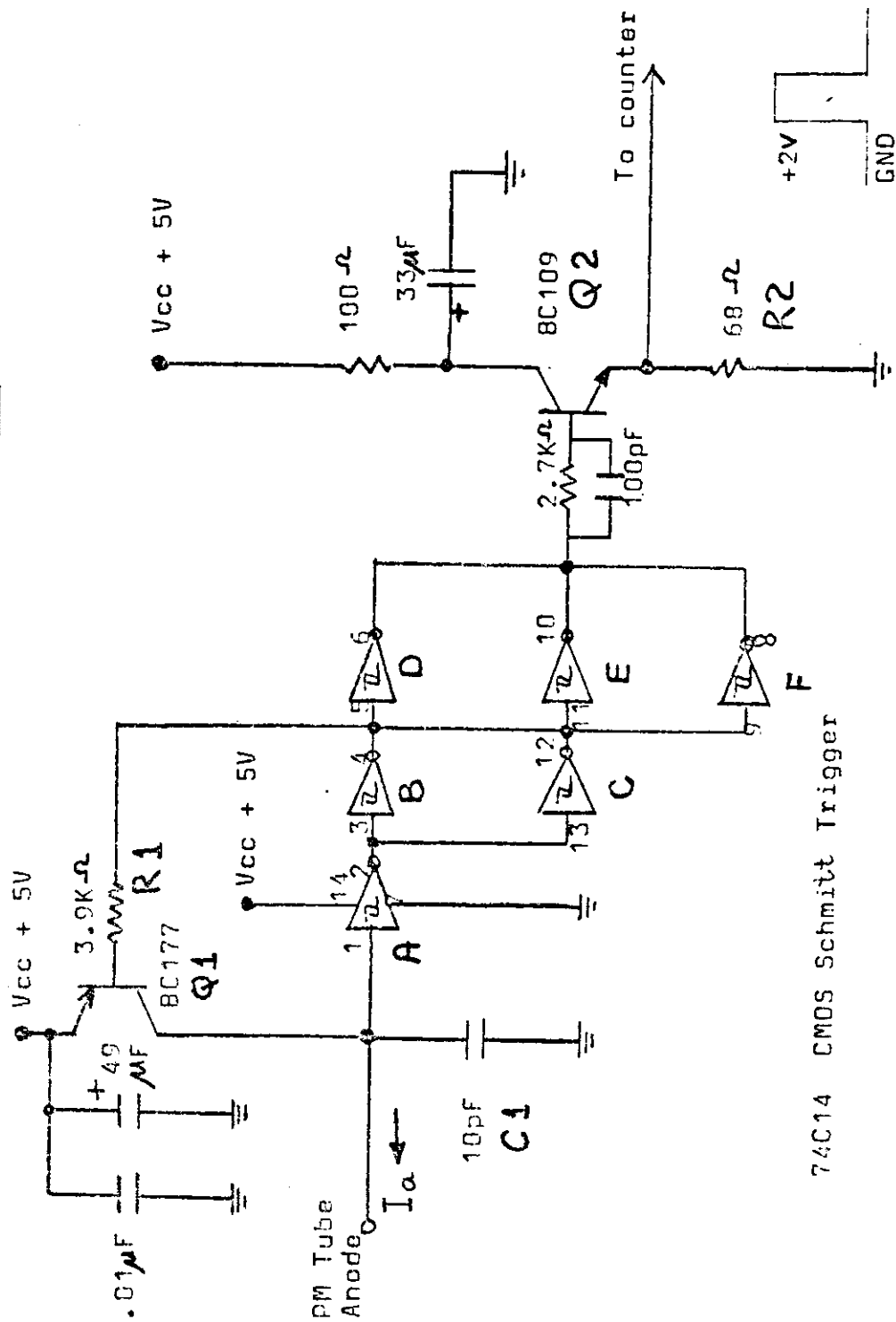


CELESTRON 8 PHOTOMETRIC EQUIPMENT, SHOWING HT POWER SUPPLY, FREQUENCY COUNTER AND HAND CONTROL.

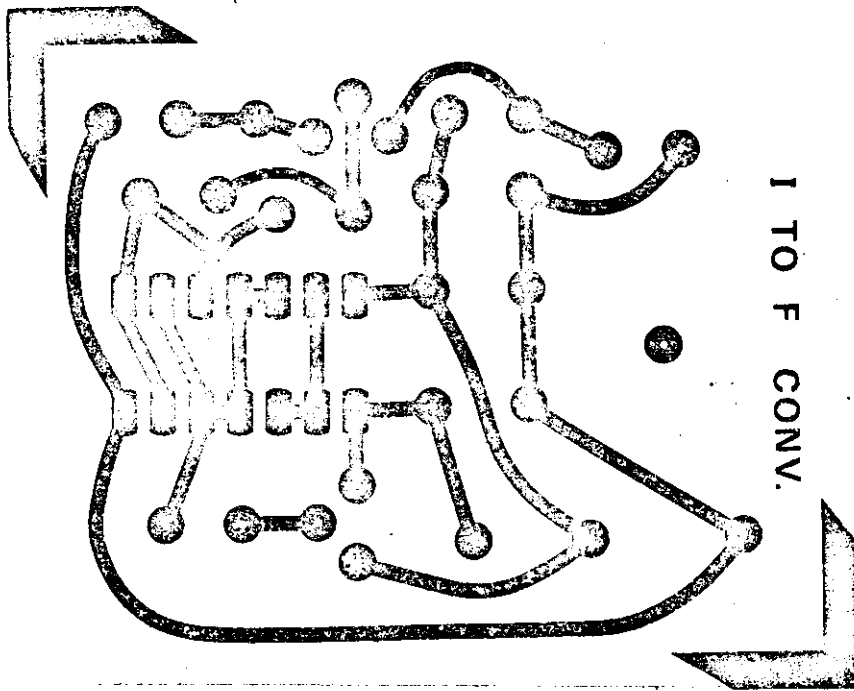


THE PHOTOMETER HEAD DETAILING CURRENT TO FREQUENCY CONVERTER AND PHOTOMULTIPLIER DYNODE RESISTOR CHAIN.

CURRENT TO FREQUENCY CONVERTER



APPENDIX FIGURE 1.

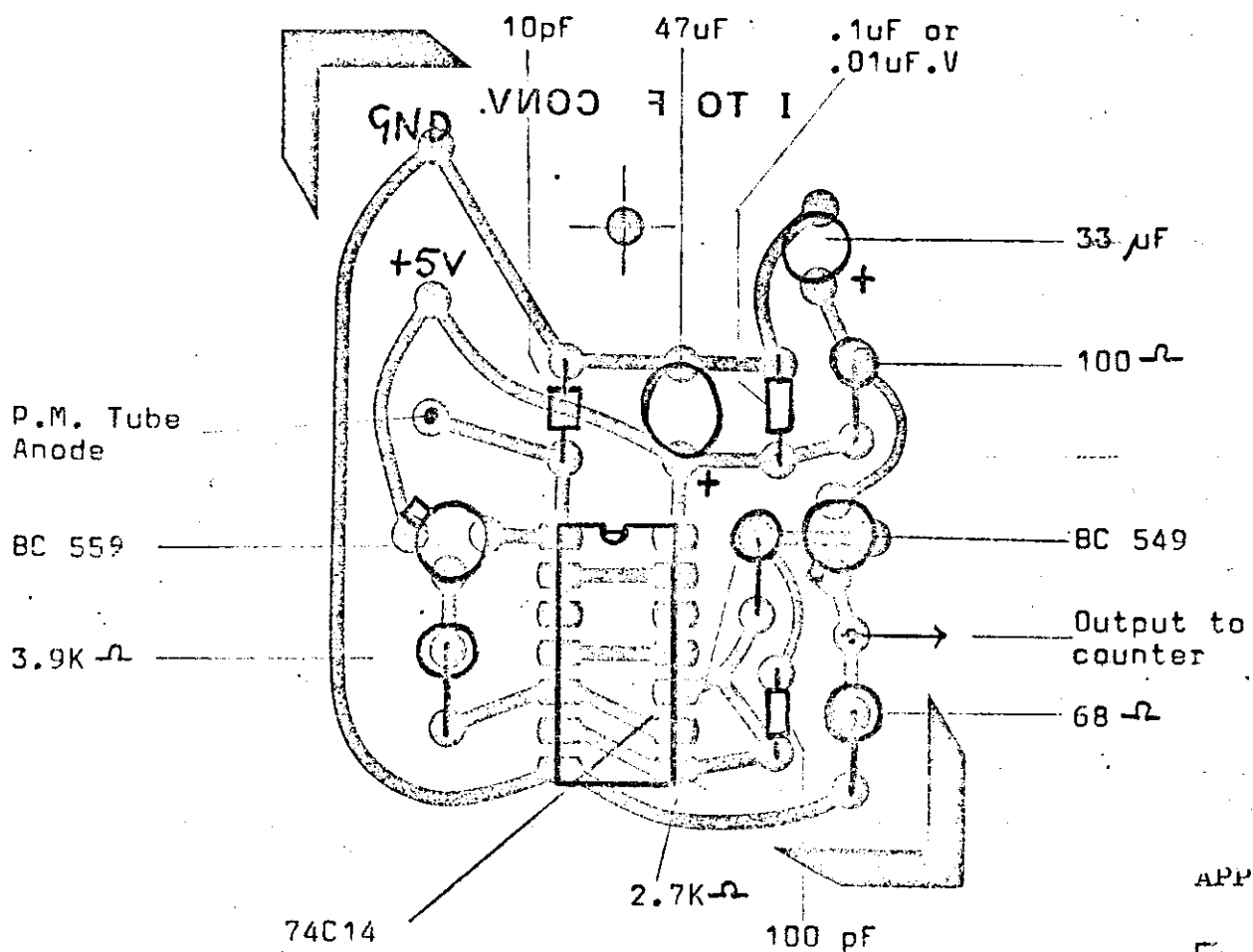


PC BOARD ART WORK
(twice full size)

APPENDIX

Fig 2

COMPONENT SIDE SHOWN



APPENDIX

Fig 3.

ASSEMBLY DRAWING - I TO F CONVERTER

REPORT OF SECTION FOR YEAR ENDED 1980 SEPTEMBER 30.

OBSERVATIONS: The following visual observations, up to 1980 August 31, have been received since the last report:

<u>OBSERVER</u>	<u>No. of OBS.</u>	<u>No. of STARS.</u>	<u>OBSERVER</u>	<u>No. of OBS.</u>	<u>No. of STARS</u>
ASHDOWN, M.L.C.	11	5	MARINO, B.	3,873	126
BACON, I.	13	8	MARSHALL, G.R.	14	7
BROWN, N.J.	1,302	80	MASSEY, A.	23	7
BRYANT, K.	59	5	MENZIES, B.	1,037	36
CAMPBELL, P.A.	4	1	MOREL, M.	40	15
CAMPOS, J.	161*	32	MUNOZ, R.	7	4
CARTER, B.	36	16	MURRAY, A.	349	40
CORKIN, J.	70	8	McNAMARA, G.	225	16
CRAGG, T.A.	1,540+	436	PAGANO, L.	12	6
DIETERS, S.	106	36	PARK, T.L.	7	3
DODSON, A.W.	50	30	PARKINSON, M.	846	70
EMMERSON, R.	409	22	PROSSER, G.L.	94*	79
FISHER, D.C.	386	36	ROSS, J.	1	1
FLEET, R.	224*	40	ROUNTHWAITE, T.	44	19
GILLER, R.	204	49	ROWE, G.	412	61
GRIFFITH, D.J.	14	9	St. GEORGE, L.E.	77	3
HARRIES-HARRIS, E.	726	67	SAUNDERS, S.J.	261	22
HAYWARD, G.	11	6	SHEPHERD, C.	3	3
HERDMAN, G.	993	56	SHINKFIELD, R.C.	131	27
HERS, J.	163*	52	STABENOW, R.	47	15
HICKEY, D.	41	11	SUMNER, B.	39	14
HOVELL, S.	1,032	259	TAYLOR, N.W.	1,682	106
HULL, O.	3,073	144	TREGASKIS, B.	321	119
HULL, (Mrs) O.A.	15	10	TREGEAR, R.	41	3
JACKSON, M.	106	76	TURLE, (Mrs) L.	61	2
JONES, A.F.	4,182	100	VENIMORE, (Rev) C.W.	942	66
KENT, (Mrs) K.E.	41	16	VILLAN, L.	98	11
KILBEY, P.	276	25	VINCENT, J.	178*	39
KOMOROUS, M.	540*	57	WALKER, W.D.G.	16	11
LESLIE, (Mrs) A	441	16	WENDEROTH, E.	14	6
LUMLEY, E.	919	40	WILLIAMS, PAUL	25	15
MARINO, A.	88	31	WILLIAMS, PETER	1,017	105

* = Results also communicated to A.A.V.S.O.

+ = Total observations for VSS, RASNZ and is additional to observations for A.A.V.S.O.

TOTAL OBSERVATIONS 29, 193

There was a slight increase in the number of observations compared to the previous year. This is very satisfactory in view of the adverse weather that affected many sites, including the bush fires that brought poor conditions to parts of Australia for several months. Once again the nine observers, who recorded more than one thousand observations accounted for 64% of the total observations. The contributions from a number of new, and mainly young members, is a pleasing feature of the year's activities. Examinations cause their contributions to be confined to certain months only, but, despite this, several have already become first class observers.

The greatest possible use has been made of the observations, and a very large number of requests from professionals have been actioned during the year.

PUBLICATIONS: Twelve issues of the Monthly Circulars were published. The material for these generally exceeds the space available. Their format was changed slightly during the year so that notes on the outbursts, or other information, is now given in the summary of observations rather than as separate notes. This change has enabled more information to be included in each Circular.

"Charts for Southern Variables" Series 11 and 12 were published.

Publications No. 7 (C/9) was distributed and No. 8 (C80) is currently in the hands of the printer.

Numerous notes on the work of the Section appeared in the Society's Newsletter.

Use of the Section's results were included in many professional publications, which also contained numerous references to papers published in our own Publications.

CHARTS: I am indebted to M. Morel, B. Summer and R.D. Winnett for their excellent skill in the production of charts. It has been possible to include a large number of photoelectric V magnitudes on recent charts, due to the careful researching of the literature by M. Morel.

Once again we have to thank N. Vogt, European Southern Observatory, for supplying identification charts and sequences for a number of southern dwarf novae.

A General Index to all charts published in Series 1 to 11 was included with Series 12. This should prove of assistance to observers in selecting stars for which observations are required. It was possible to effect an improvement in the printing of the charts issued through a change in printers.

The A.A.V.S.O. published their Variable Star Atlas for which permission was given to include sequence magnitudes for a large number of southern variables taken from our charts.

N. Vogt pointed out in "Astron. Astrophys" 88, 66 (1980) that there may be a number of dwarf novae amongst the stars catalogued as Miras for which no spectra are available. I am indebted to N. Vogt for a preprint of his paper, which has enabled a search for such objects to be commenced. This work is being being very ably carried out by B. Summer to whom I have already supplied some data from the literature. Currently I am collecting identification charts for the stars that Summer has listed and these will be available to him early in the New Year. Once he has produced the necessary detailed charts observers will be asked to keep a watch on these stars in the hope that some at least may prove to be dwarf novae (WX Hyi was originally classified as a Mira variable).

MIRA VARIABLES: Reference was made in last year's report to the computer programme set up by P.R. Wood. The main objective of this programme is to examine the observations of a large number of Mira variables extending over the last 50 years in order to detect secondary periods. The programme also produces in a convenient form the light curves and other data. The first paper resulting from this programme appears in Publications No. 8. Due to the writer's illness earlier in the year the feeding of the raw data into the computer has fallen behind, but every effort will be made in the next few months to remedy this.

Copies of our current observations of Mira variables are sent to the A.A.V.S.O. quarterly. This enables them to be used in their predictions and light curves. Their Director (J.A. Mattei) states that our observations are a great help in predicting the dates of maxima and minima of southern variables. She wishes to thank members for their observations and Gordon Smith for compiling the lists. Practical co-operation of this nature between the various Variable Star Organisations is most fruitful and avoids

duplication or error, whilst, at the same time, making the greatest use of the observations.

DWARF NOVAE: It is a great pleasure to thank observers for the very careful monitoring of dwarf novae. There is intense interest in these stars by professionals because of the problems that they pose. This has resulted in many requests for our visual records in order to obtain details of the optical behaviour of many dwarf novae at the time that observations have been made from satellites or spectroscopically. All these requests have been given prompt attention.

In particular, during the year, we have supplied by telex and cable, or by direct telephone calls, notification of outbursts detected during observing spells with the IUE satellite. Co-operative programmes of this nature were arranged with astronomers from R.G.O., University of Cambridge, E.S.O, Caltech, Los Alamos Scientific Laboratory and Goddard Space Flight Centre. For other uses detailed observations have been supplied to a number of professionals.

The value of visual monitoring of dwarf novae can be seen from the following extract from a paper by N. Vogt (Astron. Astrophys. 88 (1980)):

"This work is mainly based on continuous and precise visual observations of dwarf novae over decades performed by many, and to a large extent anonymous, amateur astronomers, in particular the members of the Variable Star Section, of the Royal Astronomical Society of New Zealand, and of the British Astronomical Association, as well as the members of the American Association of Variable Star Observers. The present study demonstrates that amateur astronomers can also substantially contribute to modern research by cooperating in a continuous and well organized manner, and by maintaining a standard in the quality of their visual observations."

The observations of members have enabled eclipses in such systems as Z Cha and OY Car to be accurately determined. It has also been possible to observe the superhumps in a number of stars of the SU UMa sub-type; to determine orbital periods and in some systems to detect changes in cycle length for supermaxima. It appears from recent observations that there have been changes in period of at least one star, but the reduction of the results is not yet complete.

There is a natural tendency, common to both professionals and our own observers, to concentrate their observations on those dwarf novae with short mean cycles. It must be stressed that it is equally as important to observe, and closely monitor, all dwarf novae.

A note on CV Aqr was published in Circ. M80/9. Investigations have continued into the history of this object, and I am indebted to Drs. Brian Marsden and Daniel W.E. Green for further information, but, unfortunately the exact location of this star is still very uncertain. Observers should carefully examine all the field stars as the one thing that does appear certain is that CV Aqr does not exist at its catalogued position.

Several variables have been found in the fields of dwarf novae and there are no doubt others not yet detected. Observers should always report any doubts they have about the assigned magnitude of any star in a variable star field. Attention is drawn to this essential in this report because of the discoveries that have already been made by several members.

R CrB STARS: Members have continued to follow the southern members of this class carefully. In particular Peter Williams organized his group to follow a number of R CrB stars closely. Albert Jones has made some specially useful observations of all southern R CrB variables.

δ Aps had an unusual minimum during the year during which it got "stuck" around 12th magnitude. This was extremely well observed by many members. The semi-periodic oscillations of RY Aps were also very well observed. Several stars were at minima during the year, of which Uw Cen was the one best observed.

RECURRENT NOVAE: No outbursts occurred. RS Oph has been well observed at minimum, but only occasional positive observations were made of the other recurrent novae under observation as they were below the threshold of most instruments.

NOVAE: Several old novae have been observed. RR Pic faded very slightly during the year. CP Pup has been seen occasionally although it is generally too faint for most instruments. Both these novae have been observed by the section since their discovery and we have very complete light curves of them.

Observations were also made of several other novae, mainly ones north of the equator.

CEPHEIDS: Observations have continued of the long period classical Cepheids with the objective of detecting any period changes. α Car has been very well observed; Beta Dor not as well and Kappa Pav rather poorly.

M. Morel has produced charts for a number of other Cepheids suitable for visual observation with small telescopes or binoculars. These appear in Publications 8. He has also observed U Car for which his chart and light curve were published in Publications 7.

Observers are reminded that observations of Cepheids should be sent to Headquarters each month along with their other observations. At the end of each observing season for each Cepheid a copy of their observations should be sent to our Cepheid Recorder, T.A. Cragg (Address: C/o Anglo-Australian Observatory, Private Bag No. 4, Coonabarabran, N.S.W. 2807, Australia).

IRREGULAR VARIABLES: Excellent observations have been secured of T Cha, type Iab, which clearly show the multiple periods that cause a wide variation in the amplitude of variations in this star. The variables, δ , Ty, R and T CrA, have also been well observed. These stars are difficult to observe because of their involvement in nebulosity and extreme care is required in making estimates. Some observations of δ CrA have been discordant but, despite this, it has been possible to determine several periods for these stars.

X-RAY VARIABLE: Sco X-1, V, V010 Sco, has been well observed. Use of these observations have been made by professionals.

ECLIPSING VARIABLES: H.D. Kennedy has communicated observations of the eclipsing binary XY Leo. His photoelectric observations have been published in this issue of our Publications.

MISCELLANEOUS VARIABLES: Observations of a number of semi-regular, RV Tau type and δ D variables have continued. H.M. Johnson has made use of the observations of AG Car in two papers on this star. Several suspected variables have been consistently followed, whilst other suspected variables have been found from examination of the field stars in a number of variable star fields. Some observers were following suspected variables of very small range that were unsuitable for visual observing. These observations have ceased since they are really a waste of time and best left to photoelectric observers.

CO-OPERATION WITH THE B.A.A. The exchange of observations with the Variable Star Section, British Astronomical Association, U.K., has proceeded smoothly throughout the year. The basis established was that we send them our observations of dwarf novae north of the celestial equator. They in turn communicate their results for such variables south of the equator. Stars in the equatorial regions are usually observed rather poorly since they tend to be neglected in favour of stars that are accessible at higher altitudes.

By pooling the observations from both hemispheres a very much better coverage is possible. The arrangement is that the B.A.A. will reduce and publish the combined results of the northern stars, whilst we will deal with the southern stars.

There has also been a very satisfactory exchange of other data--publications, charts, and sequences. I am indebted to Doug Saw, the present Director of the V.S.S., B.A.A., and his assistants and predecessors for their cooperation.

RECORDER: Gordon Smith has continued to carry out the onerous duties of recorder. His duties extend to the checking and the entering of all observations on the permanent records after data for the Monthly Circulars have been extracted. This work he performs in a very efficient manner which takes quite a load off my shoulders. He also prepares the quarterly copies of observations for the A.A.V.S.O. and the B.A.A. I am deeply grateful for his assistance.

GENERAL: "The Observation of Variable Stars" has continued to provide guidance to many new observers. Steady sales of this Instructional Manual have continued throughout the year. A new edition is scheduled for 1962 by which time stocks of the present edition will have been exhausted.

The series of articles appearing in SKY & TELESCOPE dealing with the work of the A.A.V.S.O. in particular and of Variable Stars in general has attracted a great deal of interest. Because of our close co-operation with the A.A.V.S.O. these articles have also served to stimulate interest in our own section.

A revision of the book "THE STUDY OF VARIABLE STARS" by Campbell and Jacchia has been long overdue. In fact for some years I have urged Dr. Janet Mattei to undertake this work. She has recently informed me that Dr. Luigi Jacchia has been working on a revised edition which will be published some time in 1961. I am sure that members will find the new edition a most valuable addition to their library.

FINANCE: The arrangements whereby ASTRONOMICAL RESEARCH LTD., handle all the finances of the Section has proved most satisfactory. The reasons for this were outlined in the previous year's report. The change has also enabled grants to aid publications to be secured during the current year.

ACKNOWLEDGEMENTS: Observations alone make the section a success. The fact that a very high standard is maintained by observers makes the results so valuable. That can be seen from the use that is made of the observations by so many professionals. It is thus my very great pleasure to thank most sincerely all observers firstly for their records, and, secondly, for their cooperation and help throughout the year.

It is always difficult to single out observers for special mention when all contribute so well. However once again Albert Jones has made a particularly valuable contribution, notably not only for its numbers but also for the accuracy of his results. N.W. Taylor, who also works alone, has made, as in past years a notable contribution. His very accurate timing of the eclipses of dwarf novae have been remarkable accurate and most valuable.

Another notable contribution came from T.A. Cragg, who apart from his own observing forms an important link with the Anglo-Australian Observatory. Tom has been able to get down to fainter limits than most observers which is most useful in obtaining knowledge of stars at minima. Likewise, N.J. Brown's results also reach fainter limits than most observers. His observations of dwarf novae which he follows so consistently are most worth while.

The various local groups have the advantage of not working alone as each group includes a number of observers in the same area. The success of these groups owe much to their leaders, in particular Bruce Tregaskis, Peter Williams, Roy Emmerson and Eric Harries-Harris, Bruce Sumner and Arthur Page. The latter contributes no observations himself because of other programmes, but he has interested several keen and efficient observers in joining the Section. The results from the Auckland group are outstanding due to the work of Brian Marino and Dick Hull in particular. There are many who space does not allow to be mentioned individually but to one and all I say a most sincere thank you. You are all carrying out observations that are valuable and important. I hope that your interest will be maintained in 1981 and that you have clear skies.

I wish to thank the many professionals who have worked with the Section during the year. Their encouragement and the use they have made of our results have been most stimulating. Their financial support through subscriptions has been most helpful. In turn I hope that our results have been of use to them.

1980 December 24

Frank M. Bateson
Director.

NOTICES.

ADDRESS: Correspondents are reminded that the address of the writer, and of the Section, is:

P.O. BOX 3093,
GREERTON.
TAURANGA,
NEW ZEALAND.

It would be appreciated if all correspondence could be sent to the above address to avoid misplaced mail when the writer is away.

CHARTS FOR SOUTHERN VARIABLES:

Stocks of Series 3, 4, 5 and 7 are exhausted after several printings. These issues will not be reprinted. Where necessary revised charts for some of the stars in these series will appear in later issues.

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