A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 66.

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THE RR LYRAE — VARIABLE TT LYNCIS

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ABSTRACT

Three colour photoelectric observations of the RR Lyrae variable TT Lyncis obtained at the Konkoly Observatory and Skalnate Pleso Observatory are discussed. The investigation shows a constant period of light changes and a stable light curve of the variable. A colour - colour diagram was constructed. For the distance of the variable 660 pc was obtained.

1. INTRODUCTION

The variable TT Lyn is a relative bright RR Lyrae-type star. It was discovered by Hoffmeister /1949/. It was scarcely observed and very insufficiently studied. The first time the star was investigated by Tsesevich /1956/ and later on photographically and also visually by Ahnert /1959, 1960/ who found $0^d.597416$ for the period. The light curves, both visual and photographic published by Ahnert /1959/ show an unusually great dispersion of individual observations which is evidently caused by the applied observational methods. There are only few photoelectric observations obtained by Jones /1966/ and by Sturch /1966/. The present study is based mainly on the photoelectric observations obtained at Konkoly Observatory in Budapest and at Skalnate Pleso Observatory.

Spectral classification on the basis of objective prism spectra was made by Alania /1967, 1969/ from the intensities of absorbtion hydrogen and ionized calcium lines. He determined Preston's quantity ΔS which changed from the value $\Delta S = 7$ in maximum to $\Delta S = 12$ during the minimum light. The spectral type changes from FO in maximum light to F8 in minimum light according to classification of the hydrogen lines. The radial velocity curve was obtained by Woolley and Aly /1966/ who found that the radial velocity relative to the Sun $\varrho_0 = -62,7 \pm 3,4$ km/sec and the amplitude of radial velocity changes by $\Delta V_r = 60,9 \pm 10,9$ km/sec during the period of light variation.

2. OBSERVATIONAL MATERIAL AND REDUCTION

In this paper mainly results of the interpretation of the observing material obtained at Konkoly Observatory Budapest and at Skalnate Pleso Observatory are presented. Photoelectric observations in Budapest were obtained at the 24-inch f/6 reflector with a photoelectric photometer equipped with colour filters for the UBV photometry.

Variable TT Lyn was observed photographically at Skalnate Pleso Observatory in the years 1959 - 1961 and photoelectrically from 1961 onwards at the 24-inch f/5,5 reflector. The photographic observations were obtained on Agfa Astro-panchromatisch plates without colour filter by the method of multiple exposures. Twenty three plates yielded 395 exposures of sufficient quality for further investigation. The greatest part of the observations was obtained at the same telescope equipped with a photoelectric photometer. A short description of the photometer together with the method of observation and reduction was given in a previous paper Tremko /1964/. A detailed description of the photometer will be published later. In the period from 1961 until 1964 altogether 3692 photoelectric observations were obtained in yelow colour; 267 of them of insufficient accuracy were excluded from the treatment. The corrections for differential extinction were not applied since the angular distance between comparison star and the variable is small. The set of yellow observations was supplied with observations in blue and ultraviolet colour in the period 1966 - 1967. The last mentioned observations were used for the construction of light curves in three colours. The observations obtained in the instrumental ubv system were converted into the standard UBV system.

THE PERIOD AND THE LIGHT CURVE

The period due to the small extent of observations was earlier computed only with low accuracy. Thus the value published by Ahnert /1959/ is accurate only to five decimals. In the third edition of the General Catalogue of Variable Stars /Kukarkin et al. 1969/ the period was given with higher accuracy, but our computations have shown that even this period must be corrected. The great number of our observations gives us the possibility to study the stability or eventual changes of the period. As the accuracy of the visual observations is not sufficient, we decided to use for the computation of the period well defined photoelectric epochs of maxima only. The early photographic and mainly visual epochs of maxima deviate from the elements:

$$\mathrm{Max}_{\mathrm{hel}} = \mathrm{J.D.}\ 2436651.3570 + 0\overset{d}{.}59743398 \cdot E$$

obtained by us. These deviations could hardly be explained by a change of the period before J.D. 2436000. We may suppose that this difference is caused by the inaccuracy of the visual epochs before that date.

The list of epochs of maxima together with O - C values and further informations are collected in Table I. The O - C diagram for the maxima from Table I. is on Fig. 1.
As the scale on Fig. 1. is too small for the epochs determined

photoelectrically, an O - C diagram with a greater scale was constructed for these maxima in Fig. 2. O - C differences for the epochs of maxima and also for the ascending branch at $V = 9^{m}_{.}936$ were tested for Blažko effect. The phase shifts of the ascending branch amount to $0^{d}_{.}0005$ at most. As the mean error of observations on the ascending branch is $\pm 0^{d}_{.}0008$, the observed oscillations are inside the limits of observational errors.

Table I.

Max. hel. J.D. 2430000+	E	O - C	Observer	Notes
5599,33	- 1761	+ 0,05	Tsesevich	v
5601,25	- 1758	+ 0,18	-"-	v
5608,31	- 1746	+ 0,07	-"-	v
5722,50	- 1555	+ 0,15	-"-	v
5747,54	- 1513	+ 0,10	-"-	v
5753,45	- 1503	+ 0,04	-"-	v
6229,60	- 706	+ 0,03	Ahnert	pg
6232,58	- 701	+ 0,02	-"-	pg
6274,40	- 631	+ 0,02	-"-	pg
6287,53	- 609	+ 0,01	-"-	pg
6609,5275	- 70	- 0,0091	Tremko	pg
6611,32	- 67	- 0,01	Ahnert	v
6611,3307	- 67	+ 0,0018	Tremko	pg
6626,30	- 42	+ 0,04	Ahnert	v
6630,44	- 35	- 0,01	-"-	v
6651,3586	0	+ 0,0016	Detre	pe
6663,32	+ 20	+ 0,01	Ahnert	v
6679,4361	+ 47	- 0,0003	Detre	pe
6961,4210	+ 519	- 0,0042	Tremko	pg
7016,404	+ 611	+ 0,015	Ahnert	v
7017,567	+ 613	- 0,017	-"-	v
7026,553	+ 628	+ 0,007	-"-	v
7028,353	+ 631	+ 0,017	-"-	v
7321,6797	+ 1122	+ 0,0018	Tremko	pe
7327,6496	+ 1132	- 0,0027	-"-	pe
7669,3825	+ 1704	- 0,0020	-"-	pe
7673,5664	+ 1711	- 0,0001	-"-	pe
7696,2665	+ 1749	- 0,0025	-"-	pe
8378,5371	+ 2891	- 0,0015	-"-	pe
8381,5247	+ 2896	- 0,0011	-"-	pe
8400,6420	+ 2928	- 0,0017	-"-	pe
8406,6188	+ 2938	+ 0,0008	-"-	pe
8408,4113	+ 2941	+ 0,0010	-"-	pe
8414,3861	+ 2951	+ 0,0014	-"-	pe
8415,5800	+ 2953	+ 0,0005	-"-	pe
8418,5668	+ 2958	+ 0,0001	-"-	pe
8458,5951	+ 3025	+ 0,0003	-"-	pe

For the construction of the composed UBV light curves only the photoelectric observations obtained at the Skalnate Pleso Observatory were used. The V light curve is on Fig. 3. Dots represent the mean four observations, circles the mean of two observations. Fig. 4. and 5. represent individual B and U observations, respectively. Slight changes of the heights of maxima and brightness of minima were observed within some few hundredths of magnitude. The photoelectric observations show also slight changes in the form of the ascending branch and of the hump, but no periodicity resembling a Blažko effect was found. The variable TT Lyn has in maximum light the brightness $9^{m}_{,}476$ and in minimum light $10^{m}_{,}161$ in V, in excellent agreement with data obtained recently by Jones /1966/. The value of M - m derived from the mean yellow light curve is $0^{P}_{,}180$, and the hump is placed at phase 0, 95. The light curve is smooth on the descending branch. The colours at maximum and minimum light are as follow:

	U - B	B - V
maximum	$+ 0^{m}_{,}167$	$+ 0^{m}_{,}256$
minimum	$+ 0^{m}_{,}039$	$+ 0^{m}_{,}424$

COLOUR - COLOUR DIAGRAM AND THE DISTANCE OF THE VARIABLE

On the basis of three-colour observations obtained at the Skalnate Pleso Observatory a colour - colour diagram of the variable was constructed. For its construction the data from Tab. II. were used. The shape of the obtained colour - colour diagram /Fig. 6/ is typical for this type of variables. Only the U - B value for the phase 0. 2 should be higher by a few hundredths. The numbers at the different points of the curve on Fig. 6 denote the phases of the light changes.

The photometric data give us the possibility to determine the distance of the variable if the absolute magnitude is known. The absolute magnitude can be derived from the period - absolute magnitude relation /Woolley et al. 1965/.

$$M_V = 0^{m}_{.}0 - 2^{m}_{.}5 \log P \qquad /1/$$

Table II.

Phase	U - B	B - V
0,00	+ 0,167	+ 0,256
0,10	+ 0,154	+ 0,279
0,20	+ 0,098	+ 0,317
0,30	+ 0,146	+ 0,397
0,40	+ 0,052	+ 0,423
0,50	+ 0,036	+ 0,445
0,60	+ 0,006	+ 0,450
0,70	+ 0,030	+ 0,413
0,80	+ 0,038	+ 0,414
0,90	+ 0,002	+ 0,391
0,91	+ 0,039	+ 0,355
0,98	+ 0,140	+ 0,287

From this relation we obtain the following value for the absolute median magnitude : $M_V = 0\overset{m}{.}56$. The distance of the variable can be computed from the well known relation:

$$M_V = m_V + 5 - 5 \log r - A_V \qquad /2/$$

The visual interstellar absorption can be determined from reddening. It is assumed that stars which are more than 100 pc above the galactic plane and have great galactic latitude b are reddened by 0.05 cosec b /Woolley et. al. 1965/. Thus the reddening for TT Lyn should be $0\overset{m}{.}075$ and the total visual absorption $A_V = 0\overset{m}{.}226$. We can compute the visual absorption also from the relation which was derived from the study of high latitude RR Lyrae type variable stars /Woolley et. al. 1965/:

$$A_V = 3 \left[/B/ - /V/ - 0.24 \right] \qquad /3/$$

As the mean B - V value is $+ 0\overset{m}{.}381$ for TT Lyn, the visual absorption should be $0\overset{m}{.}423$. We prefer the determination of the interstellar absorption by the first mentioned method, as TT Lyn can have an intrinsic colour which differs from the mean value + 0.24 for high galactic latitude RR Lyrae type variables. By assuming that the median visual magnitude of TT Lyn is $9^{m}.890$, we obtain for the distance the value r = 660 pc.

CONCLUSION

TT Lyn is a variable star of RRab type with constant period and stable light curve. Blažko effect is not present. The star belongs to the group of RR Lyrae type stars with high Δ S. Such stars are of low metal abundance, they are relatively old and have large motion relative to the Sun. For TT Lyn no proper motion data are available. On the basis of the period - luminosity relation the absolute magnitude of TT Lyn was determined and after applying the correction for the interstellar absorption a distance of r = 660 pc was derived.

I would express my tkanks to Prof. Dr. L. Detre for giving at my disposal the observational material of TT Lyn obtained at the Konkoly Observatory and for many advices and stimulating discussions. I thank members of the staff of the Skalnate Pleso Observatory, especially J. Petras and L. Petrik, for their help in the observations.

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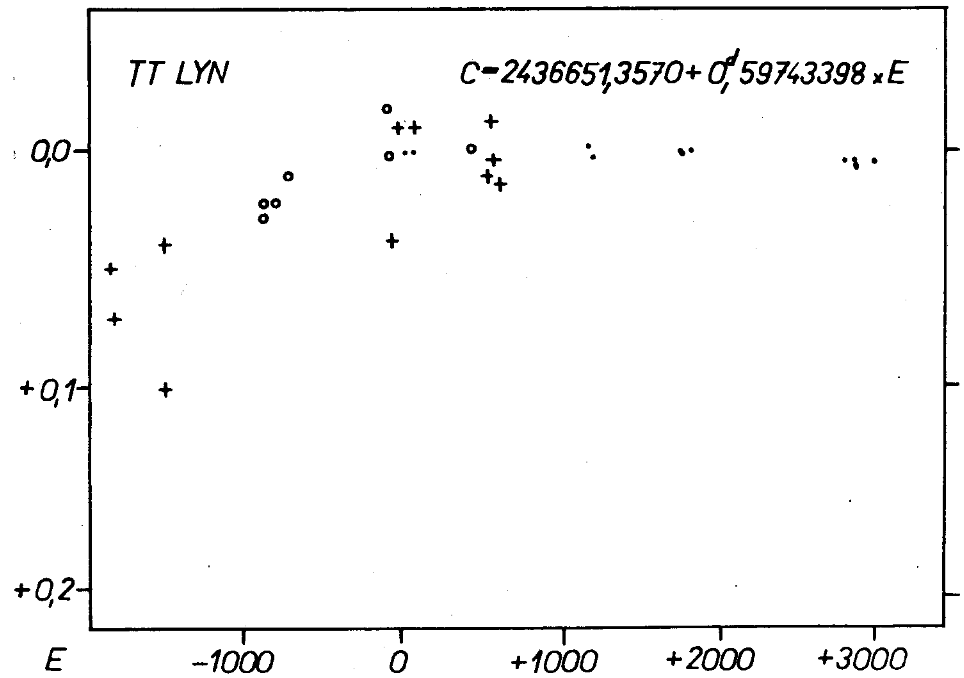

Fig. 1. O - C diagram for all epochs of maxima; crosses denote visual epochs, circles photographic epochs and full dots photoelectric epochs.

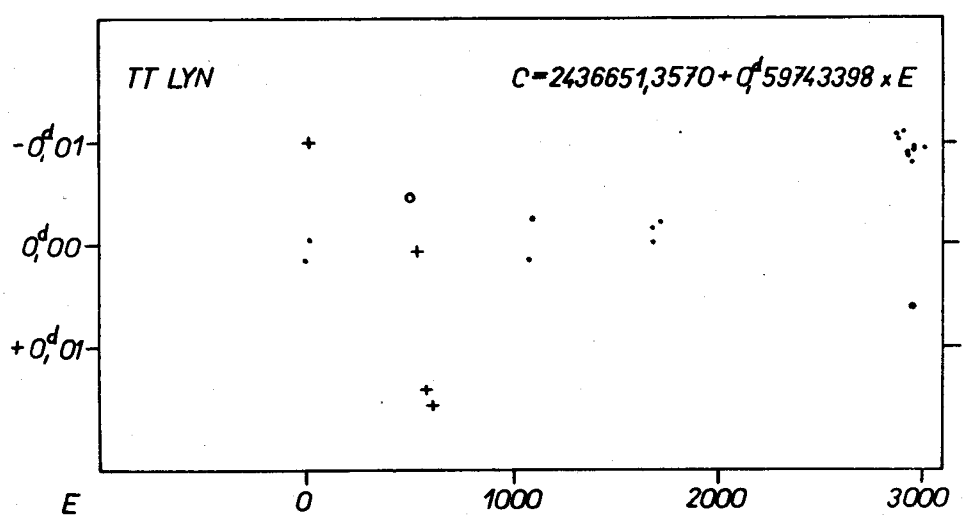

Fig. 2. O - C diagram for the epochs with E>O; crosses denote visual epochs, circels photographic epochs and full dots photoelectric epochs.

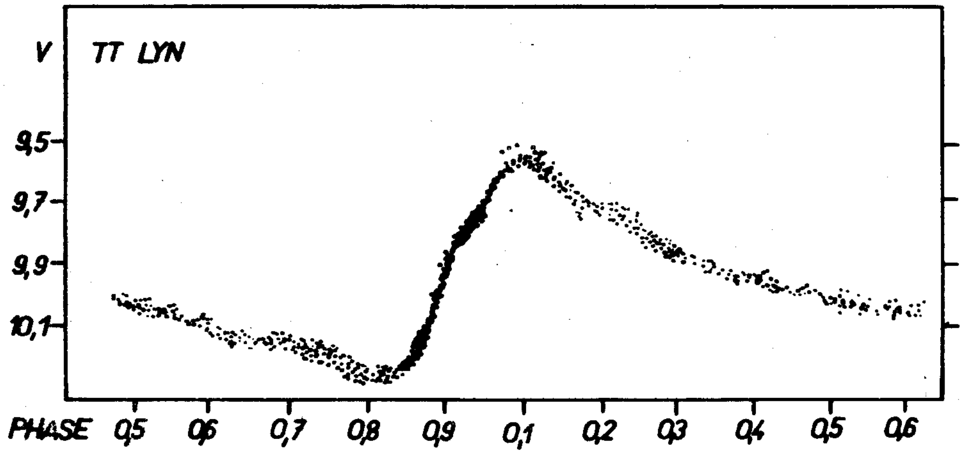

Fig. 3. V photoelectric light curve of TT Lyn. Full dots represent four observations, open circles two observations.

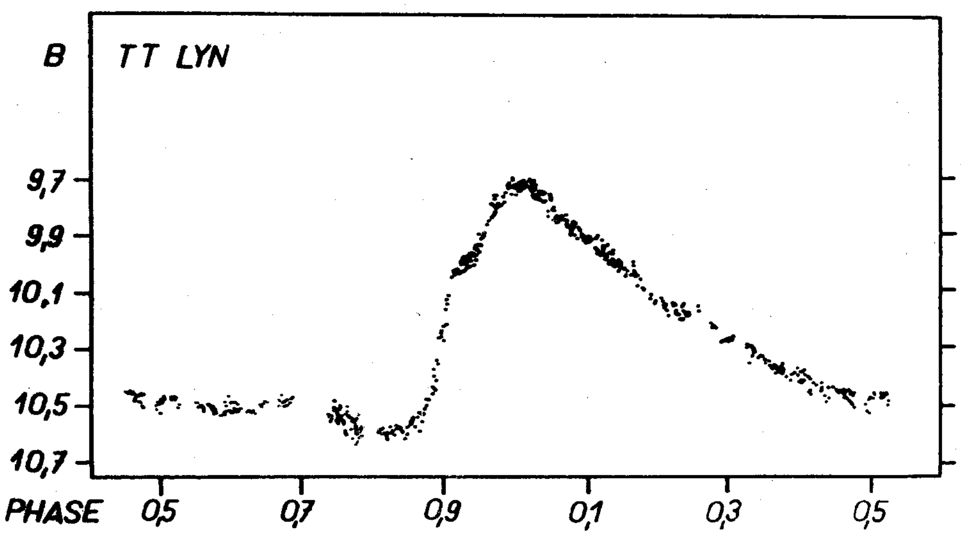

Fig. 4. B photoelectric light curve of TT Lyn.

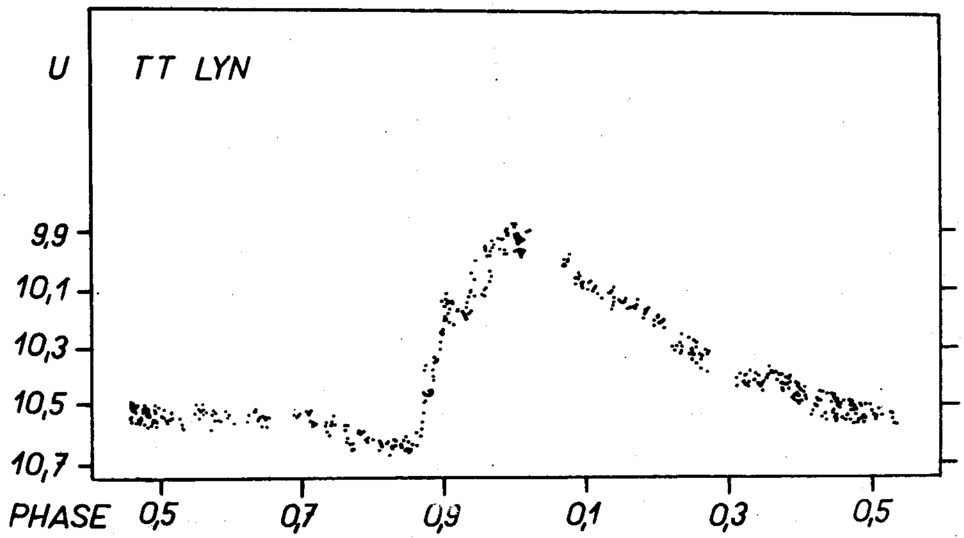

Fig. 5. U photoelectric light curve of TT Lyn.

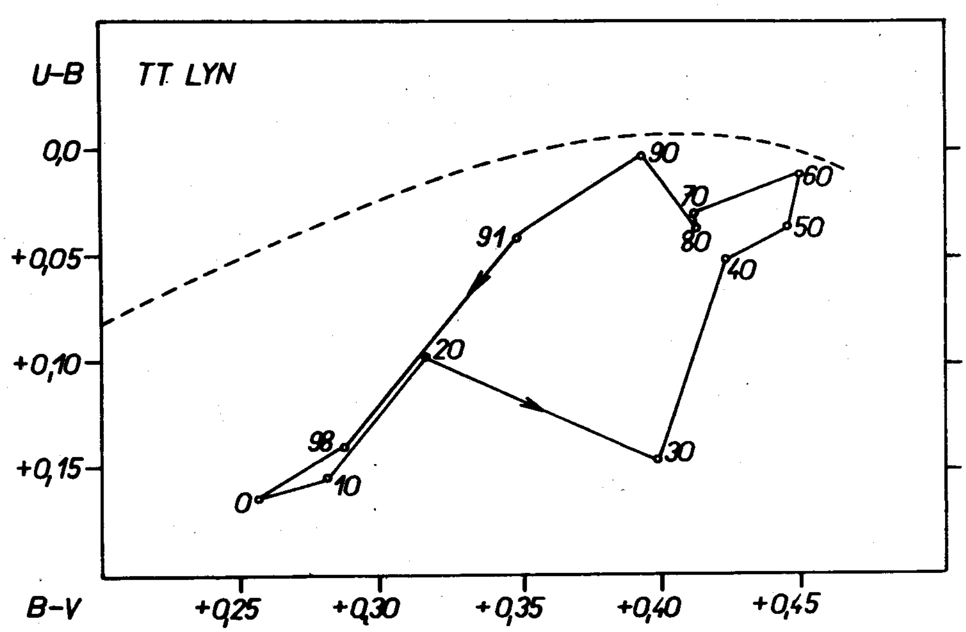

Fig. 6. Colour - colour diagram of TT Lyn. The numbers at the curve denote the phase.

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THREE COLOUR PHOTOMETRY OF W CVn, LIGHT CURVE AND PERIOD

BUDAPEST, 1974

ABSTRACT

Three colour photoelectric observations of the variable W CVn obtained at Konkoly Observatory and at Skalnaté Pleso Observatory were interpreted. The investigation shows secular change of the period and a stable light curve. The interstellar absorption in the direction of the variable is discussed and the absolute magnitude from the period - luminosity relation was derived. Colour - colour diagram was constructed and distance of 980 pc for the variable was determined.

INTRODUCTION

The variable star W CVn belongs to the group of short period RRab Lyrae-type variables. It was discovered by Ceraski in 1907 on plates made by Blazko /Ceraski 1907/. Later was investigated by Zinner /1912, 1916/, who discovered an increase in brightness near the minimum light. She discovered similar increasing in brightness on the ascending branch and at the phase $0^{P}_{.}47$. The last however changed its place in various cycles. Bugoslawski /1927/ discovered secondary oscillations on the light curve which recurred with a period of 0.16057 days. The period of secondary oscillations was not constant but changed during a cycle of 43.53 days. Photographic observations obtained by Jordan /1929/ and Robinson /1930/ did not confirm Bugoslawski's conclusions on periodic secondary oscillations. The light curves derived by both authors show a conspicuous wave close to the minimum. Similarly Parenago /1930/ found light curve to be smooth but the brightening before minimum escaped his attention. In the years 1931 - 1933 Detre /1934/ observed the variable by a Graff wedge photometer and collected 369 observations. According to his observations the light curve was smooth and the amplitude of the wave close to minimum was only $0^{m}_{.}02$ which differed from the value $0^{m}_{.}12$ previously found by Jordan /1929/. Later the star was observed visually or photographically by several observers /Radlova 1934/, /Kleissen 1938/, /Nachapkin 1940/, /Alania 1954/, /Strelkova 1960/, /Ahnert 1961/, /Satanova 1961/. Photoelectric observations are scarce with exception of those obtained at Konkoly Observatory and Skalnaté Pleso Observatory. Geyer /1961/ obtained UBV photoelectric observations in the range of the phase $0^{P}_{.}8$ - $0^{P}_{.}1$ and determined some photometric parameters of the variable. Sturch /1966/ obtained few UBV photoelectric observations for the program of colour indices of RR Lyrae-type stars near minimum light. The latest photoelectric observations are those obtained by Fitch et al. /1966/. Radial velocity was measured by Joy /1938/ who found a mean value of RV = + 26 km/sec. The spectrum of the variable is changing from A6 to F6 and Preston's quantity Δ S reaches a value of 7 /Woolley et al. 1965/.

OBSERVATIONAL MATERIAL AND REDUCTION

The variable was observed photographically at Konkoly Observatory in Budapest with 16-inch astrograph by the method of multiple exposures. Together 288 observations were obtained on the emulsion "Guilleminot superfulgur". No colour filter was used in the observations. The photographic material was measured and reduced by a method widely used also at other observatories. The brightnesses of the comparison stars were determined by the comparison with those from North Polar Sequence. The list of the photographic plates together with further data are given in Table I.

Table I.

J.D.	Date	Plate	N
2429373	20. Apr 1939	H 1106	43
2429401	17. May 1939	H 1147	25
2429401	17. May 1939	H 1148	40
2429401	17/18. May 1939	H 1149	30
2429425	10. June 1939	H 1164	8
2429456	11/12. July 1939	H 1182	60
2429461	16. July 1939	H 1187	27
2433453	20. June 1950	H 2124	25
2434457	21. March 1953	H 2639	30

On the basis of the photographic observations obtained at Konkoly Observatory four epochs of maxima were derived. There are included in the Table II. The variable starting from 1959 was intensively observed photoelectrically at Konkoly Observatory and at Skalnaté Pleso Observatory. Photoelectric observations in Budapest were obtained at 24-inch, f/6 reflector with a photoelectric photometer equipped with 1 P 21 photomultiplier and colour filters for the photometry in B and V region. Photoelectric observations of the variable at Skalnaté Pleso Observatory were obtained in two observational seasons in the years 1963 and 1964 with a photoelectric photometer attached at 24-inch, f/5.5 reflector. The optical part of the photometer is equipped with quarz Fabry lens which images the entrance pupil of the telescope into a form of disc of 4.3 mm in diameter on the photocathode of 1 P 21 photomultiplier. The photomultiplier was supplied from high voltage stabilizer NBZ 411 type and an electronic recorder EZ 4 type was used. The detailed description of the photometer will be done in fortcoming paper. The set of yellow observations obtained in the years 1963 - 1964 was supplied with the observations in B and U colours in the years 1967 and 1968. The standard filters for the UBV photometry were used. The observations obtained in the instrumental ubv system were converted into the standard UBV system.

THE PERIOD AND THE LIGHT CURVE

The long series of the observations over 40000 periods made possible the study of secular changes of the period. In our study we used the epochs of the maxima published by Detre /1934/ and mainly observations obtained by Detre and Tremko /this paper/. From Detre's list /Detre 1934/ we omitted two epochs derived by Jordan and we computed from Jordan's observations new epochs of maxima. We omitted from newer observations the epoch of the maximum derived by Strelkova /1960/, as it shows a very great residual from the calculated epoch. Probably there is a printing error in the original paper.

It is remarkable that the elements published by Prager /1930/ include parabolic term for the secular change of the period:

$$Max_{phg} = J.D.\ 2421077.977 + 0.5517622 \times E - 0.468\ 10^{-9} \times E^2 \qquad /1/$$

Later Detre /1934/ derived following elements:

$$Max_{hel} = J.D.\ 2421402.4206 + 0.55175981 \times E \qquad /2/$$

The last computation is that provided by Tsesevich /1966/:

$$Max_{hel} = J.D.\ 2421077.9868 + 0.551758775 \times E \qquad /3/$$

It is notworthy the deviation of - $0\overset{d}{.}008$ of the photoelectric epoch of maximum obtained by Geyer /1961/ from the elements /3/. Our computations give following elements:

$$Max_{hel} = J.D.\ 2421402.4270 + 0.55175834 x E \qquad /4/$$

From the O - C values which are presented in the Table II. and also from the Fig. 1. it is clearly seen that the period is not constant. We did not compute the numerical value of the secular change as it is not clear whether the observed shortening is continuous or not. The latest observed epoch of the maximum /Fitch et al. 1966/ confirms our results about secular change of the period and it is shown that the statement put by Tsesevich /1966/ is not valid.

Table II.

Max. hel. J.D. 2400000+	E	O - C	Observer	Notes
15804.828	- 10145	- 0.011	Payne-Gaposchkin	pg
20251.450	- 2086	- 0.009	Zinner	v
21077.980	- 588	- 0.013	Robinson	pg
21402.427	0	000	Blazko	v
22081.6350	+ 1231	- 0.0065	Jordan	pg
22839.7576	+ 2605	+ 0.0002	Jordan	pg
24621.380	+ 5834	- 0.005	Parenago	pg
26477.504	+ 9198	+ 0.004	Detre	phm
26483.575	+ 9209	+ 0.005	Detre	phm
26488.542	+ 9218	+ 0.007	Detre	phm
26509.508	+ 9256	+ 0.006	Detre	phm
26520.545	+ 9276	+ 0.008	Detre	phm
26540.406	+ 9312	+ 0.006	Detre	phm
26556.407	+ 9341	+ 0.005	Detre	phm
26908.437	+ 9979	+ 0.013	Detre	phm
27260.457	+ 10617	+ 0.012	Detre	phm
27281.426	+ 10655	+ 0.014	Detre	phm
27311.200	+ 10709	- 0.007	Radlova	v
27543.4939	+ 11130	- 0.0034	Kleissen	pg

Table II. cont.

Max. hel. J.D. 2400000+	E	O - C	Observer	Notes
27558.390	+ 11157	- 0.005	Soloviev	v
27628.468	+ 11284	0.000	Soloviev	v
27927.516	+ 11826	- 0.005	Soloviev	v
27955.663	+ 11877	+ 0.002	Soloviev	v
28305.4779	+ 12511	+ 0.0023	Kleissen	pg
29360.431	+ 14423	- 0.007	Nachapkin	v
29456.447	+ 14597	+ 0.003	Tremko	pg
29461.422	+ 14606	+ 0.013	Tremko	pg
33453.391	+ 21841	+ 0.010	Tremko	pg
34130.377	+ 23068	- 0.011	Alania	pg
34457.580	+ 23661	- 0.001	Tremko	pg
35244.3875	+ 25087	- 0.0010	Detre	pe
35601.394	+ 25734	+ 0.018	Geyer	pg
36232.5813	+ 26878	- 0.0024	Geyer	pe
36305.4155	+ 27010	- 0.0053	Detre	pe
36343.4895	+ 27079	- 0.0016	Detre	pe
36348.4570	+ 27088	+ 0.0001	Detre	pe
36573.5685	+ 27496	- 0.0058	Detre	pe
36574.6705	+ 27498	- 0.0073	Detre	pe
36648.6094	+ 27632	- 0.0004	Detre	pe
36877.601	+ 28047	- 0.008	Satanova	pg
37025.458	+ 28315	- 0.006	Ahnert	v
38085.3844	+ 30236	- 0.0078	Tremko	pe
38448.4414	+ 30894	- 0.0078	Tremko	pe
38450.6447	+ 30898	- 0.0115	Tremko	pe
38464.4427	+ 30923	- 0.0074	Tremko	pe
38497.5455	+ 30983	- 0.0101	Tremko	pe
38789.977	+ 31513	- 0.011	Fitch	pe

The period for the interval J.D. 2436305 - J.D. 2438497 was derived from the photoelectric epochs of the mean light, obtained by Detre and Tremko /this paper/:

$$\text{Mean light}_{hel} = \text{J.D. } 2436305.3669 + 0.55175735 \times E \qquad /5/$$

The value of the period is lower as given by the equation /4/.

The epochs of the mean light on the ascending branch were tested for Blazko effect. The oscillation of the ascending branch is very small and lies within the limits of the observational errors. The heights of the maxima, the deeps of the minima and the heights of the hump at the ascending branch also do not show substantial variation. The presence or the absence of the brightening short before minimum in the observations of the different observers can be partly explained by the fact that the range of the brightening depends on wavelenght. The other couse can be longer exposures of some photographic observations.

The list of the epochs of the maxima, O - C differences and further data are collected in the Table II. The photoelectric epochs of the mean light which were used for the computation of the elements /5/ are in the Table III. and corresponding O - C differences are plotted on the Fig. 2. The photoelectric observations obtained at the Skalnaté Pleso Observatory were used for the construction of the U, B, V, light curves. The variable W CVn reaches in the V region the maximum brightness $10^{m}.065$ and in the minimum light $10^{m}.921$. Thus the amplitude of the light changes is $0^{m}.856$ which is in good agreement with the value derived from the photoelectric observations obtained by Detre in Budapest. M - m value derived from the V light curve is $0^{m}.153$ and the hump at the ascending branch is placed at the phase $0^{P}93$. The hump on the descending branch is located at the phase $0^{P}704$ and it is the most conspicuous in the B colour.

Table III.

Mean light. hel. J.D. 2430000 +	E	O - C	Observer	Notes
6305.3657	0	- 0.0012	Detre	pe
6348.4012	78	- 0.0028	Detre	pe
6574.6278	488	+ 0.0033	Detre	pe
6648.5609	622	+ 0.0009	Detre	pe
8085.3366	3226	+ 0.0005	Tremko	pe
8448.3925	3884	+ 0.0001	Tremko	pe
8450.5987	3888	- 0.0008	Tremko	pe
8497.4985	3973	- 0.0004	Tremko	pe

The colours in the maximum and in the minimum light are as follows:

	U - B	B - V
maximum	+ 0.071	+ 0.217
minimum	+ 0.070	+ 0.431

The U - B and B - V data for the minimum light differ only by 0.001 from those published by Sturch /1966/. The our observations confirm the supposition raised by Sturch /1966/ about the bluishing of the RR Lyrae-type variables with the P > $0^{d}.5$ around the phase $0^{P}.7$. The U, B, V light curves are on the Figures 3, 4 and 5.

COLOUR - COLOUR DIAGRAM

Three colour observations of the variable make possible to construct U - B/B - V diagram. For the construction of the two colour diagram the data from the Table IV. were used. Two colour diagram for the variable W CVn is rather complicated mainly owing to the bluer colour around the phase $0^{P}.70$. The numbers at the different points of the two colour diagram on Fig. 6. denote the phase of the light changes. From the absolute magnitude and from the photometric data we can determine the distance of the variable if the interstellar absorption is known. The absolute magnitude can be derived on the basis of the period - absolute magnitude relation for the RR Lyrae-type variable with a period greater than 0.45 days /Woolley et al. 1965/:

$$M = - 0^{m}.10 - 2.5 \log P \qquad /6/$$

The distance r then can be derived from the well known equation:

$$M_V = m_V + 5 - 5 \log r - A_V \qquad /7/$$

The value A_V can be computed from the reddening. According to Woolley et al. /1965/ the stars with z coordinate higher as 100 parsecs above the galactic plane and in higher galactic latitudes are reddened by 0.05 x cosec b. The investigation performed by Sturch /1966/ has shown that the value for the reddening term for the stars with $b > 56^{o}$ is 0.02 x cosec b only, if the excesively reddened regions in Taurus and Ophiuchus are omitted but the stars with $b > 70^{o}$ are kept. Thus the reddening for the variable is very low and reaches $0^{m}.034$ and then the total visual absorption $A_V = 0^{m}.103$ if we accept the numerical value 3.03 for the ratio of total to selective absorption /Wickramasinghe N. C. 1967/. The ratio of total to selective absorption depends on the position of the star in the Galaxy relative to the Sun and can reach considerable higher value. Thus the derived total absorption can be considered as the lowest value. Woolley et al. /1965/ on the basis of the study of high galactic latitude RR Lyrae-type variables derived following relation for the determination of the visual absorption:

$$A_V = 3 \left[/B/ - /V/ - 0.24 \right] \qquad /8/$$

The mean B - V value for W CVn is $0^{m}.374$ and according to relation /8/ the visual absorption reaches $0^{m}.402$. Geyer /1961/ has found that W CVn is reddened by $0^{m}.08$ which leads to the visual absorption of $0^{m}244$. The determination of the absorption according to the method derived by Woolley et al. /1965/ is very sensitive to the intrisic colour of the variable. The last term in the equation /8/ seems to be underestimated and the scatter in the B - V and mainly in U - B shows /Sturch 1966/ that even this high latitude sample of RR Lyrae-type variables is in this sense inhomogeneous. For these reasons we prefer the value of the visual absorption derived by the first method. As the median visual brightness $V = 10^{m}.606$ and the absolute visual magnitude computed from the equation /6/ $M_V = +0^{m}.54$, the resulting distance of the variable derived with the aid of the equation /7/ is 980 pc.

Table IV.

Phase	U - B	B - V
0.00	+ 0.071	+ 0.217
0.10	+ 0.099	+ 0.272
0.20	+ 0.104	+ 0.334
0.30	+ 0.155	+ 0.322
0.40	+ 0.113	+ 0.399
0.50	+ 0.122	+ 0.420
0.60	+ 0.022	+ 0.447
0.65	+ 0.007	+ 0.474
0.70	+ 0.143	+ 0.367
0.71	+ 0.157	+ 0.331
0.73	+ 0.186	+ 0.361
0.75	+ 0.150	+ 0.409
0.77	+ 0.113	+ 0.423
0.87	+ 0.044	+ 0.457
0.93	- 0.025	+ 0.254
0.95	+ 0.012	+ 0.257

CONCLUSION

The variable star W CVn is RRab type with stabile and smooth light curve excluding the hump on the ascending branch which is most pronounced in B colour. The period is not constant and the secular shortening from the earliest observations was found but Blazko effect is not present. Two colour diagram has a rather complicated form due to the brightening at the phase $0\overset{p}{.}7$. Due to high glactic latitude of the variable the interstellar absorption is low and the adopted value is $0\overset{m}{.}10$. We determined the absolute magnitude which is $M_V = + 0\overset{m}{.}54$ from the period - luminosity relation and after removing the interstellar absorption the distance of the variable r = 980 pc was found.

The author wishes to thank Prof. Dr. L. Detre for the opportunity to use the observing material of W CVn obtained at Konkoly Observatory and for many advices and stimulating discussions. He is indebted to the members of the staff of the Skalnaté Pleso observatory mainly to Messrs. L. Petrík, J. Petras and P. Zimmermann for assistance with 24-inch observing and for the help with the reductions of the photoelectric observations.

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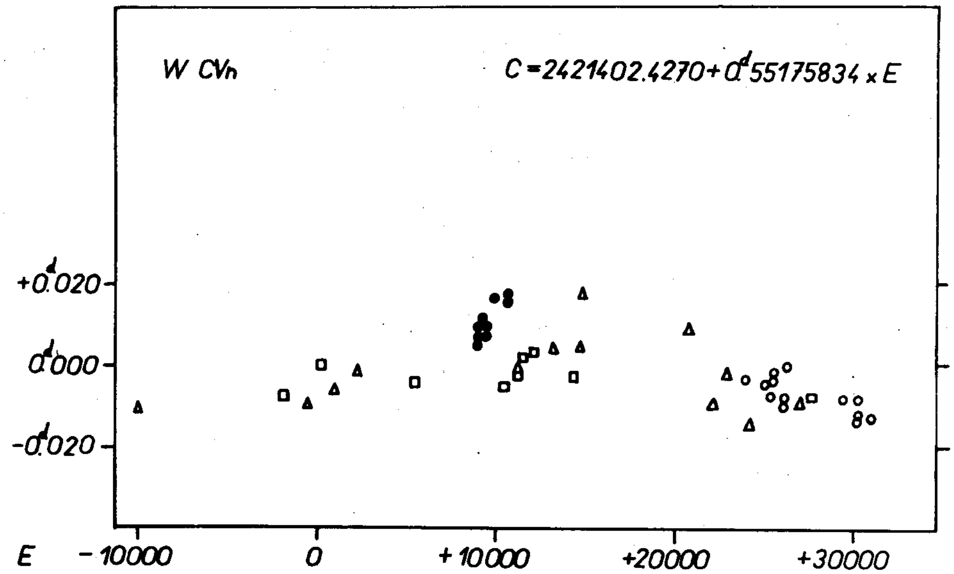

Fig. 1. O - C diagram for the epochs of maxima; squares denote visual observations, triangles photographic observations, full dots photometric observations and open circles photoelectric observations.

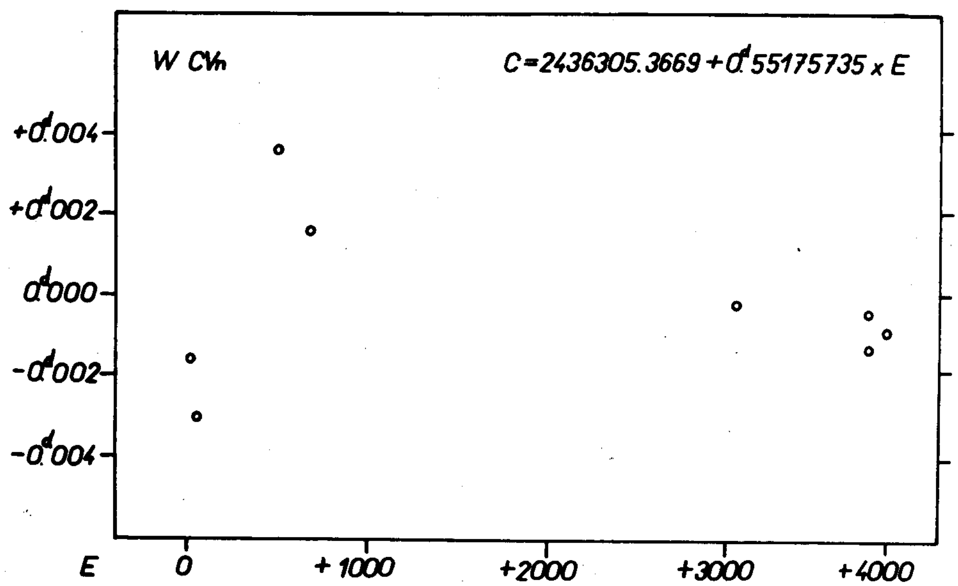

Fig. 2. O - C diagram for the epochs of the mean light from the Table III.

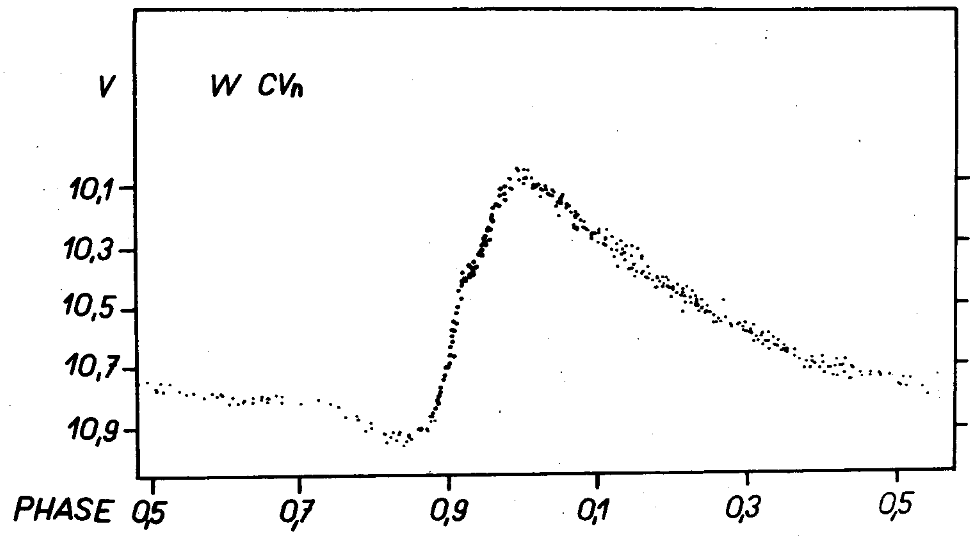

Fig. 3. V photoelectric light curve of W CVn. Full dots represent four observations, open circles represent two observations.

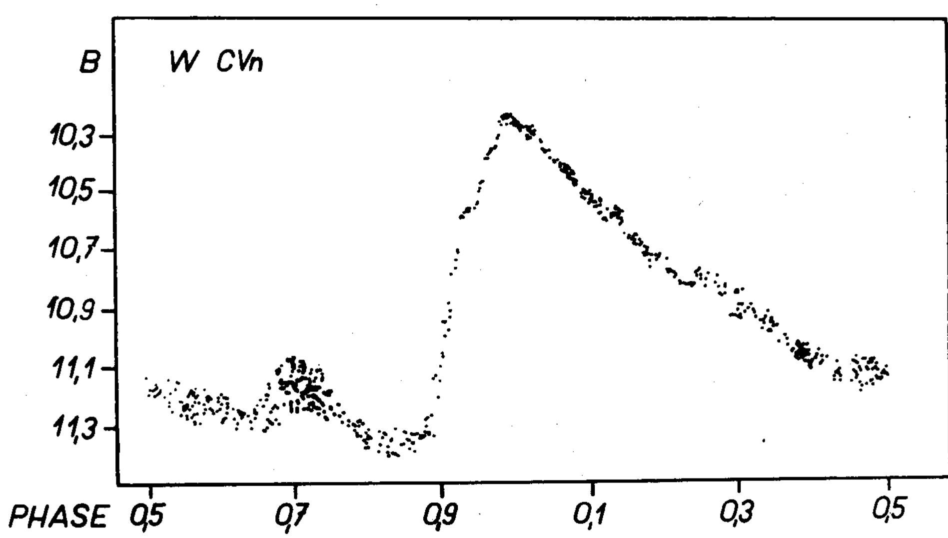

Fig. 4. B photoelectric light curve of W CVn.

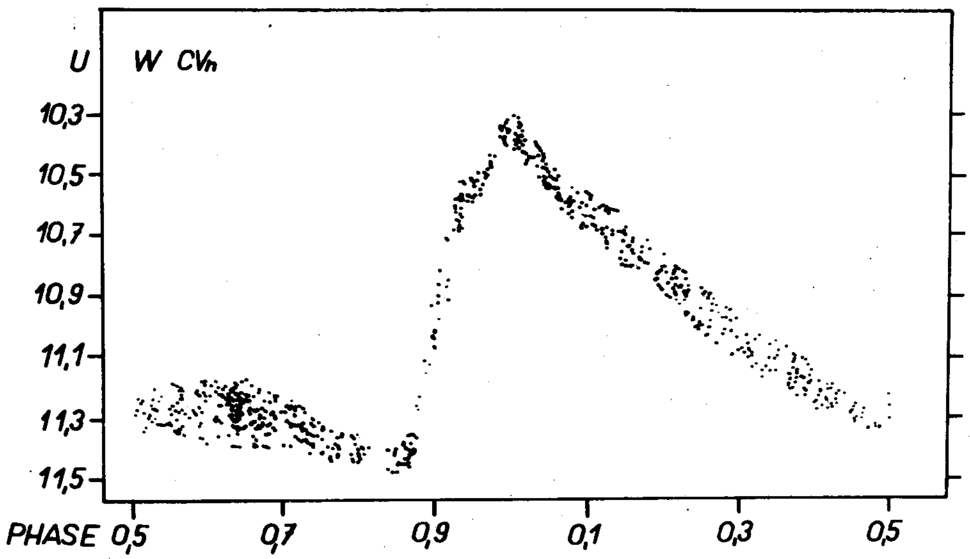

Fig. 5. U photoelectric light curve of W CVn.

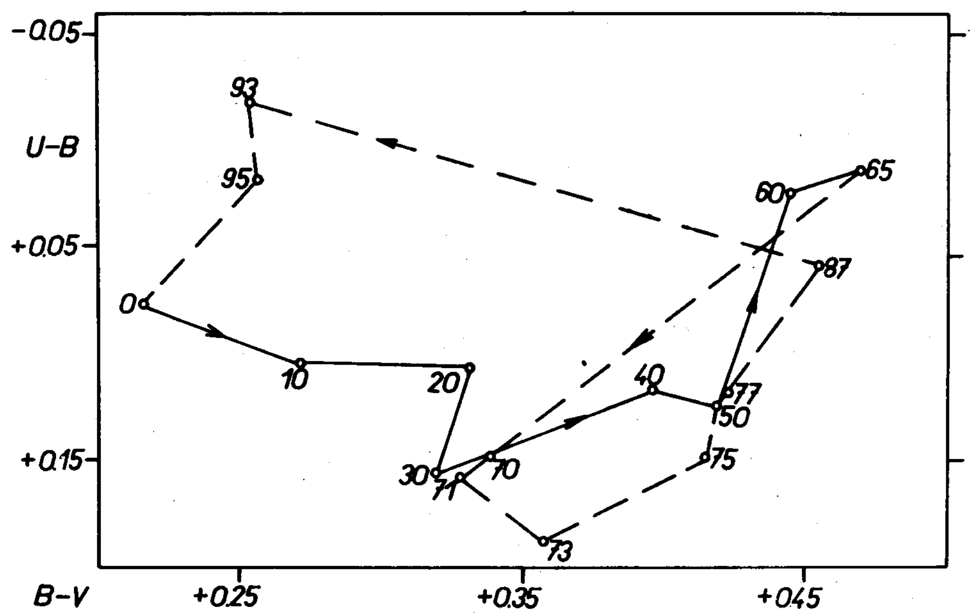

Fig. 6. Colour - colour diagram of W CVn. The numbers at the curve denote the phase.

A MAGYAR
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DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 68.

L. G. BALÁZS

DISTRIBUTION OF STARS OF SPECTRAL TYPES F7 AND EARLIER IN A LYRA REGION

BUDAPEST, 1975

DISTRIBUTION OF STARS OF SPECTRAL TYPES F7 AND EARLIER IN A LYRA REGION

SUMMARY

A study has been made of the spatial distribution of early type stars in a region of intermediate galactic latitude. Objective prism plates were used to survey an area of 19.5 □° in Lyra for all stars of spectral type F7 and earlier down to 13th photographic magnitude. 524 stars were detected, for which spectral types and photographic UBV colours were obtained. The stars were separated into four groups - spectral class A1 and earlier, A2-A7, A8-F2, and F3-F7 - and the space densities determined for each group. The space density curves show that the first two groups both appear to be composed of two kinematically distinct subsystems, each having a Gaussian velocity distribution but with a ratio of the velocity dispersions of 1.8:1. These two subsystems probably differ in age and it may be significant that the derived age difference, about 3×10^8 years, is close to the time-difference between two consecutive periods of star formation predicted by the density wave theory of spiral structure. Further observations, however, are needed to rule out other birth mechanisms having the same characteristic time.

INTRODUCTION

The distribution of the stars off the galactic plane is of considerable interest in order to understand some of the dynamical properties of our stellar system. To derive the three-dimensional distribution, we must analyse data concerning the apparent surface distribution in those galactic latitudes that are usually called "high" ($|b|$ approx. $\geq 40^\circ$) and "intermediate" (approx. $40^\circ \gtrsim |b| \geq 10^\circ$). The overwhelming majority of objects recognisable in high and intermediate galactic latitudes belongs to mean main-sequence stars and ordinary giants of spectral types A - K. In this paper we analyse stars F7 and earlier in an area of 19.5 □° in Lyra.

OBSERVATIONAL MATERIAL

An area of 19.5 square degrees centred on $l = 62.69^{\circ}$, $b = +15.99^{\circ}$ ($\alpha = 18^{h}42^{m}$, $\delta = +33^{\circ}20'$) was chosen for investigation. The observations were carried out with the 60/90/180 cm Schmidt telescope of the mountain station of the Konkoly Observatory. Spectral types and UBV colours were derived for 524 stars brighter than 13^{th} photographic magnitude. The spectral classes are based on three objective prism plates taken with a 5° UBK7 (uv transmitting) prism that gives a dispersion of 580 Å/mm at Hγ. Kodak OaO emulsions were used, and the widening was 18", equivalent to 0.16 mm on the plate. The classification criteria were those given by STOCK and SLETTEBAK (1959) and STOCK (1971). The plates were made with double exposures of 6^{m} and 24^{m} so that any systematic variations in the classification with photographic density could be estimated.

The UBV photometry is based on four plates taken in each colour. The filters, emulsion types, and exposure times used are given in the following table:

U:	Kodak OaO + Schott UG1 2 mm filter	exp. time: 10^{m}
B:	Kodak OaO + Schott GG13 2 mm filter	" " : 5^{m}
V:	Kodak OaD + Schott GG14 2 mm filter	" " : 4^{m}

The international system is connected with the instrumental system according to the equations:

$$V_{instr} = V - 0.05(B-V) - 0.01$$
$$(B-V)_{instr} = 1.08(B-V) + 0.04$$
$$(U-B)_{instr} = 1.11(U-B) - 0.04(B-V) + 0.02$$

The plates were measured with the Becker-type iris photometer of the Konkoly Observatory, using a photoelectric sequence obtained with the Konkoly Observatory 60 cm photometric telescope. The mean errors of the photographically determined colours are $\pm 0^{m}.08$, $0^{m}.07$ and $0^{m}.06$ for U, B, and V, respectively.

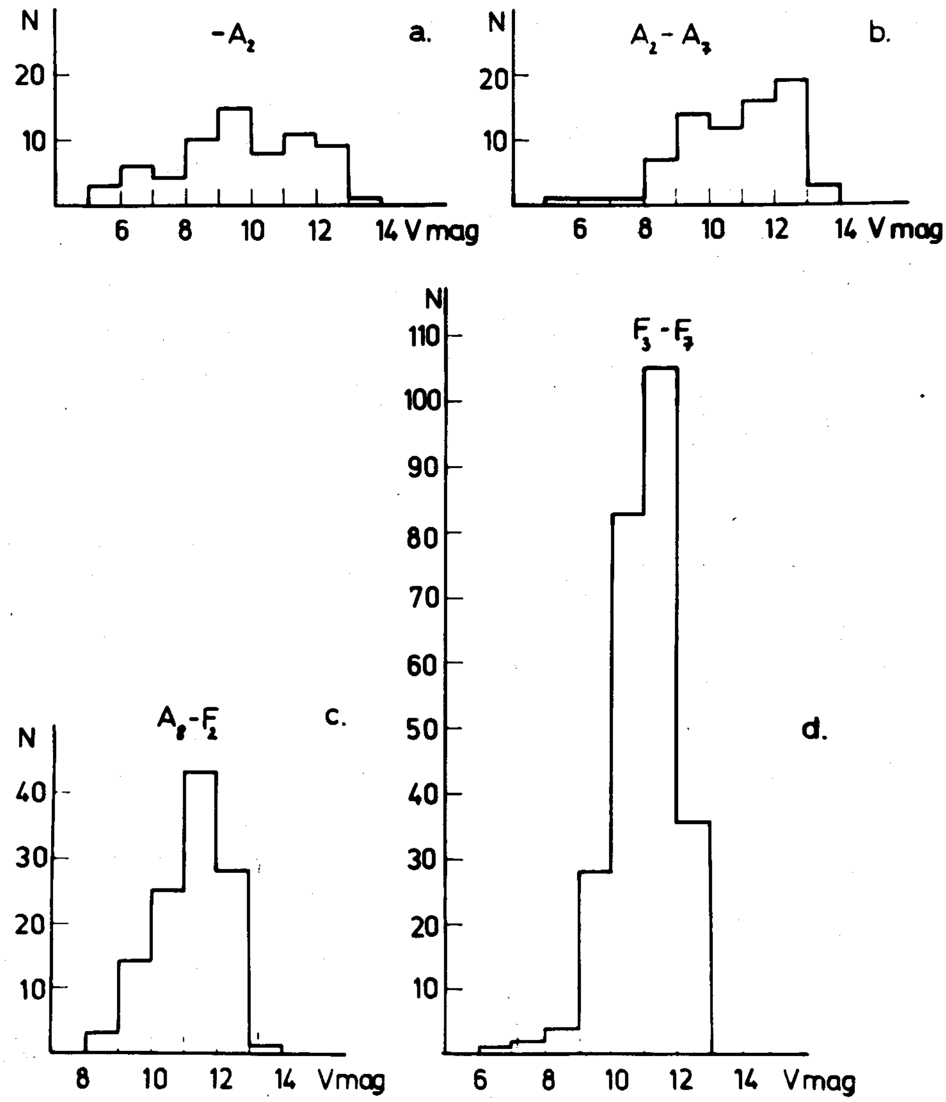

Figure 1.a.-d. The distribution of the stars against V magnitude.

THE SPACE DISTRIBUTION OF THE STARS

According to the sharpness of the classificational criteria and to the number of stars in each subclass four subgroups were determined: Stars earlier than A2, A2-A7, A8-F2, and F3-F7. The distribution of the stars against the V magnitude, in the subgroups defined, are demonstrated in Figs. 1a-1d. For determining the interstellar absorption the stars in each subgroup were divided into five groups according to their visual brightness: <7; 7-9; 9-11; 11-12; and >12. For each subgroup mean spectral types and colour indices were determined. Adopting JOHNSON's (1963) relation between intrinsic colour indices and spectral types the E_{B-V} and E_{U-B} colour excesses were obtained. The colour excesses determined by this method are plotted in Fig. 2. as a function of the distance modulus obtained by substracting from the mean V magnitude of each subgroup the absolute magnitude belonging to the mean spectral type. Adopting a ratio of total to selective absorption $R = A_V/E_{B-V} = 3$ for the total absorption a value $A_V = 0.06\rho$ could be obtained, where $\rho = V-M_V$. According to this formula the absorption in the observed direction at a distance of 300 pc amounts to 75% of the absorption at 1000 pc indicating that the interstellar dust is concentrated in a 80 pc half thick layer along the galactic plane for this galactic longitude. Our determination is in good agreement with FITZGERALD's (1968) data ($0.1 \leq E_Y < 0.2$) for this area.

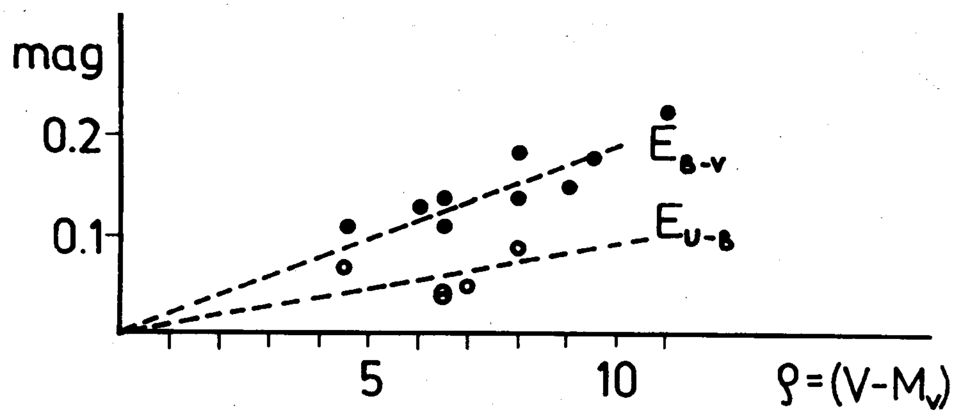

Figure 2. The colour excesses (E_{B-V} and E_{U-B}) as functions of uncorrected distance modulus.

The space densities were derived by grouping the stars in order of the distance modulus, obtained from the measured V magnitude and the mean absolute magnitude of the spectral type, corrected for the absorption and dividing the number of stars by the volume containing them. Assuming a Gaussian distribution of absolute magnitudes at a given spectral type the mean absolute magnitude at a given visual brightness can be obtained using the basic convolution equation of stellar statistics. The computation results the formula (MALMQUIST 1936)

$$\overline{M(m)} = M_o - \frac{\sigma^2}{A(m)} \frac{dA(m)}{dm}$$

where M_o, σ, and $A(m)$ are the intrinsic absolute magnitude, the standard deviation of the Gaussian distribution, and the number of stars in a m $\pm\frac{1}{2}$ interval, respectively.

The densities derived by this method are plotted in Figs. 3a-3d. The dashed lines show the limit of the completness of the sample caused by the limiting magnitude of classification. We shall discuss in the following section the spatial-distribution of the stars of each subclass separately and in more detail.

DISCUSSION OF THE SPACE DENSITIES

The density-gradients ($\frac{\partial\nu}{\partial r}$) of the different subgroups are nearly the same up to 600 pc, except for the break-down caused by the plate limit. At about 600pc the density-gradient of the A2-A7 stars changes and becomes smaller. A similar change is visible in the distribution of stars younger than A2 at 1000 pc but it is based on a small number of stars and therefore its singificance is questionable. Other authors (VAN RHIJN 1955, KUROCHKIN 1958, PERRY 1969, WOLLEY and STEWARD 1967), however, derived a similar change in the density gradient at stars younger than A2 so this effect in our case seems to be realistic. The spatial distribution of the A stars near the galactic poles shows a similar space density curve as those stars in our case. The similarity between this distributions and those obtained by the present investigation suggests that the observed density gradients of stars younger than A2, and A2-A7, in our case, are mainly due to the contributions of the gradients perpendicular to the galactic plane to the gradient in the line of sight.

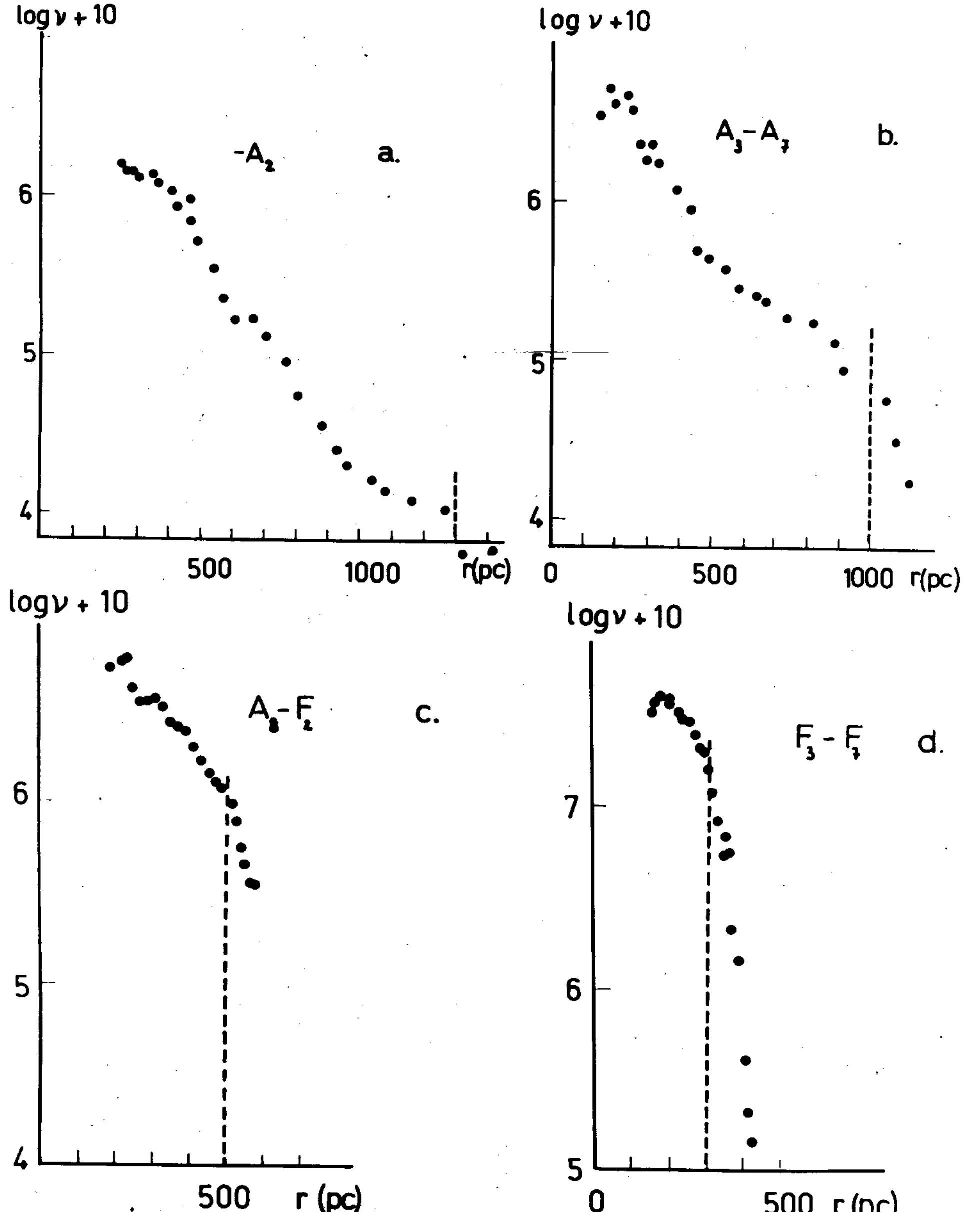

Figure 3.a.-d. The derived space densities of the different subgroups. (The dashed lines show the limit of the completness of the sample.)

Supposing that the distribution of stars in the phase space is an even function of the Z velocity component we can derive the following relation connecting the spatial density, the standard deviation of the Z velocity component and the gravitational potential (OGORODNIKOV 1965):

$$\frac{\partial(\nu\sigma_z^2)}{\partial z} = -\nu \frac{\partial\Phi}{\partial z}$$

After integration and elementary computations we obtain:

$$\sigma_z^2(z) = -\frac{\nu(0)}{\nu(z)}\{\int_0^z \frac{\partial\Phi}{\partial z}\frac{\nu(z)}{\nu(0)}\, dz - \sigma_z^2(0)\}$$

In our case we can take ν from our observations making the assumption that ν depends mainly on the z coordinate. We assume that the same holds for $\frac{\partial\Phi}{\partial z}$ in the direction observed and take it from the observations in the galactic caps (reviewed by OORT 1965). $\sigma_z(0)$ may be varied inside reasonable limits according to the observed data. If the formula given above has resulted a horizontal straight line in the $\sigma_z(z)$;z diagram we should assume that the velocity distribution, in the area observed, is Gaussian, since in that case $\sigma_z(z)$ is independent of z. Using the eye-estimated density curve of the stars A2-A7 derived from our observations and substituting $\sigma_z(0)=6.8$ km/sec we get the curve plotted in Fig.4. The curve runs approximately horizontally up to 70pc and above 180 pc, and the ratio of the velocity dispersions characterising the two horizontal parts of the curve equals to 1:1.8. Nearly the same ratio (1:2) was observed by WOOLLEY et al. (1969) and HARDING et al. (1971) for A0 stars in the south galactic cap. For $\sigma_z(0)$ they obtained 9 km/sec. Therefore the shape of the density curve may be explained as a superposition of two Gaussian velocity distributions having the above ratio of the velocity dispersions. At z = 0 the ratio of the densities of the two subsystems equals to about 1:7, and 1:70 in the case of stars younger than A2 if we adopt the change of the density gradient at r = 1000 pc as a real effect. It is to be mentioned that JONES (1972) found that the M giants in the south galactic cap had a similar dispersion dependence to those plotted in Fig.4. His $\sigma_z(0)= 7$ km/sec agrees very well with our value but the increase of velocity dipersion is stronger than in our case.

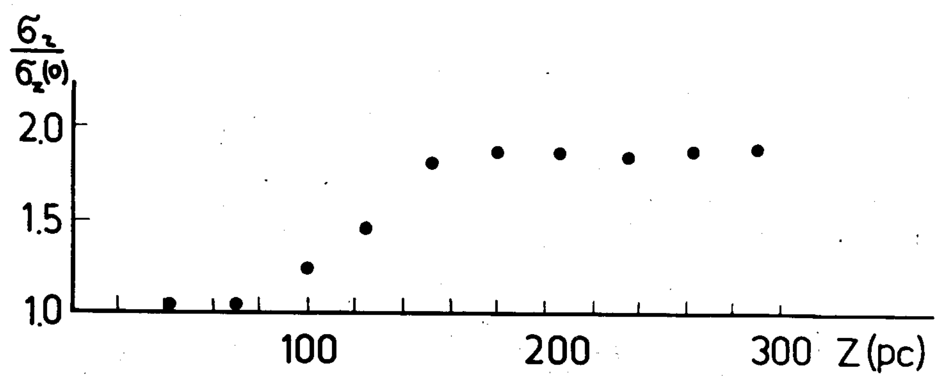

Figure 4. The $\sigma_z(z)/\sigma_z(0)$ ratio computed from the density curve of A2-A7 stars plotted against the height (z) above the galactic plane.

The explanation that the shape of the density curve and the z dependence of the velocity dispersion of the A type stars caused by a condensation of those stars around the sun seems to be improbable, because the search for determining the spatial density of these stars, reported by McCUSKEY (1965), does not show significant condensation in the direction of our observed area projected onto the galactic plane. Moreover the condensations are different at different spectral types but in our case the density gradients are nearly independent of the spectral type at the first part of the density curves.

The less compact subsystem is more prominent among the A2-A7 stars than among stars earlier than A2, which have mostly a spectral type B8 or later. Fig. 5 shows the logarithmic ratio of the density of the less compact component to the total density at z=0 using the data of different investigators. The most prominent feature in this figure is the "break" at A0 in the values of the ratios.

If stars are born continuously the exsistence of two kinematically different subsystems would be difficult to explain. This supports the idea of steplike birth. Taking into account that the

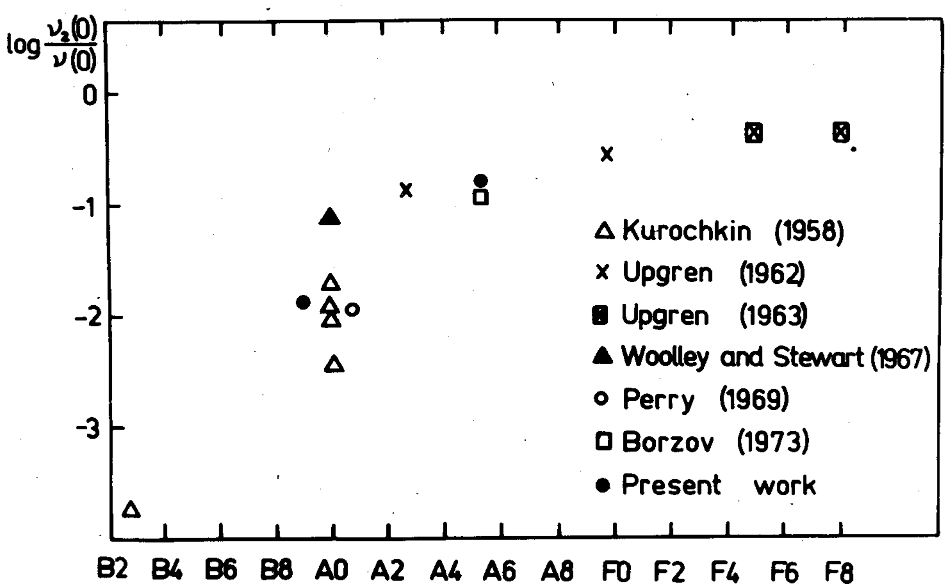

Figure 5. The logarithm of the ratio of the density of the less compact component to the total density at z=0 using the data of different investigators.

young stars are more concentrated to the galactic plane than the older stars and that the less compact subsystem increases in its prominence towards stars having longer lifetimes it is reasonable to suppose that the two kinematically different subsystems differ in age,too. The time difference between two "birth events" may be estimated by the lifetime of the stars at which the "break" appears in Fig. 5. Using the theoretical lifetimes published by IBEN (1967) and the empirical bolometric absolute magnitudes of DAVIS and WEBB (1970) and the absolute visual magnitudes of JUNG (1970, 1971) the lifetimes of the A0 stars are about $3x10^8$years. The uncertainties of the spectral classification of the late type B and early type A stars on spectrograms of small scale determine a confidence interval around AO in Fig. 5. The edges of this interval are the spectral types B8 and A2. The lifetime τ of the stars at which the "break" appears lies therefore in the interval: $1.5x10^8$yrs<τ<$5.5x10^8$yrs. According to the density wave theory (LIN and SHU 1964, 1966, LIN et al. 1969), a stream of stars and interstellar matter passes the density wave twice in a rotational period generating a shock wave in the interstellar matter (ROBERTS 1969) which causes a high stellar birth rate. The time between two passages equals to $2.5x10^8$years at the distance of the sun from the galactic centre. Our estimated time of $3x10^8$years is close to this theoretical value within the uncertainties of the estimation.

According to this picture the newly formed stars in the shock front of the density wave would have nearly circular orbits and a small velocity dispersion. As WOOLLEY and CANDY (1968) pointed out the interaction between the irregularities of the galactic gravitational field and the stars having small eccentricity orbits causes an increase of the eccentricity and,consequently, of the velocity dispersion perpendicular to the galactic plane. Therefore the older subsystem has a greater dispersion.

On the basis of the present observational material it is not possible to rule out other birth mechanisms having the same characteristic time. However, in directions in which the distances to the shock front along the stream lines and consequently the time passed are different we may expect differences in the changes of the velocity dispersions and of the spatial densities perpendicular to the galactic plane.

CONCLUSIONS

The shape of the space density curve of the B8-A1 and A2-A7 type stars may be explained as a superposition of two Gaussian velocity distributions having a ratio of the velocity dispersions of 1:1.8. The existence of two kinematically different subsystems supports the idea of steplike formation of the stars. The time difference between two "birth events", about $3x10^8$years, is close to the time the star streaming needs between two passages of the density wave. On the basis of the present observational material it is not possible to rule out other birth mechanisms having the same characteristic time. Observations in directions in which the distances to the shock front along the stream lines are different may solve the problem.

ACKNOWLEDGEMENTS

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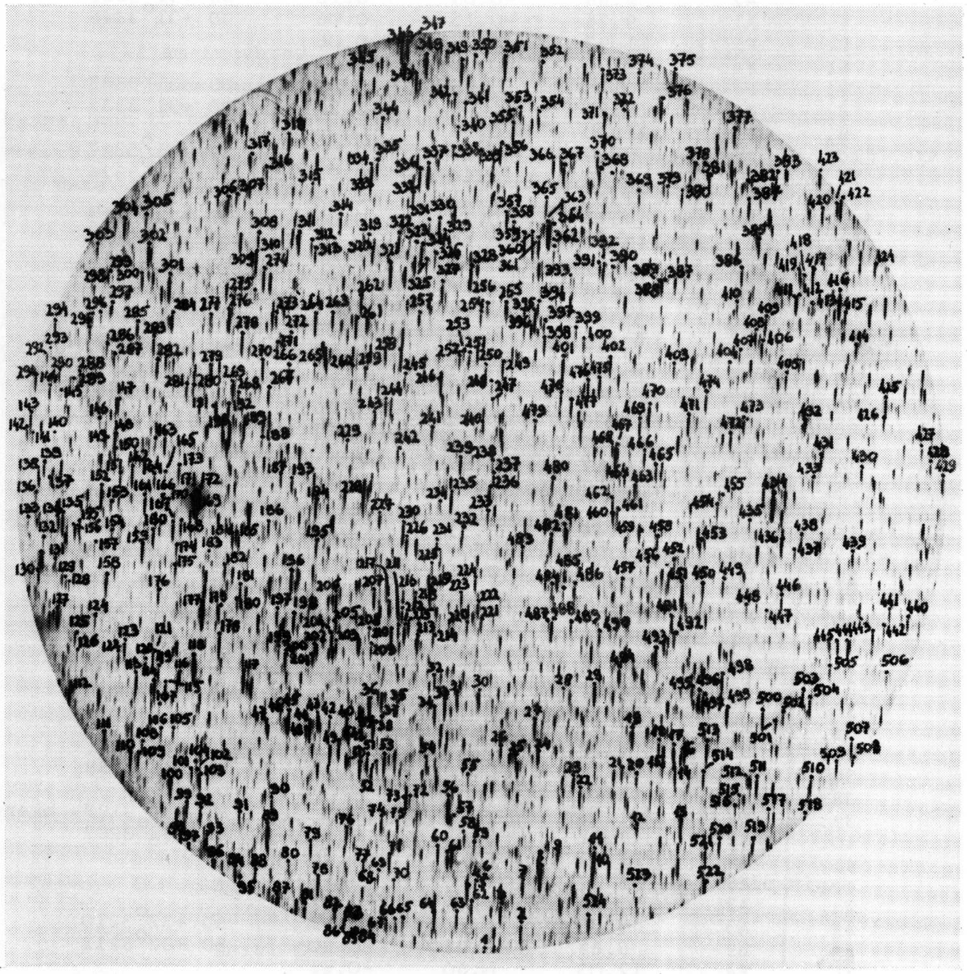

Finding chart of the survey stars. North is at the top and East is at the left.

TABLE

Spectra and UBV data of the survey stars

No.	Sp.	V	B-V	U-B	remarks
1.	A1	10.86	-0.19	0.01	BD $+31^{\circ}3341$
2.	F5	9.97	0.39	-0.05	BD $+31^{\circ}3334$
3.	A2	9.86	-0.07	0.15	BD $+31^{\circ}3338$
4.	A1	9.76	-0.15	0.06	BD $+31^{\circ}3346$
5.	F5	11.92	0.19	0.06	
6.	F4	12.32	0.38	-0.05	
7.	F7	10.18	0.45	0.02	BD $+31^{\circ}3333$
*8.	A1	6.39	-0.04	-0.26	BD $+31^{\circ}3332$
9.	F5	11.30	0.56	-0.03	
*10.	A2	7.37	0.28	0.05	BD $+31^{\circ}3327$
11.	F7	9.94	0.44	-0.02	BD $+31^{\circ}3326$
12.	F6	11.45	0.51	-0.12	
*13.	A3	9.17	0.16	0.05	BD $+31^{\circ}3317$
14.	F5	10.50	0.49	-0.07	
15.	F5	12.09	0.54	-0.06	
16.	A2	11.84	0.27	0.18	
17.	F6	10.67	0.32	0.07	
18.	A3	11.69	0.20	0.06	
*19.	A1	9.88	0.30	0.03	BD $+32^{\circ}3177$
20.	F2	12.03	0.43	-0.08	
*21.	A7	11.50	0.39	0.07	
22.	B2	11.36	-0.14	0.16	
*23.	F0	10.70	0.29	0.04	
24.	F5	10.67	0.57	-0.11	BD $+32^{\circ}3184$
*25.	F5	11.59	0.65	-0.11	
26.	F5	11.44	0.52	-0.07	
*27.	F2	10.36	0.37	0.00	BD $+32^{\circ}3186$
28.	F4	12.84	0.85	-	
29.	A9	9.78	0.34	-0.07	BD $+32^{\circ}3178$
*30.	F3	11.04	0.35	-0.05	
*31.	F1	10.80	0.27	-0.03	
*32.	A7	11.65	0.27	0.01	BD $+32^{\circ}3199$
*33.	F2	10.34	0.53	0.05	
34.	F7	10.26	0.60	-0.09	BD $+32^{\circ}3191$
35.	A7	11.91	0.20	0.02	
36.	B9	9.22	-0.06	-0.08	
37.	F3	12.35	0.46	-0.20	BD $+32^{\circ}3199$
38.	F5	12.10	-	-	blend
39.	F7	9.10	-	-	BD $+32^{\circ}3198$, blend
40.	A2	8.91	-0.01	0.10	BD $+32^{\circ}3203$
41.	A3	11.43	0.11	-0.09	
42.	A6	11.99	0.40	-0.14	
43.	A2	10.83	0.36	-0.01	
44.	A3	8.55	0.30	0.13	BD $+32^{\circ}3210$
45.	B9	8.89	-0.05	-0.20	BD $+32^{\circ}3212$
46.	F4	12.03	0.50	-0.21	
47.	F2	11.38	0.38	-0.06	
48.	A7	11.54	0.48	-0.25	
49.	A8	9.30	0.16	-0.02	BD $+32^{\circ}3204$
50.	F7	9.80	0.57	0.00	BD $+31^{\circ}3360$

Table

/Continued/

No.	SP.	V	B-V	U-B	remarks
51.	F6	9.92	0.69	0.18	
52.	A5	12.64	0.49	-0.26	
53.	A9	10.30	0.29	-0.07	BD +31°3358
54.	F6	10.91	0.57	-0.20	
*55.	A3	12.79	0.33	-0.02	
*56.	A9	5.68	0.35	0.00	BD +31°3348
57.	A7	12.59	0.36	-0.22	
58.	A7	11.81	0.24	-0.16	
59.	A4	12.41	0.16	-0.13	
60.	F6	10.04	0.42	-0.06	BD +31°3349
61.	F5	10.47	0.35	-0.15	
62.	A5	10.91	0.28	-0.07	
63.	F5	10.68	0.37	-0.25	
64.	F6	9.31	0.40	-0.15	BD +31°3350
65.	F3	12.27	0.43	-0.06	
66.	F5	12.75	0.30	-0.27	
67.	A5	12.03	0.14	-0.07	
68.	A6	13.00	0.29	-0.22	
69.	F6	11.61	0.43	-0.20	
70.	A7	12.50	0.35	-0.16	
71.	A7	10.62	-0.17	-0.39	BD +31°3354
72.	F0	12.47	0.44	-0.25	
73.	F5	10.01	0.34	-0.02	BD +31°3352
74.	F5	11.45	0.53	-0.05	BD +31°3357
75.	F5	11.65	0.36	-0.14	
76.	F4	10.96	0.19	-0.01	
77.	F0	11.57	0.31	0.01	
78.	F0	9.27	0.26	0.03	BD +31°3362
79.	A7	10.21	0.08	0.09	BD +31°3363
80.	F0	11.75	0.25	-0.12	
81.	F5	10.62	0.37	0.01	
82.	F2	11.79	0.22	0.03	
83.	F5	11.82	0.33	-0.15	
84.	A9	11.02	0.14	0.19	
85.	F2	12.54	0.43	-0.05	
86.	F4	11.50	0.18	-0.02	
87.	A6	9.58	0.09	0.10	BD +31°3368
88.	F5	11.08	0.40	-0.07	
*89.	B4	6.04	-0.14	-0.61	BD +31°3369
90.	F1	11.42	0.25	-0.09	
91.	A5	11.88	0.21	0.00	
92.	A0	10.86	0.00	0.03	BD +31°3372
93.	F0	10.89	0.14	-0.02	
94.	F2	11.87	0.36	-0.27	
95.	F2	11.28	0.26	-0.10	
96.	A0	8.48	-0.05	-0.09	BD +31°3371
*97.	B6	6.62	-0.01	-0.11	BD +31°3373
98.	A2	9.44	-0.08	0.05	BD +31°3374
99.	F1	10.95	0.28	-0.06	
100.	F5	10.56	0.47	-0.06	

Table
/Continued/

No.	Sp	V	B-V	U-B	remarks
101.	F2	11.28	0.31	0.05	
102.	F6	12.21	0.86	-0.20	
103.	F4	10.62	0.36	-0.02	
104.	F0	12.43	0.44	-0.32	
105.	F6	11.8	-	-	blend
106.	F4	12.24	0.45	-0.27	
107.	A9	13.03	0.52	-0.10	
108.	F1	12.01	0.34	-0.10	
109.	F1	11.53	0.28	-0.19	
110.	A9	10.71	0.07	0.16	BD $+31^{\circ}3379$
111.	F7	10.81	0.76	0.24	
112.	F5	9.82	0.37	0.08	BD $+32^{\circ}3238$
113.	F4	9.87	0.30	0.06	BD $+32^{\circ}3233$
114.	B9	9.83	-0.05	0.17	BD $+32^{\circ}3230$
115.	A7	10.58	0.19	0.04	BD $+32^{\circ}3229$
116.	F5	11.0	-	-	
117.	A3	8.56	0.14	0.10	BD $+32^{\circ}3221$
*118.	A3	5.22	0.11	0.03	BD $+32^{\circ}3228$
119.	F5	11.10	0.56	-0.13	
120.	A9	11.62	0.24	-0.09	
121.	F5	10.64	0.40	0.01	
122.	F4	11.50	0.47	-0.19	
123.	F3	10.14	0.34	0.09	BD $+32^{\circ}3235$
124.	F5	12.14	0.42	-0.14	
125.	F4	11.96	0.50	-0.19	
126.	F2	12.75	0.59	-0.07	
127.	A2	9.70	-0.01	0.19	BD $+32^{\circ}3242$
128.	F6	12.41	0.57	-0.18	
129.	F5	12.29	0.57	-0.30	
130.	F5	11.31	0.34	-0.02	
131.	A4	12.34	0.29	-0.06	
132.	F3	12.39	0.85	-0.10	
133.	F4	12.46	0.58	-0.21	
134.	F4	11.20	0.36	0.04	
135.	A0	8.83	0.03	0.26	BD $+33^{\circ}3245$
136.	F4	12.21	0.61	-0.18	
137.	F5	12.54	0.73	-0.23	
138.	F3	10.94	0.26	0.11	
139.	F5	11.02	0.37	-0.03	
140.	F3	12.83	0.64	-	
141.	F5	12.44	0.54	-0.21	
142.	A5	11.87	0.25	0.01	
143.	A5	10.50	0.11	0.18	
144.	F5	11.15	0.54	-0.04	
145.	A3	12.83	0.61	-	
146.	A	12.92	0.76	-	
147.	F2	11.01	0.48	0.13	BD $+33^{\circ}3239$
148.	F2	10.39	0.36	0.08	BD $+33^{\circ}3238$
149.	F4	12.46	0.57	-0.24	
150.	A4	12.07	0.37	-0.07	

Table
/Continued/

No.	Sp.	V	B-V	U-B	remarks
151.	F2	11.8	-	-	blend
152.	B8	8.65	0.08	0.04	BD +33°3241
153.	F6	12.38	0.62	-0.18	
154.	A8	12.24	0.41	0.05	
155.	F1	10.74	0.35	0.14	BD +33°3244
156.	F6	10.99	0.42	0.03	
157.	A6	12.72	0.51	-0.21	
158.	A1	11.63	0.03	-0.10	
159.	F3	9.89	0.54	0.10	BD +32°3234
160.	F1	10.17	0.29	0.14	BD +32°3232
161.	A4	9.75	0.14	0.33	BD +33°3232
162.	F2	9.09	0.51	-0.01	BD +33°3236
163.	A8	12.17	0.57	-0.16	
164.	A6	11.69	0.30	0.03	
165.	F3	12.43	0.58	-0.19	
166.	F0	12.15	0.51	-0.09	
167.	F6	10.8	-	-	BD +33°3228 blend
168.	F4	11.03	0.47	0.07	
169.	F3	10.1	-	-	blend
170.	B2	7.0	-	-	blend
171.	A1				BD +33°3223, β Lyrae
172.	A7	9.79	0.23	0.43	
173.	A9	10.97	0.65	0.08	
174.	F6	11.44	0.56	-0.02	
175.	F1	11.58	0.59	0.00	
176.	A2	11.38	0.31	0.19	
*177.	B2	5.89	-0.16	-0.65	BD +32°3227
178.	F6	8.66	0.56	0.10	BD +32°3223
179.	A8	10.86	0.29	0.23	
180.	F5	11.98	0.59	-0.19	
181.	F3	11.01	0.51	-0.03	
182.	F6	10.67	0.41	0.37	
183.	F6	11.77	0.59	-0.16	
184.	F5	11.11	0.46	0.09	
185.	F3	11.92	0.43	0.07	
186.	F5	11.16	0.50	-0.01	
187.	F0	11.42	0.64	0.06	
188.	F0	12.50	0.61	-	
189.	F2	10.24	0.44	0.06	
190.	A2	6.84	0.37	0.09	BD +33°3215
191.	F7	10.61	0.52	0.14	BD +33°3219
192.	F0	10.44	0.35	0.18	
193.	F0	11.6	-	-	blend
194.	F5	9.9	-	-	BD +33°3204, blend
195.	F3	11.08	0.45	0.01	
196.	A5	9.00	0.19	0.25	BD +32°3214
197.	F4	10.93	0.45	0.05	
198.	F2	10.12	0.43	0.00	
199.	F4	12.19	0.64	-0.28	
200.	F2	10.80	0.37	0.03	

Table

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No.	Sp.	V	B-V	U-B	remarks
201.	F0	11.48	0.48	-0.03	
202.	F6	11.92	0.58	-0.19	
203.	F6	11.41	0.55	-0.19	
204.	F6	10.28	0.51	0.04	BD $+32^{\circ}3208$
205.	A5	11.98	0.13	0.16	
206.	F5	10.01	0.40	0.09	BD $+32^{\circ}3207$
207.	F2	9.89	0.38	0.18	BD $+32^{\circ}3200$
208.	F5	12.06	0.65	-0.28	
209.	F5	11.67	0.59	-0.15	
210.	A4	9.77	0.19	0.15	BD $+32^{\circ}3195$
211.	F3	11.54	0.52	-0.19	
212.	F2	10.13	0.40	0.00	
213.	F6	10.43	0.56	-0.03	BD $+32^{\circ}3194$
214.	F0	12.27	0.42	-0.04	
215.	F5	10.54	0.58	0.00	
216.	F2	11.62	0.50	-0.10	
217.	F1	11.18	0.16	0.02	
218.	F2	10.68	0.43	0.02	
219.	A1	9.76	0.13	0.16	BD $+32^{\circ}3193$
220.	A7	11.23	0.44	0.19	
221.	A3	11.76	0.27	0.13	
222.	F5	10.97	0.58	0.03	
223.	F1	10.77	0.66	0.15	
224.	F5	10.90	0.49	-0.02	
225.	F6	12.25	0.61	-0.19	
226.	A6	10.21	0.13	0.19	BD $+33^{\circ}3193$
227.	F0	11.01	0.27	0.09	BD $+33^{\circ}3196$
228.	A4	9.57	0.19	0.17	BD $+33^{\circ}3200$
229.	F6	11.87	0.75	-0.22	
230.	F6	9.35	0.47	-0.06	BD $+33^{\circ}3194$
231.	F5	11.03	0.40	0.15	
232.	B9	11.62	0.07	0.07	
233.	F5	11.92	0.17	0.02	
234.	A3	12.70	0.30	-0.16	
235.	A5	8.99	0.21	0.20	BD $+33^{\circ}3188$
236.	F4	11.08	0.38	0.09	
237.	F0	11.48	0.40	-0.03	
238.	F3	12.49	0.61	-0.28	
239.	F4	9.71	0.48	0.19	BD $+33^{\circ}3187$
240.	A3	11.5	-	-	
241.	F0	11.33	0.27	0.17	
242.	F5	11.14	0.58	-0.26	
243.	F5	11.04	0.51	-0.17	
244.	F6	10.29	0.47	0.14	
245.	F5	11.97	0.45	-0.26	
246.	F7	7.56	0.83	0.14	BD $+33^{\circ}3190$
247.	F5	11.3	-	-	
248.	A9	12.23	0.61	-0.08	
249.	F5	10.15	0.69	0.16	BD $+33^{\circ}3185$
250.	F5	11.57	0.58	0.05	

Table
/Continued/

No.	Sp.	V	B-V	U-B	remarks
251.	F5	11.63	0.61	0.11	BD +33°3186
252.	F4	11.44	0.70	-0.06	
253.	A0	12.50	0.32	-0.23	
254.	F6	11.13	0.70	0.06	
255.	F6	10.69	0.73	0.08	
256.	F6	11.42	0.91	-0.05	
257.	A7	10.33	1.56	1.28	
258.	A0	9.45	0.10	0.20	BD +33°3195
259.	F6	11.90	0.68	-0.18	
260.	A1	12.43	0.40	-0.02	
261.	F6	9.59	0.55	0.18	BD +34°3313
262.	F6	9.52	0.61	0.13	BD +34°3314
263.	F1	10.34	0.36	0.10	
264.	F7	8.17	0.57	0.06	BD +34°3317
265.	F0	12.25	0.53	-0.21	
266.	F5	12.19	0.53	-0.24	
267.	F0	10.35	0.30	0.19	BD +33°3210
268.	F4	11.52	0.40	0.08	
269.	B5	11.25	-0.04	-0.38	
270.	F6	8.78	0.54	0.10	BD +33°3212
271.	F1	11.85	0.45	0.05	
272.	A8	12.36	0.41	-0.11	
273.	F5	10.78	0.65	0.09	
274.	A4	8.81	0.29	0.21	BD +34°3325
275.	F5	12.46	0.58	-0.17	
276.	A0	7.82	0.25	0.26	BD 34°3729
277.	F4	11.89	0.36	0.07	
278.	F7	8.35	0.58	0.20	BD +33°3214
279.	F5	10.18	0.44	0.14	BD +33°3221
280.	F6	11.59	0.55	-	
281.	F3	11.19	0.44	-0.06	
282.	F6	10.00	0.44	0.17	BD +33°3231
283.	A4	10.10	0.13	0.24	BD +33°3233
284.	A3	9.55	0.36	0.30	BD +34°3333
285.	F2	10.89	0.33	0.09	BD +34°3338
286.	F5	12.09	0.51	-0.11	
287.	F4	11.58	0.42	-0.06	
288.	F5	12.60	0.59	-0.19	
289.	F3	12.0	-	-	
290.	F5	11.60	0.49	0.04	
291.	F3	11.12	0.23	0.13	
292.	F6	11.76	0.76	-0.02	
293.	F5	12.52	0.68	-0.30	
294.	A3	11.53	0.29	0.12	
295.	F6	11.16	0.61	-0.15	
296.	F4	12.27	0.70	-0.36	
297.	F2	10.49	0.21	0.76	BD +34°3340
298.	A4	13.09	0.41	-0.31	
299.	A0	12.02	0.00	-0.16	
300.	A7	10.51	0.34	0.23	

Table
/Continued/

No.	Sp.	V	B-V	U-B	remarks
301.	A3	6.94	0.32	0.37	BD +34°3334
302.	A3	8.54	0.74	0.18	BD +34°3337
303.	F5	11.78	0.57	-0.20	
304.	F2	9.62	0.41	0.13	BD +34°3339
305.	A2	11.83	0.41	0.17	
306.	F4	10.91	0.59	-0.04	
307.	F4	11.84	0.61	-0.17	
308.	F2	10.96	0.52	0.01	
309.	A4	12.00	0.47	-0.03	
310.	F7	7.40	0.79	0.20	BD +34°3326
311.	B9	8.15	0.25	-0.01	BD +34°3319
312.	F4	11.44	0.66	-0.06	
313.	FO	11.10	0.43	0.11	
314.	F5	10.38	0.65	0.08	
315.	AO	11.68	0.27	-0.11	
316.	F5	11.66	0.65	-0.03	
317.	F5	11.40	0.67	-0.20	
318.	F2	9.70	0.47	0.24	BD +34°3321
319.	F6	11.94	0.80	-0.26	
320.	A1	11.14	0.39	0.10	
321.	A2	6.64	0.40	0.18	BD +34°3310
322.	F5	10.53	0.67	0.02	BD +34°3309
323.	AO	13.43	0.31	-	
324.	A8	9.19	0.49	0.16	BD +34°3303
325.	F6	11.21	0.65	0.03	
326.	F5	11.71	0.79	-0.19	
327.	F3	9.44	0.58	0.00	BD +34°3299
328.	A3	7.51	0.44	0.19	BD +34°3297
329.	F6	10.47	0.64	0.08	BD +34°3300
330.	A8	8.98	0.49	0.15	BD +34°3301
331.	B3	12.58	0.60	-0.20	
332.	F5	10.98	0.80	-0.01	
333.	F7	11.29	0.76	-0.08	
334.	A2	8.7	-	-	BD +34°3312,blend
335.	FO	10.51	0.61	0.18	
336.	A3	9.70	0.31	0.18	BD +34°3305
337.	B7	6.86	0.40	-0.18	BD +34°3302
338.	F5	11.21	0.75	-0.06	
339.	FO	11.58	0.50	-0.03	
340.	FO	11.97	0.73	-0.16	
341.	F3	11.58	0.74	-0.16	
342.	F5	11.29	0.77	-0.10	
343.	F4	10.42	0.63	0.07	
344.	A9	11.11	0.62	-	
345.	F6	10.14	0.76	0.11	BD +35°3359
346.	F2	9.45	0.51	0.13	BD +35°3353
347.	F1	11.31	0.72	-0.07	
348.	B9	9.13	0.42	0.11	BD +35°3349
349.	A7	8.76	0.36	0.22	BD +35°3346
350.	A2	12.17	0.36	-0.09	

Table

/Continued/

No.	Sp.	V	B-V	U-B	remarks
351.	F1	8.5	-	-	BD $+35^{O}3342$, blend
352.	F4	11.80	0.74	-0.21	
353.	F1	11.31	0.61	0.00	
354.	F5	11.40	0.89	-0.26	
355.	B8	9.09	0.31	0.00	BD $+35^{O}3341$
356.	F4	9.54	0.68	0.02	BD $+34^{O}3295$
357.	A7	9.92	0.64	0.14	BD $+34^{O}3294$
358.	A9	12.16	0.54	-0.08	
359.	A5	10.04	0.44	0.16	BD $+34^{O}3292$
360.	F6	10.27	0.76	0.22	BD $+34^{O}3291$
361.	A9	9.51	0.40	0.23	BD $+34^{O}3290$
362.	F2	11.89	0.54	0.11	
363.	AO	7.8	-	-	blend
364.	B3	6.2	-	-	BD $+34^{O}3285$, blend
365.	F6	10.70	0.69	0.10	
366.	AO	9.88	0.25	0.28	BD $+35^{O}3284$
367.	AO	9.77	0.24	0.15	BD $+34^{O}3281$
368.	F5	10.41	0.67	0.10	BD $+34^{O}3277$
369.	F5	11.61	0.70	-0.15	
370.	F6	10.36	0.78	0.19	BD $+34^{O}3278$
371.	F3	9.99	0.46	0.02	BD $+35^{O}3331$
372.	A6	13.63	-	-	
373.	F5	9.84	0.69	0.10	BD $+35^{O}3333$
374.	A2	12.16	0.41	-0.10	
375.	F4	-	-	-	on the edge of the plate
376.	A2	8.81	0.48	0.16	BD $+35^{O}3324$
377.	F4	10.21	0.77	0.11	BD $+35^{O}3313$
378.	A9	11.43	0.80	0.23	
379.	A5	12.33	0.59	0.01	
380.	F2	10.87	0.68	0.01	
381.	F5	10.45	0.87	0.13	BD $+34^{O}3268$
382.	A9	12.54	0.50	0.09	
383.	F5	12.19	0.75	-	
384.	F4	9.19	0.73	0.11	BD $+34^{O}3263$
385.	F5	10.03	0.63	0.15	BD $+34^{O}3261$
386.	A7	10.35	0.56	0.15	
387.	A5	11.30	0.54	-0.12	BD $+34^{O}3272$
388.	FO	11.3	-	-	blend
389.	F2	12.41	0.64	-0.23	
390.	A4	12.44	0.46	0.00	
391.	F5	11.26	0.63	-0.03	
392.	F6	10.03	0.72	0.16	BD $+34^{O}3276$
393.	F4	12.36	0.66	-0.03	
394.	F5	10.94	0.62	0.05	
395.	AO	8.83	0.24	-0.05	BD $+34^{O}3289$
396.	F6	10.41	0.65	0.29	
397.	F5	11.74	0.58	0.31	
398.	F2	9.86	0.59	0.12	BD $+34^{O}3283$
399.	F2	11.78	0.72	-0.16	
400.	A9	11.40	0.54	0.11	

Table

/Continued/

No.	Sp.	V	B-V	U-B	remarks
401.	B4	7.20	0.11	-0.41	BD +33°3180
402.	F6	9.73	0.60	0.20	BD +33°3172
403.	A1	11.26	0.56	0.25	
404.	F5	11.66	0.60	0.05	
405.	F6	11.35	0.53	0.03	
406.	F5	10.49	0.63	0.12	
407.	A8	11.94	0.42	0.11	
408.	F5	10.86	0.56	0.12	BD +34°3260
409.	F5	10.97	0.55	0.05	
410.	F5	11.43	0.69	-0.01	
411.	B9	10.60	0.10	-0.07	BD +34°3252
412.	F5	11.16	0.62	0.11	
413.	F4	12.35	0.69	-0.19	
414.	F1	11.52	0.52	-0.02	
415.	F2	11.21	0.50	0.19	
416.	A0	5.80	-0.09	0.24	BD +34°3245
417.	A3	10.42	0.31	0.26	BD +34°3250
418.	F0	12.37	0.65	-0.02	
419.	A2	11.32	0.29	0.22	
420.	F5	10.59	0.75	-0.02	
421.	F1	11.56	0.52	0.06	
422.	A0	8.61	0.28	0.13	BD +34°3247
423.	F5	10.04	0.68	0.18	BD +34°3249
424.	A1	12.63	0.11	-0.46	
425.	A5	9.34	0.34	0.24	BD +33°3138
426.	A7	11.27	0.49	-0.01	
427.	F4	11.71	0.79	-0.19	
428.	F3	11.73	0.43	0.06	
429.	F3	10.20	0.35	0.21	
430.	A3	10.68	0.28	0.12	
431.	F5	10.92	0.64	-0.10	BD +33°3144
432.	F5	10.23	0.88	-0.06	BD +33°3149
433.	F5	11.20	0.70	-0.14	
*434.	A1	5.38	-0.10	-0.49	BD +33°3212
435.	F0	12.15	0.70	-0.20	
436.	A3	9.70	0.36	-0.01	BD +33°3152
437.	F4	11.91	0.63	-0.26	
438.	F5	11.85	0.67	-0.07	
439.	F5	10.73	0.59	0.00	
440.	F0	10.94	0.47	-0.03	
441.	F0	11.55	0.46	-0.01	
442.	A8	11.94	0.58	-0.13	
443.	F5	10.52	0.81	-0.12	
444.	A7	9.32	0.30	0.11	BD +32°3155
445.	A0	11.17	0.15	-0.12	
446.	F1	11.14	0.63	0.02	
447.	A5	12.41	0.78	-0.36	
448.	A6	12.25	0.51	-0.11	
449.	F6	10.69	0.69	0.03	
450.	F4	10.57	0.67	-0.10	

Table

/Continued/

No.	Sp.	V	B-V	U-B	remarks
451.	F7	9.30	0.76	-0.01	BD +32°3169
452.	F5	11.62	1.00	-0.27	
453.	F6	11.04	0.91	-0.20	
454.	F6	11.16	0.81	-0.28	
455.	A0	12.96	0.50	-	
456.	F5	11.80	0.66	-0.27	
457.	A5	11.54	0.58	-0.01	
458.	F6	11.54	0.60	-0.07	
459.	F5	10.15	0.70	-0.11	BD +32°3166
460.	F4	11.20	0.78	-0.20	
461.	F7	11.52	0.81	-0.19	
462.	F6	10.39	0.81	-0.17	BD +33°3169
463.	F5	11.78	0.68	-0.22	
464.	F3	11.57	0.68	-0.20	
465.	F5	10.56	0.70	-0.11	
466.	F6	10.67	0.69	-0.10	
467.	F6	6.90	0.83	0.08	BD +33°3171
468.	F0	11.47	0.64	-0.09	
469.	F3	9.84	0.64	0.07	BD +33°3167
470.	B8	8.51	0.40	-0.10	BD +33°3165
471.	F3	9.06	0.62	0.08	BD +33°3163
472.	F5	10.50	0.77	-0.17	
473.	F5	10.77	0.75	-0.03	
474.	F6	9.94	0.84	0.01	BD +33°3159
475.	B9	9.24	0.34	0.01	BD +33°3173
476.	F7	9.55	0.74	-0.05	BD +33°3174
477.	F5	9.53	0.86	0.01	BD +33°3179
478.	A2	10.99	0.44	0.12	
479.	A9	11.46	0.73	-0.14	
480.	F5	11.06	0.76	-0.14	
481.	A0	10.38	0.30	-0.01	BD +33°3178
482.	F7	9.51	0.90	0.30	BD +33°3181
483.	F6	10.92	0.75	-0.09	
484.	F5	11.86	0.67	-0.11	
485.	F2	12.13	0.65	-0.11	
486.	F0	10.93	0.59	-0.07	
487.	F0	12.64	0.62	-0.27	
488.	A4	9.32	0.67	0.03	BD +32°3183
489.	F5	11.49	0.77	-0.21	
490.	F5	11.45	0.87	-0.29	
491.	F4	11.13	0.70	-0.32	BD +32°3170
492.	F4	11.67	0.78	-0.23	
493.	F7	9.4	-	-	BD +32°3175, blend
494.	F4	10.68	0.56	-0.11	
495.	F5	11.61	0.64	-0.19	
496.	F6	10.98	0.79	0.05	
497.	B8	10.03	-0.02	-0.39	BD +32°3165
498.	A8	9.45	0.34	0.02	BD +32°3162
499.	A9	9.35	0.43	0.01	BD +32°3161
500.	A3	9.77	0.27	0.00	BD +32°3159

Table
/Continued/

No.	Sp.	V	B-V	U-B	remarks
501.	F4	12.02	0.52	-0.31	
502.	A2	12.08	0.29	-0.06	
503.	F6·	9.96	0.77	-0.11	
504.	F3	9.62	0.46	-0.11	BD +32°3157
505.	F5	11.35	0.58	-0.17	
506.	F4	11.89	0.49	-0.18	
507.	F6	10.29	0.58	-0.14	BD +32°3154
508.	F2	11.14	0.30	-0.12	
509.	F3	11.12	0.16	-0.03	
510.	F6	10.51	0.55	-0.06	BD +31°3301
511.	F6	9.37	0.54	-0.05	BD +31°3305
512.	A8	12.37	0.51	-0.11	
513.	A1	9.51	0.01	-0.08	BD +32°3164
514.	F6	10.81	0.55	0.03	
515.	A4	12.62	0.30	-0.18	
516.	A8	12.32	0.53	-0.20	
517.	A8	12.47	0.48	-0.07	
518.	F5	10.49	0.54	-0.10	
519.	A6	12.03	0.72	-0.27	
520.	F5	10.38	0.47	-0.07	BD +31°3310
521.	F3	10.65	0.38	-0.03	BD +31°3312
522.	A5	8.94	0.32	0.07	BD +31°3311
523.	A3	13.03	0.54	-0.13	
524.	F6	10.10	0.45	-0.03	

Notes to the table:

An asterisk at the left upper side of the running number denotes photoelectrically measured colours.

Blend is remarked if the photographic image of the measured star is distorted by a neighbouring star.

A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

NR. 69.

S. KANYÓ

U, B, V PHOTOMETRY OF THE MULTIPLE PERIODIC RR LYRAE STAR RV URSAE MAIORIS

BUDAPEST, 1976.

Felelős kiadó: Szeidl Béla

768110 MTA KESZ Sokszorosító. F. v.: Szabó Gyula

U,B,V PHOTOMETRY OF THE MULTIPLE PERIODIC RR LYRAE STAR RV URSAE MAIORIS

SUMMARY

Three-colour photoelectric photometry of the RR_{ab} variable star RV Ursae Maioris, is presented. Period and total light curve changes of the star during the Blazhko period and O-C diagrams of both the main and the secondary periods are investigated. It was found that a certain phase point / φ_s=0,94/ of the ascending branches of the light curves showed no oscillation during the Blazhko period, which is hardly compatible with the assumption of the superposition of beat periods. A long cycle of 6-8 years in the O-C variations of the ascending branch was also found. Similar long cycle variations are shown by other RR Lyrae stars exhibiting the Blazhko effect, this variation being reminiscent of the solar magnetic cycle.

INTRODUCTION

RV Ursae Maioris is an RRab Lyrae variable star whose light variation was among the firsts discovered. The variability of RV UMa was announced by Cerasky in 1907 /Cerasky 1907/, and its light elements were derived by Blazhko /1908/. According to the properties of the observed light curve and the period /$P=0^d.4684$/ Blazhko classified the star as a short periodic δ Ceph variable. In 1920, Jordan and Subbotin pointed out independently the strong variation of the light curve of RV UMa /Jordan, 1920; Subbotin, 1927/

Photographic observations of RV UMa were initiated at the Konkoly Observatory by Julia Balázs and Detre with a 16 cm astrograph in 1936. A great number of observations were made in Budapest confirming the existence of a Blazhko effect, however, the secondary period could not be determined until photoelectric observations were made by Balázs and Detre in 1956-1957. Using all published observations they derived for the secondary period $P_s=90^d.8$. They constructed O-C diagrams for both the fundamental and the secondary period over a time interval of 50 years.

According to Preston the spectral type of RV UMa at minimum light is F4 from H-lines and A6 from the CaII-line giving $\Delta S=8$ /Preston, 1959/. On 34 nights in 1959 and 1960 Preston obtained a total of 113 spectrograms of the star; with the X-spectrograph of the Mount Wilson 60-inch reflector concurrently Spinrad carried out photoelectric observations on the UBV system with the 20-inch reflector of the Leushner Observatory in Berkeley. In addition four light rises were observed by Preston with the 60-inch reflector in 1960. They used these series of photoelectric and spectroscopic observations to point out some peculiarities in the 90-day cycle /Preston and Spinrad, 1967/.

THE PHOTOELECTRIC OBSERVATIONS

The present author observed RV UMa photoelectrically during the period 1961-1969, at first in yellow and blue, later also in ultraviolet light. Additional measurements were obtained by Csank, Gefferth and Lovas on the B, V system in 1958-59. The observations ranged over all phases of the primary and secondary periods. In this way it was possible to study the variations of complete light- and colour-curves in the 90-day cycle.

The distribution of the observations is listed in Table I.

Table I

Year	Number of nights	Number of observations			
		Yellow	Blune	Ultra-violet	Total
1958	6	69	69	-	138
1959	10	138	138	-	276
1976	50	1356	1356	-	2712
1962	47	593	593	562	1748
1963	17	26	275	275	576
1964	15	110	110	110	330
1965	1	16	16	-	32
1968	2	33	33	14	80
1969	2	37	37	-	74
Total	150	2378	2627	961	5966

All observations were made with the 24-inch reflector of the Konkoly Observatory. The unrefrigerated photometer employed was equipped with an RCA 1P21 photomultiplier up to 1961, after that time with an EMI 9502B phototube.

The following filters were used

Colour	Type	λ eff
yellow	Schott GG 11	5600 Å
blue	" BG 12+GG 13	4300 Å
ultraviolet	" UG 1	3950 Å

The photomultiplier output was amplified by a d.c. amplifier. The linearity of the instrument seemed to be warranted within the mesaurring interval.

The comparison star for our observations was the visual double star BD+55°1616. Spinrad used the same comparison star while BD + 54° 1610, used by Preston as a comparison star, was chosen as the check star. Both stars are within 20' to the variable. The photoelectric data for these stars were adopted from the measurements of Preston and Spinrad /Table II/.

Table II

	V	B-V	U - B
BD+55°1616	9.963	+ 0.507	- 0.114
BD+54°1610	9.62	+ 0.580	+ 0.095

Observations of standard stars published by Johnson and Morgan /1953/ were used to transfer the differential magnitudes and colours from the instrumental system u,b,v to the international U, B, V system by the formulae:

$$\Delta V = \Delta v + \Delta/B-V/ \quad /1/$$
$$\Delta/B-V/ = \mu \Delta/b-v/ \quad /2/$$
$$\Delta/U-B/ = \phi \Delta/u-b/ \quad /3/$$

The values of the coefficients were determined from time to time, though not frequently enough to be able to trace small variations caused by variability of sky transparency. Therefere, only the most significant variations of the coefficients were taken into account - specially that due to a transition from a silvered mirror to an aluminized one in 1961. Beginning with 1963 we have obtained sufficient data for the coefficients. The different sets of these coefficients are given in Table III, while the reduced observations are listed in Table IV.

Table III

Time interval		ε	μ	ψ
From feb.	1958			
to May	1963	- 0,132	1,05	1,08
	1964	- 0,14	1,12	1,16
Apr.	1965	- 0,136	1,17	1,09
January	1968	- 0,166	1,208	1,10
March	1968	- 0,156	1,152	1,00
January	1969	- 0,130	1,194	1,02
May	1969	- 0,177	1,181	0,955

LIGHT - CURVE VARIATIONS

The main purpose of this investigation was to study the variations of the light curve in V and the B-V and U-B colour curves in the 90 -day cycle for all phases / φ / of the $0^{d}.468$ period. However the observations were concentrated on the phases φ = 0,85 - 0,05, i. e. on the minimum ascending branch and maximum of the light curve. Some individual V, B-V and U-B curves for these phases are represented in Fig. 1. To obtain complete light curves for all phases /the phase of highest maximum being taken as ψ=0/ of the 90^{d} secondary period the same procedure was applied as by Julia Balázs and Detre /1939/ for AR Herculis. From the observed light curves the magnitudes were read off for a set of φ - phases and these magnitudes were then plotted versus ψ . In this way we obtained a sequence of curves representing the variation in the light curve for definite φ-phases as a function of ψ .

For derivation of proper φ and ψ -values the O-C diagrams must first be constructed for both the fundamental and secondary period. For C, the elements of Balázs and Detre /1957/ were used, viz.

/J.D. /maximum light/ = 2417861, 4292+$0^{d}_{,}468063203$ E /I/

and

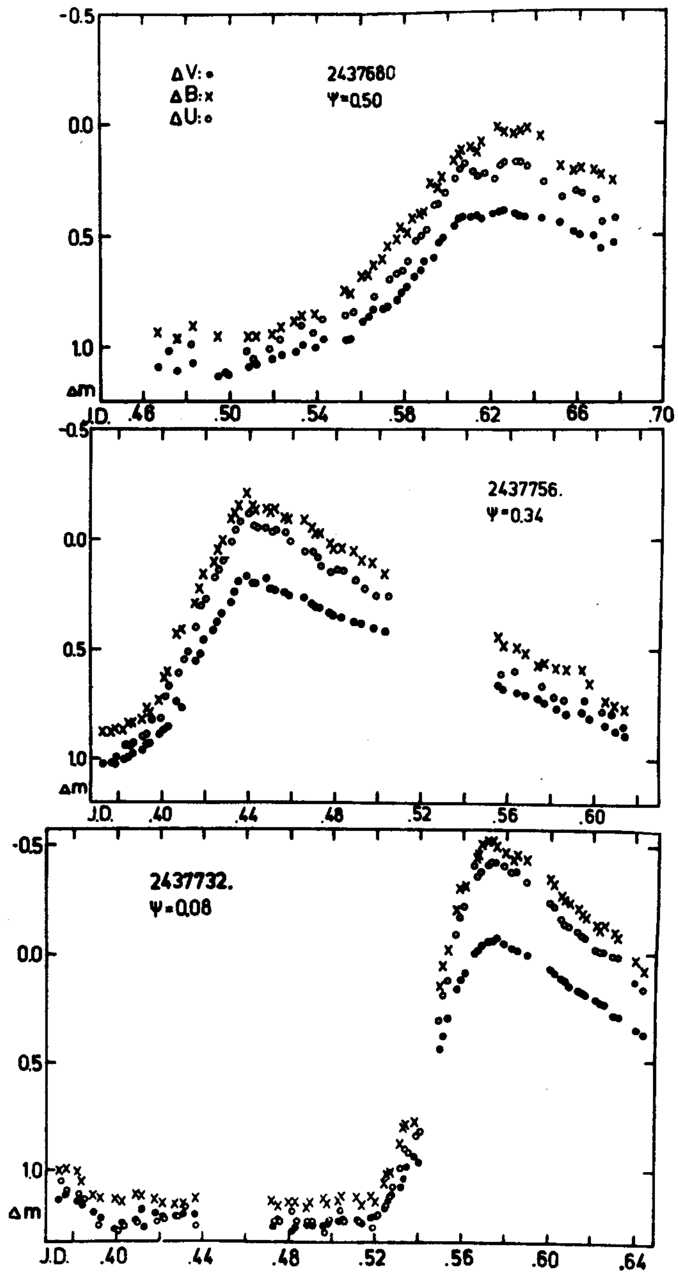

Figure 1 The observed light curves in UBV according to different phase points of Blazhko period.

J. D. /brightest maximum/ = 2418060 + 90,12 x N. /II/ where E and N are epoch counts in the respective periods. For each year the actual fundamental and secondary periods were determined by using the O-C /I/ and O-C /II/ curves. For instance the fundamental period obtained for 1961 /when the greatest number of observations were collected/ was

$$P = 2437327{,}692 + 0^{d}{,}468061103 \ . \ E$$

and the secondary period

$$P_s = 2437359 + 92^{d}{,}12 \ . \ N.$$

The brightest maxima were chosen from every observational season and are given in Table V. The O-C diagrams constructed for these maxima are shown in Fig 2. They are typical for RR Lyrae stars having a secondary period and their structure can be considered as resulting from the cumulative effects of random period changes. Even so, the comparison of O-C/II/ reveals two important characteristics:

1. The long cycles resulting from cumulative effects of random period changes are opposite in phase in the two diagrams. That is a change in the secondary period is accompanied by an opposite change in the fundamental period.

2. The changes expressed in units of the respective period are much larger for the secondary period than for the main one.

These characteristics are especially conspicuous for RW Draconis and in some respect also for RR Lyrae /see Detre, 1970/. They are considered to be of fundamental importance for the interpretation of the secondary period.

A few $V = V / \psi /_{\varphi = const}$ - diagrams are represented in Fig. 3a. The scatter in V is largely due to the random variations in the periods which makes an exact determination of φ and ψ impossible. This is proved by the fact that the scatter is largest in the ascending branch, between phases $\varphi =$ = 0,85 to 0,975, which part of the light curve is especially sensitive to random phase variations.

Table V.

Observed maxima

Year	J.D. 2430000+	ΔM^v	ΔM^b	ΔM^{uv}
1958	6229,6	+0,420	+0,120	
	6245,5	+0,290	-0,005	
	6282,5	+0,015	-0,390	
1959	6655,6	+0,085	-0,300	
	6680,4	+0,385	+0,105	
	6684,6	+0,428	+0,100	
	6692,5	+0,372	+0,080	
	6724,4	-0,050	-0,460	
1961	7327,7	+0,335	-0,015	
	7331,4	+0,295	-0,055	
	7339,-	-	-	
	7344,5	+0,060	-0,415	
	7345,5	+0,020	-0,435	
	7360,5	-0,060	-0,640	
	7365,6	-0,045	-0,525	
	7376,4	+0,010	-0,430	
	7395,6	+0,226	-0,175	
	7396,5	+0,255	-0,140	
	7397,4	+0,260	-0,130	
	7404,5	+0,365	-0,025	
	7411,5	+0,410	+0,045	
	7418,5	+0,345	0,00	
	7424,6	+0,260:	-0,150	
	7456.-	-	-	
	7463,4	0,000	-0,470	
1962	7652,5	-0,010	-0,375	-0,380
	7680,6	-0,395	+0,035	+0,175
	7702,6	+0,185	-0,250	-0,125
	7732,6	-0,065	-0,510	-0,420
	7756,4	+0,170	-0,190	-0,110
	7769,5	+0,360	+0,050	-
	7780,3	+0,365:	-0,025	+0,040
	7806,5	-0,010	-0,385	-0,280:
	7808,4	-0,050	-0,445	-0,410
	7815,4	-0,090	-0,500	-0,470
	7829,5	-0,170	-0,560	-0,520:
1963	8003,6	-0,070	-0,500	-0,475
	8019,5	+0,125	-0,265	-0,175
	8047,6	-	+0,130	+0,220
	8085,5	-	-0,450	-0,350
	8086,4	-	-0,445	-0,380
	8090,6	-	-0,400	-0,370
	8114,5	-	-0,138	-0,050
1964	8415,5	+0,325	-0,040	+0,100
	8457,6	-0,090	-0,500	-0,360
	8496,4	+0,350	0,000	+0,135
	8503,5	+0,300	-0,055	+0,115
	8548,4	-0,030	-0,520	-0,340

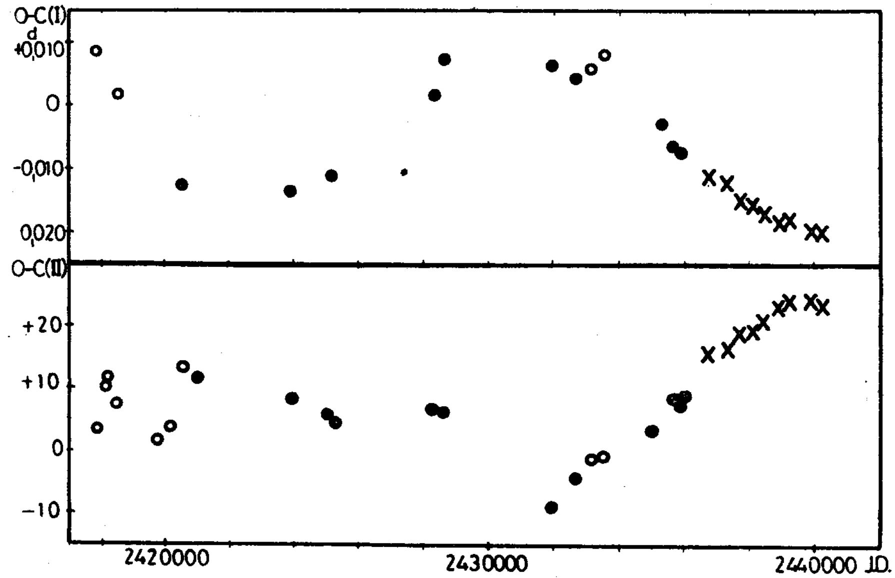

Figure 2
The O-C values for the fundamental O-C/I/ and for the secondary periods O-C/II/

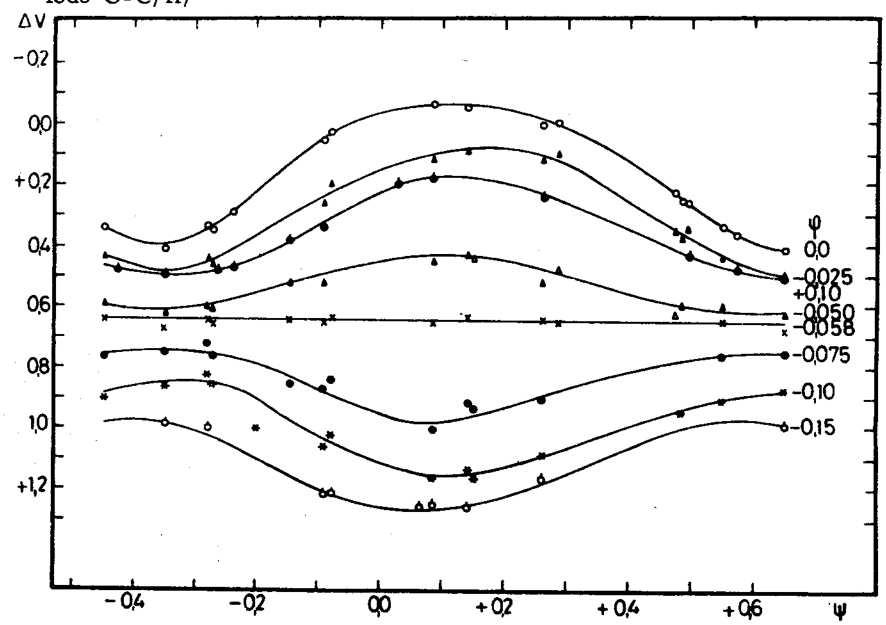

Figure 3a

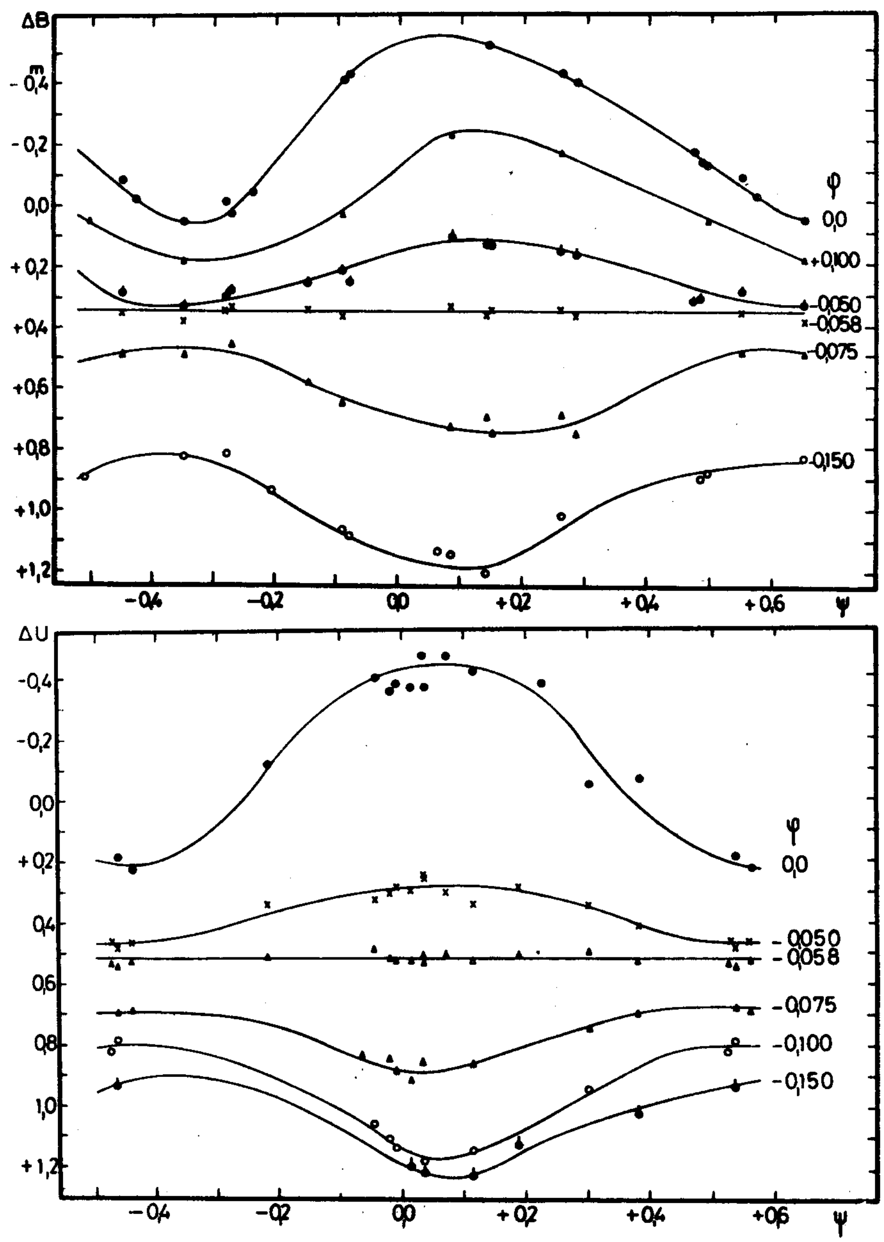

Figure 3

Similar marks on the diagram represent a certain φ phase value of the fundamental period obtained from the light curves of different Blazhko phase ψ . Figures 3a, b, c are in ΔV, ΔB and ΔU respectively.

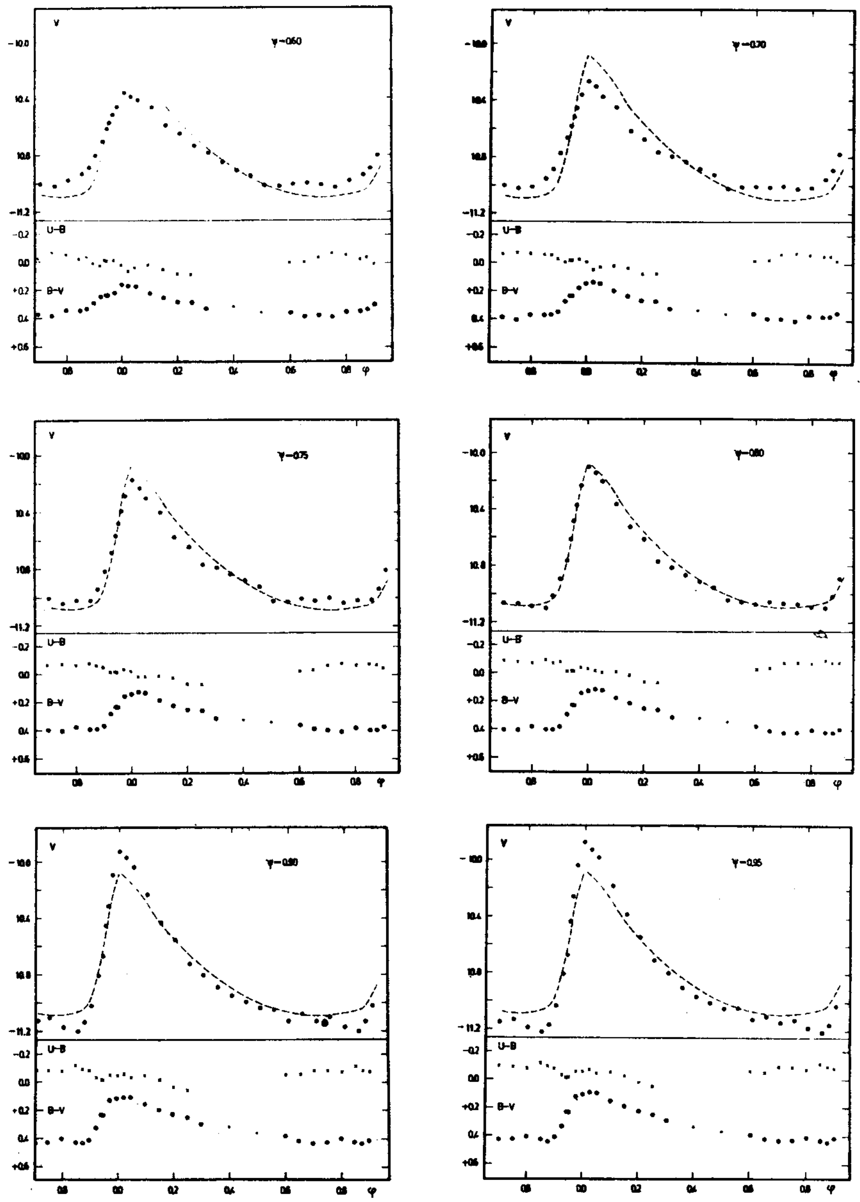

Figure 4
The diagram shows the flattened light curves of different secondary period phase ψ constructed from figures 3a,b,c.

The same procedure was carried out in B and U, as well /Fig.3b, 3c/ Using these curves the V / φ / $_{\psi\,=\mathrm{const}}$, B-V / φ / $_{\psi\,=\mathrm{const}}$ and U-B / φ / $_{\psi\,=\mathrm{const}}$ diagrams /Figs. 4a and b/ were constructed on which all the following discussions are based.

The two-colour diagrams at different phases of the secondary period are shown in Fig. 5.On the loops the phases of the main period are also indicated. The dashed line is the relation for the main sequence stars.

The V magnitudes and B-V colour indices at minimum light and maximum light and the U-B ranges δ_2/ defined by Preston, Ann. Rew.of Astr. and Astroph.Vol. 2,1964/ are plotted versus ψ in Fig. 6. The V and B-V ranges are correlated and the values of V are more strongly variable at maximum light than at minimum light as in the case of other RR Lyrae stars with Blazhko effect.

Our photometric results are in good agreement with those obtained by Preston and Spinrad /Ap. J. 147, 1967/. Nevertheless there are some slight differences expecially in the δ_2 values beause accurate observations in U-B could not be made under the unsatisfactory observing conditions near Budapest.

Figures 7a and b show the amplitude variation ΔA of the m/ ψ / curves and the phase ψ of the maxima of the same curves plotted against φ. Δ A have two maxima in each colour. The first of the maxima is at phase φ = = 0,90 on the ascending branch and the second one - which is higher, is at the phase of the light maximum / φ =0,00/. It is evident from the figure that the light curves do not change significantly between the φ = 0,35 – 0,55 phase interval during the Blazhko cycle. It is however, rather surprising that there is a very deep minimum at phase 0,94 on the ascending branch between the two maxima mentioned above. This deep minimum indicates that there exists a point on the ascending branch which does not show any significant oscillation during the Blazhko cycle while the ascending branch before and after it and especially the light maximum shows considerable oscillation. It is very interesting to compare our results with those obtained for AR Herculis by Almár /1961/. The same curves obtained for AR Her. also show double maxima but at other phases. The essential difference is that the first maximum of AR Her. is higher than the second one and the deep minimum is situated at the phase of light maximum.

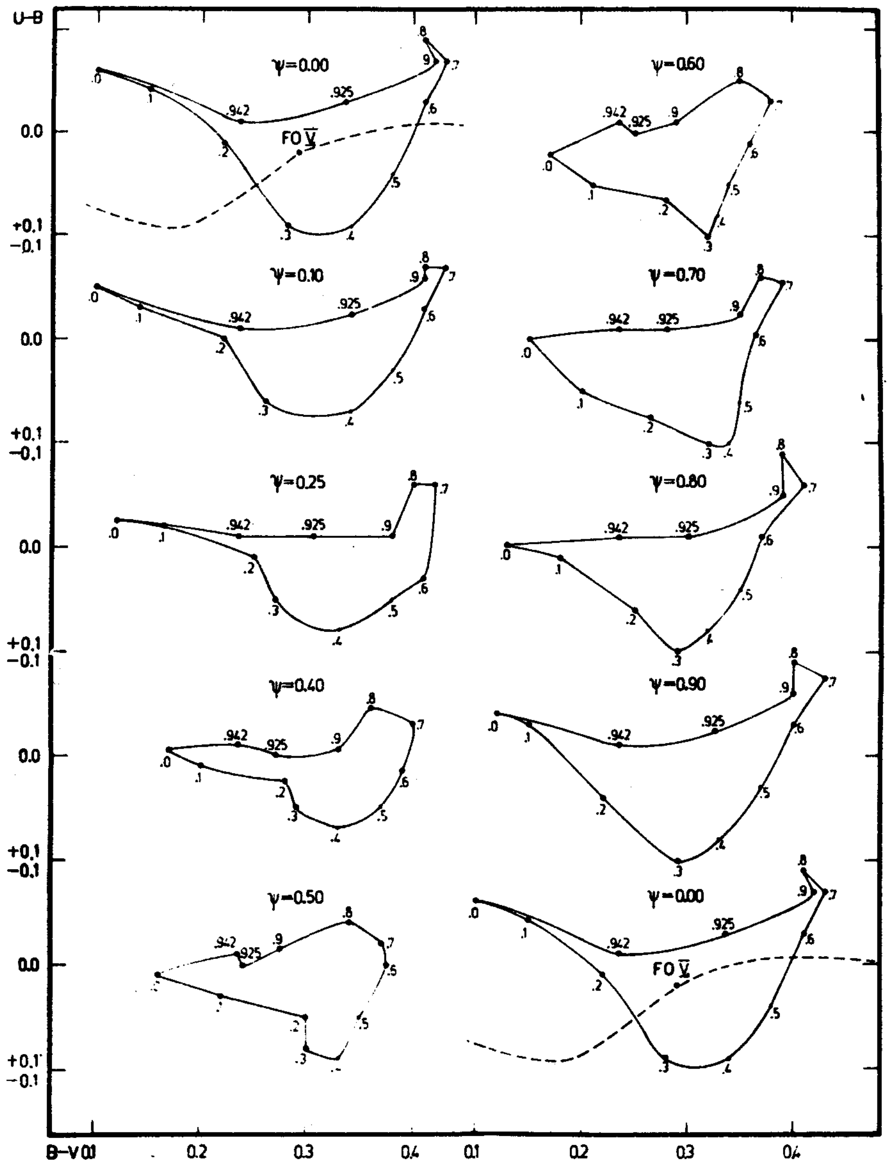

Figure 5
The two-colour diagrams at different phases of the secondary period.
The dashed line represents the main sequence.

Table VI./1

ψ \ φ	0,00	0,025	0,05	0,10	0,15	0,20	0,25	0,60	0,65	0,70	0,75	0,80	0,85	0,875	0,90	0,925	0,942	0,950	0,975	
0,00	-0,050	-0,070	-0,050	-0,045	-0,025	+0,020	+0,040	-0,050	-0,040	-0,090	-0,080	-0,070	-0,100	-0,085	-0,075	-0,030	-0,010	-0,010	-0,050	0,00
0,05	-0,050	-0,065	-0,050	-0,035	-0,025	0,000	+0,030	-0,050	-0,025	-0,090	-0,080	-0,070	-0,090	-0,075	-0,075	-0,025	-0,010	-0,010	-0,050	0,05
0,10	-0,045	-0,060	-0,050	-0,030	-0,020	0,000	+0,015	-0,040	-0,010	-0,085	-0,080	-0,070		-0,065	-0,070	-0,025	-0,010	-0,010	-0,050	0,10
0,25	-0,020	-0,030	-0,035	-0,010	+0,010	+0,020	0,000	0,000	+0,025	-0,070	-0,075	-0,065	-0,020	-0,025	-0,030	-0,010	-0,010	-0,010	-0,030	0,25
0,40	0,000	0,000	0,000	0,000	+0,040	+0,040	+0,010	+0,010	+0,020	-0,040	-0,060	-0,060		-0,010	-0,025	+0,010	-0,010	-0,010	-0,015	0,40
0,50	+0,020	+0,030	+0,020	+0,005	+0,050	+0,060	+0,060	0,030	+0,010	-0,020	-0,050	-0,040		-0,020	-0,025	+0,025	-0,010	-0,010	-0,005	0,50
0,60	+0,020	+0,065	+0,040	+0,025	+0,050	+0,080	+0,080	0,000	0,000	-0,030	-0,060	-0,050	-0,020	-0,035	+0,010	+0,025	-0,010	-0,010	-0,010	0,60
0,70	0,000	+0,050	+0,035	+0,030	+0,040	+0,080	+0,080	-0,010	-0,015	-0,060	-0,065	-0,055	-0,050	-0,050	-0,020	0,000	-0,010	-0,010	-0,020	0,70
0,75	-0,015	+0,020	+0,020	+0,015	+0,030	+0,075	+0,075	-0,020	-0,025	-0,060	-0,070	-0,060	-0,070	-0,060	-0,040	-0,010	-0,010	-0,010	-0,030	0,75
0,80	-0,025	-0,010	0,000	-0,005	+0,015	+0,070	+0,070	-0,030	-0,035	-0,070	-0,075	-0,065	-0,090	-0,070	-0,070		-0,010	-0,010	-0,035	0,80
0,90	-0,040	-0,050	-0,030	-0,045	-0,010	+0,040	+0,060	-0,050	-0,050	-0,085	-0,080	-0,070	-0,110	-0,085	-0,075	-0,025	-0,010	-0,010	-0,045	0,90
0,95	-0,050	-0,065	-0,040	-0,045	-0,020	+0,030	+0,050	-0,060	-0,050	-0,090	-0,085	-0,075	-0,110	-0,090	-0,075	-0,025	-0,010	-0,010	-0,050	0,95

Table VI./2

ψ \ φ	0,00	0,025	0,05	0,10	0,15	0,20	0,25	0,30	0,40	0,50	0,60	0,65	0,70	0,75	0,80	0,85	0,875	0,90	0,925	0,942	0,950	0,975	
0,00	0,100	0,100	0,090	0,150	0,185	0,220	0,240	0,280	0,339	0,387	0,395	0,420	0,430	0,435	0,410	0,430	0,440	0,420	0,335	0,235	0,235	0,125	0,00
0,05	0,90	0,095	0,085	0,150	0,185	0,220	0,240	0,275	0,345	0,384	0,400	0,420	0,435	0,440	0,415	0,430	0,435	0,420	0,340	0,235	0,235	0,125	0,05
0,10	0,090	0,095	0,080	0,150	0,180	0,220	0,240	0,260	0,345	0,382	0,400	0,420	0,435	0,400	0,415	0,430	0,430	0,415	0,340	0,235	0,235	0,125	0,10
0,25	0,120	0,115	0,125	0,165	0,205	0,250	0,270	0,270	0,353	0,360	0,410	0,410	0,425	0,425	0,400	0,415	0,395	0,380	0,305	0,235	0,235	0,150	0,25
0,40	0,160	0,160	0,180	0,200	0,260	0,315	0,300	0,285	0,366	0,344	0,390	0,400	0,390	0,400	0,360	0,375	0,350	0,330	0,250	0,235	0,235	0,205	0,40
0,50	0,170	0,175	0,185	0,225	0,260	0,300	0,300	0,310	0,338	0,350	0,375	0,370	0,360	0,380	0,340	0,340	0,315	0,275	0,230	0,235	0,235	0,240	0,50
0,60	0,160	0,165	0,170	0,220	0,250	0,280	0,280	0,325	0,313	0,355	0,350	0,380	0,370	0,385	0,345	0,345	0,330	0,290	0,245	0,235	0,235	0,215	0,60
0,70	0,150	0,140	0,150	0,200	0,235	0,265	0,270	0,325	0,324	0,348	0,355	0,390	0,390	0,405	0,370	0,375	0,370	0,350	0,275	0,235	0,235	0,180	0,70
0,75	0,145	0,130	0,135	0,190	0,225	0,255	0,260	0,320	0,326	0,337	0,360	0,390	0,400	0,410	0,380	0,395	0,395	0,370	0,285	0,235	0,235	0,160	0,75
0,80	0,135	0,120	0,125	0,180	0,215	0,250	0,260	0,310	0,314	0,340	0,370	0,400	0,415	0,415	0,390	0,410	0,410	0,390	0,300	0,235	0,235	0,150	0,80
0,90	0,120	0,110	0,110	0,160	0,200	0,230	0,250	0,300	0,322	0,360	0,380	0,415	0,435	0,425	0,400	0,425	0,435	0,410	0,325	0,235	0,235	0,130	0,90
0,95	0,110	0,100	0,100	0,155	0,195	0,225	0,250	0,290	0,340	0,367	0,390	0,420	0,430	0,430	0,410	0,430	0,445	0,415	0,335	0,235	0,235	0,125	0,95

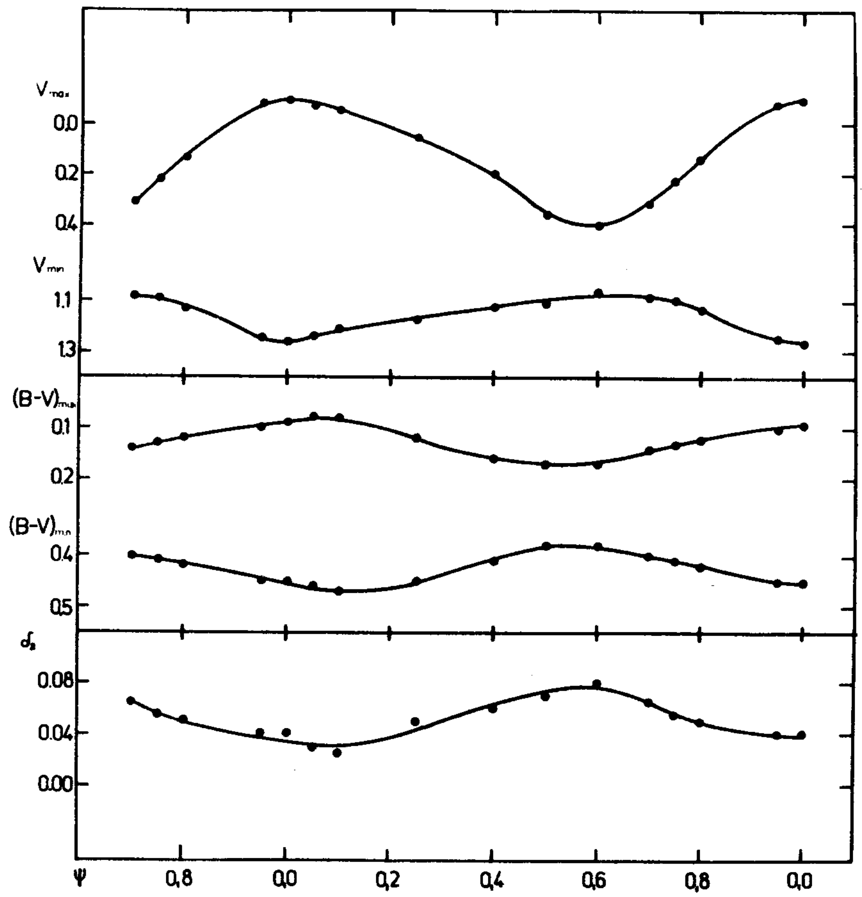

Figure 6
The curves show the typical variation of V_{max}, V_{min}, $/B-V/_{max}$, $/B-V/_{min}$ and δ_2 Preston index, during the secondary period.

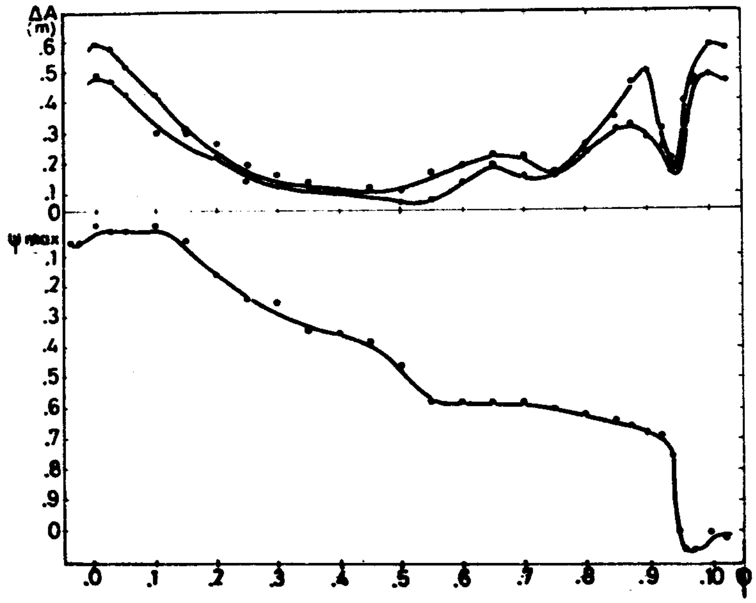

Figure 7a

Figure 7a shows the amplitudes of light curves belonging to different phases φ of figures 3a and 3b.

Figure 7b

Ψ_{max} points show the ψ secondary phase of maxima of φ phase curves in the figure 3.

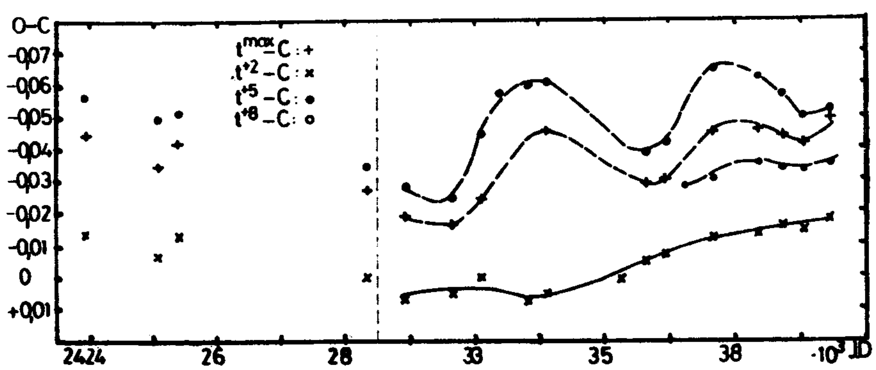

Figure 8

The O-C secular variations of three magnitude levels of the ascending branch of the main period.

This may be connected with the behaviour of the double light maximum of AR Her which appears at certain phases of the secondary period while no double maximum can be observed for RV UMa. The most important theoretical consequence of the fact that there is no oscillation on a certain phase point of the ascending branch of RV UMa during the Blashko period suggests that the fundamental and the secondary period can not arise due to two beat periods. That is to say in the case of superposition of beat periods the ascending branch of the main period would need to oscillate to produce the required effect in each of its phase points during the Blazhko period.

Figure 8 shows the /O-C/ secular variation of three magnitude levels of the ascending branch of the main period. The /O-C/ variations of the magnitude levels m:0,8, 0,5, 0,3 are cyclic and coincident with each other. The length of the cycle is approximately 6-8 years. The cyclic variation of these fixed magnitude points of the ascending branch is due to the secular cyclic variation of the light curve form. When the /O-C/ is more positive, the rising branch of the light curve is always steeper during the secondary period and vice versa; the less positive the /O-C/ variation the more sinusoidal in form the light curve.

Whatever the cause of the cyclic variation of the light curve form, the length of this cyclic variation of RV UMa is commensurable with that of RR Lyrae. However, this length of cyclic variation corresponds to the magnitude of the magnetic solar cycle therefore the suspicion that the cyclic variation is a magnetic variation of the variable star, as suggested by Detre, seems reasonable.

TABLE VII.

Year	E	t^{max}	t^{max} – C	t^{+2} – C	t^{+5} – C
		243 ...			
1958	39243	6229,6210	-0,0125	-0,0255	-
	39277	6245,5425	-0,0510	-0,0261	-0,0411
	39356	6282,5095	-0,0151	-0,0316	-0,0391
1959	40153	6655,5540	-0,0170	-0,0360	-0,0435
	40206	6680,3650	-0,0133	-0,0318	-0,0483
	40215	6684,5810	-0,0099	-0,0229	-0,0454
	40232	6692,5450	-0,0030	-0,0215	-0,0425
	40300	6724,3630	-0,0133	-0,0373	-
1961	41589	7327,6970	-0,0127	-0,0317	-0,0497
	41597	7331,4425	-0,0118	-	-
	41614	7339,-	-	-0,0343	-0,0443
	41625	7344,5470	-0,0130	-0,0355	-0,0420
	41627	7345,4860	-0,0102	-0,0352	-0,0442
	41644	7353,4430	-	-0,0357	-0,0407
	41655	7358,5940	-0,0079	-0,0359	-0,0459
	41659	7360,4650	-0,0092	-0,0390	-0,0427
	41670	7365,6125	-0,0104	-0,0363	-0,0414
	41674	7367,4825	-0,0126	-	-
	41676	7368,4180	-0,0132	-	-
	41689	7374,5040	-0,0121	-	-
	41693	7376,3725	-0,0113	-0,0373	-0,0423
	41734	7395,5600	-0,0189	-0,0394	-0,0479
	41736	7396,4970	-0,0180	-0,0375	-0,0500
	41738	7397,4350	-0,0162	-	-
	41749	7402,5880	-0,0119	-0,0324	-0,0485
	41753	7404,4570	-0,0151	-	-
	41768	7411,4775	-0,0156	-0,0309	-0,0526
	41783	7418,5020	-0,0120	-0,0300	-0,0515
	41796	7424,5870	-0,0118	-0,0333	-0,0463
	41864	7456,-	-	-0,0363	-0,0411
	41869	7463,4365	-0,0116	-0,0366	-0,0411

$t^{+8}-C$	t	t–C	N	φ	ΔB^{max}	ΔB^{min}	C
-	0,594	-0,0395	201	0,616	+0,120	-	,6335
-	0,513	-0,0346	201	0,792	-0,005	-	,5476
-	0,4895	-0,0351	202	0,203	-0,390	-	,5246
-0,0525	0,5313	-0,0397	206	0,342	-0,300	+0,850	,5710
-0,0833	0,340	-0,0383	206	0,618	+0,105	-	,3783
-0,0684	0,5535	-0,0374	206	0,664	+0,100	+0,880	,5909
-0,0730	0,5135	-0,0345	206	0,752	+0,080	+0,910	,5480
-	-	-	207	0,106	-0,460	-	,3763
-0,0817	0,6675	-0,0422	213	0,800	-0,015	+0,975	,7097
-	-	-	213	0,842	-0,055	-	,4543
-	0,3700	-0,0413	213	0,932	-	-	,4113
-0,0540	0,5205	-0,0395	213	0,988	-0,415	+1,065	,5600
-0,0542	0,4574	-0,0388	213	0,999	-0,435	+1,075	,4962
-	0,415	-0,0382	214	0,089	-	-	,4532
-0,0559	0,5595	-0,0424	214	0,143	-0,490	+1,050	.6019
-0,0507	0,4300	-0,0442	214	0,164	-0,640	+1,075	,4742
-0,0489	0,5845	-0,0384	214	0,221	-0,525	+1,210	,6229
-	-	-	214	0,242	-	-	,4951
-	-	-	214	0,252	-	-	,4312
-	-	-	214	0,320	-	-	,5161
-0,0533	0,348	-0,0403	214	0,341	-0,430	+0,990	,3883
-	0,5345	-0,0444	214	0,553	-0,175	-	,5789
-0,0700	0,470	-0,0450	214	0,564	-0,140	+0,950	,5150
-	-	-	214	0,574	-0,130	+1,025	,4512
-0,0709	-0,5585	-0,0414	214	0,631	-0,090	+0,925	,5999
-	-	-	214	0,652	-0,025	-	,4721
-0,0801	0,4505	-0,0426	214	0,730	+0,045	+0,900	,4931
-0,0765	0,4705	-0,0435	214	0,808	0,000	+0,950	,5140
-0,0678	0,5578	-0,0410	214	0,876	-0,150	+1,000	,5988
-0,0483	0,3872	-0,0399	215	0,230	-	+1,180	,4271
-0,0485	0,4090	-0,0391	215	0,307	-0,470	-	,4481

TABLE VII.(cont.)

Year	E	t^{max}	$t^{max}-C$	$t^{+2}-C$	$T^{+5}-C$	$t^{+8}-C$
		243.....				
1962	42283	7652,5275	-0,0181	-	-	-
	42343	7680,6100	-0,0194	-0,0294	-0,0509	-0,0819
	42390	7702,6165	-0,0134	-0,0334	-0,0422	-0,0584
	42454	7732,5720	-0,0124	-0,0354	-0,0429	-0,0494
	42505	7756,4390	-0,0166	-0,0371	-0,0501	-0,0641
	42533	7769,5440	-0,0189	-0,0309	-0,0484	-0,0664
	42556	7780,3100	-0,0169	-0,0299	-	-
	42612	7806,5270	-0,0114	-0,0334	-0,0406	-0,0494
	42616	7808,3970	-0,0137	-0,0357	-0,0437	-0,0527
	42627	7813,5415	-0,0194	-0,0324	-0,0364	-0,0434
	42631	7815,4210	-0,0106	-0,0346	-0,0391	-0,0471
	42661	7829,4600	-0,0135	-0,0370	-0,0430	-0,0490
1963	43031	8003,6475	-0,0094	-0,0354	-0,0405	-0,0519
	43067	8019,500	-0,0152	-	-	-
	43127	8047,5805	-0,0185	-0,0230	-0,0470	-
	43208	8085,4910	-0,0131	-0,0331	-0,0386	-0,0481
	43210	8086,4295	-0,0107	-0,0337	-0,0373	-0,0457
	43219	8090,6390	-0,0138	-0,0346	-0,0398	-0,0453
	43270	8114,5050	-0,0190	-0,0355	-0,0442	-0,0558
1964	43913	8415,4750	-0,0171	-0,0320	-0,0501	-
	44003	8457,5975	-0,0168	-0,0388	-0,0427	-0,0518
	44086	8496,4400	-0,0211	-0,0376	-0,0598	-0,0836
	44101	8503,4750	-0,0160	-0,0345	-0,0540	-
	44197	8548,4035	-0,0151	-0,0331	-	-

Y

t	t-C	N	ψ	ΔB^{max}	ΔB^{min}	C
-	-	217	0,405	-0,375	-	,5456
0,5880	-0,0414	217	0,716	+0,035	+1,010	,6294
0,5895	-0,0389	217	0,961	-0,250	-	,6284
0,5445	-0,0399	218	0,293	-0,510	+1,145	,5844
0,4105	-0,0451	218	0,559	-0,190	+0,920	,4556
0,5205	-0,0409	218	0,704	+0,050	-	,5614
-	-	218	0,822	-0,025	-	,3269
0,5008	-0,0376	219	0,113	-0,385	+1,050	,5384
0,3720	-0,0387	219	0,134	-0,445	+1,150	,4107
0,5240	-0,0354	219	0,192	-0,385	+1,200	,5594
0,3940	-0,0376	219	0,212	-0,500	-	,4316
0,4330	-0,0405	219	0,368	-0,560	+0,975	,4745
0,6190	-0,0379	221	0,301	-0,500	-	,6569
-	-	221	0,477	-0,265	-	,5079
0,5505	-0,0405	221	0,489	+0,130	-	,5910
0,4675	-0,0366	222	0,209	-0,450	+1,260	,5041
0,4066	-0,0336	222	0,220	-0,445	+1,150	,4402
0,6150	-0,0378	222	0,265	-0,400	+1,160	,6528
0,4826	-0,0414	222	0,420	-0,138		,5240
0,4458	-0,0428	225	0,871	-0,040	+0,900	,4886
0,5740	-0,0430	226	0,338	-0,500	+1,150	,6143
0,4125	-0,0511	226	0,769	0,000	-	,4636
0,4377	-0,0468	226	0,847	-0,055	-	,4845
-	-	227	0,346	-0,520	-	,4186

TABLE VIII.

$A^{\underline{m}}\varphi$, $CI\varphi$ and $\psi^{\underline{max}}\varphi$ of RV Uma

1958 – 64 years

φ	ΔA^{v}	ΔA^{b}	ΔA^{uv}	Δ/B-V/	Δ/U-B/	ψ max
0,000	+0,490	+0,590	+0,635	+0,135	+0,260	0,00
0,025	+0,470	+0,580	+0,585	+0,110	+0,350	0,02
0,050	+0,425	+0,515	+0,530	+0,125	+0,290	0,02
0,100	+0,300	+0,425	+0,420	+0,140	+0,145	0,00
0,150	+0,300	+0,310	+0,350	+0,140	+0,130	0,05
0,200	+0,220	+0,260	+0,210	+0,130	+0,100	0,16
0,250	+0,195	+0,140	+0,200	+0,125	+0,165	0,24
0,300	+0,125	+0,160	+0,200	+0,090	+0,255	0,25
0,350	+0,125	+0,140	-	+0,070	+0,220	0,34
0,400	+0,105	+0,110	-	+0,060	+0,220	0,35
0,450	+0,115	+0,110	-	-	-	0,38
0,500	+0,075	+0,110	-	+0,050	+0,135	0,46
0,550	+0,080	+0,170	-	-	-	0,58
0,600	+0,135	+0,195	-	+0,095	+0,210	0,58
0,650	+0,195	+0,225	-	-	-	0,58
0,700	+0,160	+0,220	-	+0,150	+0,140	0,58
0,750	+0,165	+0,160	+0,200	+0,105	+0,220	0,60
0,800	+0,235	+0,260	+0,218	+0,125	+0,170	0,62
0,850	+0,310	+0,350	+0,300	+0,160	+0,135	0,64
0,875	+0,325	+0,465	+0,350	+0,110	+0,235	0,66
0,900	+0,285	+0,500	+0,440	+0,240	+0,160	0,68
0,925	+0,255	+0,310	+0,225	+0,190	+0,070	0,69
0,940	+0,175	+0,220	+0,160	+0,310	+0,190	0,75
0,950	+0,185	+0,210	+0,190	+0,070	+0,090	0,00
0,960	+0,320	+0,400	+0,360	+0,220	+0,215	0,06
0,975	+0,460	+0,480	+0,545	+0,110	+0,220	0,06

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Table IV.

Observations in U,B,V.

J.D. 2400000+	V	(B-V)	(U-B)
36229.5960	10.604	+0.217	
.5987	.565	.233	
.6049	.488	.238	
.6077	.468	.203	
.6147	.392	.220	
.6175	.401	.192	
.6204	.382	.208	
.6304	.385	.225	
.6335	.401	.237	
.6372	.401	.204	
.6510	.434	.210	
.6546	.439	.213	
.6580	.444	.218	
.6708	.488	.246	
.6748	.518	.223	
.6781	.539	.230	
.6909	.552	.259	
.6944	.564	.267	
36245.5001	10.780	+0.238	
.5032	.719	.264	
.5070	.655	.330	
.5134	.582	.280	
.5162	.536	.231	
.5188	.487	.251	
.5258	.343	.204	
.5307	.307	.152	
.5391	.265	.204	
.5435	.249	.214	
.5524	.279	.218	
.5558	.303	.172	
.5585	.338	.158	
.5664	.374	.191	
.5691	.388	.190	
.5719	.395	.189	
.5810	.436	.257	
.5851	.462	.201	
.5941	.495	.230	
.5995	.545	.225	
.6352	.741	.236	
.6400	.753	.256	
.6520	.826	.336	
.6575	.831	.291	
36282.4898	10.495	+0.328	
.4934	.389	.315	
.4962	.269	.168	
.5016	.111	.142	
.5042	.048	.155	
.5070	9.999	.120	
.5097	.983	.102	

J.D. 2400000+	V	(B-V)	(U-B)
36282.5125	9.982	+0.099	
.5154	.979	.113	
.5182	.990	.100	
.5248	10.010	.096	
.5284	.034	.071	
.5318	.036	.087	
.5380	.082	.097	
.5435	.107	.099	
.5524	.144	.144	
.5553	.191	.149	
.5576	.221	.136	
.5769	.345	.178	
.5796	.343	.211	
.5825	.337	.243	
.5888	.434	.220	
.5917	.434	.217	
.5946	.436	.233	
.6008	.481	.237	
.6037	.509	.222	
.6064	.504	.213	
36655.5100	10.944	+0.220	
.5141	.948	.360	
.5162	.957	.365	
.5204	.913	.310	
.5225	.858	.357	
.5245	.813	.259	
.5287	.683	.255	
.5308	.580	.274	
.5329	.491	.289	
.5374	.300	.226	
.5395	.256	.191	
.5416	.206	.191	
.5457	.225	.165	
.5478	.090	.130	
.5499	.068	.111	
.5541	.052	.117	
.5561	.047	.126	
.5582	.049	.131	
.5624	.062	.113	
.5645	.054	.113	
.5707	.063	.096	
36680.3030	10.915	+0.312	
.3087	.911	.284	
.3135	.855	.327	
.3229	.770	.274	
.3251	.792	.278	
.3271	.758	.308	
.3315	.697	.311	
.3333	.686	.261	

J.D. 2400000+	V	(B-V)	(U-B)
36680.3347	10.651	+0.289	
.3402	.573	.306	
.3419	.571	.287	
.3437	.530	.187	
.3478	.472	.176	
.3493	.478	.161	
.3512	.487	.162	
.3552	.458	.153	
.3570	.435	.173	
.3589	.405	.212	
.3634	.357	.227	
.3649	.354	.216	
.3738	.350	.236	
.3801	.373	.222	
.3821	.383	.213	
.3847	.364	.201	
.3900	.339	.217	
.3938	.355	.225	
.3978	.430	.155	
.3997	.427	.151	
36684.5033	10.989	+0.395	
.5054	.990	.364	
.5075	.966	.323	
.5116	.916	.357	
.5137	.908	.361	
.5158	.942	.359	
.5200	.887	.425	
.5220	.887	.405	
.5241	.890	.354	
.5283	.877	.338	
.5304	.865	.342	
.5345	.912	.302	
.5387	.784	.241	
.5408	.787	.251	
.5450	.722	.246	
.5470	.683	.278	
.5491	.673	.254	
.5533	.627	.204	
.5554	.612	.210	
36684.5575	10.586	+0.204	
.5616	.500	.260	
.5637	.475	.256	
.5658	.461	.240	
.5720	.431	.184	
.5741	.411	.204	
.5783	.391	.203	
.5804	.394	.213	
.5845	.392	.177	
.5889	.391	.184	
.5917	.400	.178	
.5967	.431	.138	
36692.4492	10.998	+0.387	
.4509	.994	.373	
36692.4527	10.989	+0.367	
.4545	.994	.375	
.4648	.960	.351	
.4672	.956	.352	
.4745	.933	.373	
.4775	.913	.220	
.4817	.893	.210	
.4838	.896	.287	
.4862	.873	.226	
.4904	.837	.301	
.4926	.799	.318	
.4948	.766	.309	
.5002	.681	.339	
.5020	.673	.329	
.5039	.664	.322	
.5084	.640	.300	
.5102	.622	.280	
.5116	.604	.289	
.5151	.560	.256	
.5165	.539	.250	
.5179	.527	.257	
.5213	.482	.248	
.5227	.464	.251	
.5241	.461	.244	
.5278	.433	.210	
.5292	.419	.221	
.5306	.407	.210	
.5344	.385	.196	
.5359	.377	.199	
.5373	.369	.194	
.5442	.348	.212	
36692.5456	10.337	+0.213	
.5492	.334	.219	
.5511	.338	.212	
.5529	.353	.211	
.5569	.371	.208	
.5587	.380	.208	
.5606	.394	.216	
.5647	.414	.217	
.5668	.426	.212	
.5689	.447	.229	
.5737	.488	.217	
.5763	.506	.190	
36724.3459	10.301	+0.134	
.3502	.194	.120	
.3519	.145	.123	
.3564	.019	.109	
.3577	9.978	.112	
.3591	.926	.111	
.3631	.907	.100	
.3645	.913	.089	
.3662	.920	.094	
.3700	.920	.095	
.3729	.925	.103	

J.D. 2400000+	V	(B-V)	(U-B)
36724.3796	9.925	+0.048	
.3817	10.028	.058	
.3837	.032	.084	
.3879	.038	.101	
37327.4429	10.946	+0.435	
.4476	.953	.439	
.4505	.977	.407	
.4521	.983	.432	
.4560	.991	.442	
.4578	.991	.413	
.4595	11.004	.444	
.5012	.029	.361	
.5053	.014	.364	
.5071	.039	.371	
.5089	.033	.384	
.5129	.042	.413	
.5180	.036	.364	
.5219	.014	.333	
.5237	.020	.372	
.5254	.019	.379	
.5293	.017	.385	
.5314	.018	.392	
.5330	.023	.382	
.5367	.035	.425	
.5393	.032	.413	
.5410	.033	.419	
.5504	.034	.391	
.5519	.020	.357	
.5536	.026	.379	
.5584	.013	.361	
.5597	.014	.351	
.5611	.018	.362	
.5652	.051	.373	
.5674	.053	.354	
.5688	.029	.382	
.5727	.053	.393	
.5741	.023	.396	
.5761	.016	.415	
.5803	.029	.429	
.5820	.031	.413	
.5837	.030	.414	
.5903	.022	.394	
.5976	.035	.375	
.6007	.038	.367	
.6154	10.987	.324	
.6172	.972	.352	
.6189	.984	.337	
.6242	.967	.337	
.6260	.960	.329	
.6279	.960	.315	
.6359	.908	.262	
.6379	.878	.275	
.6407	.865	.312	
.6484	.793	.248	

J.D. 2400000+	V	(B-V)	(U-B)
37327.6522	10.771	+0.294	
.6535	.768	.279	
.6571	.746	.287	
.6585	.720	.271	
.6603	.696	.268	
.6663	.622	.242	
.6677	.621	.217	
.6691	.611	.223	
.6728	.580	.201	
.6743	.551	.209	
.6759	.526	.187	
.6774	.509	.163	
.6808	.448	.190	
.6823	.433	.200	
.6837	.415	.180	
.6852	.395	.178	
.6886	.376	.151	
.6903	.347	.157	
.6919	.321	.153	
.6934	.303	.151	
.6984	.299	.159	
.6999	.297	.156	
.7014	.306	.167	
.7055	.293	.167	
.7074	.307	.156	
.7109	.311	.148	
.7133	.307	.188	
.7178	.316	.151	
37331.4368	10.311	+0.181	
.4414	.255	.173	
.4482	.259	.162	
.4518	.266	.159	
.4560	.274	.122	
.4575	.288	.127	
.4592	.292	.127	
.4634	.315	.094	
.4670	.318	.152	
.4742	.342	.192	
.4795	.406	.234	
.4811	.409	.226	
.4828	.392	.098	
.4866	.424	.196	
.4883	.418	.194	
.4942	.425	.231	
.4993	.497	.127	
.5049	.618	-0.066	
.5067	.617	.021	
.5095	.630	.026	
.5209	.608	+0.050	
.5268	.624	.250	
.5289	.620	.319	
37334.3988	10.823	+0.337	
.4034	.835	.318	
.4054	.833	.334	

J.D. 2400000+	V	(B-V)	(U-B)
37334.4095	10.852	+0.330	
.4123	.871	.295	
.4156	.862	.339	
.4203	.862	.322	
.4225	.881	.325	
.4248	.898	.366	
.4317	.899	.359	
.4337	.900	.376	
.4362	.917	.336	
.4418	.938	.361	
.4440	.936	.387	
.4466	.928	.331	
.4513	.934	.368	
.4536	.940	.348	
.4562	.950	.357	
.4614	.960	.376	
.4636	.961	.373	
.4656	.972	.415	
.4713	.969	.343	
.4739	.984	.338	
.4763	.998	.337	
.4867	11.014	.395	
.4888	.027	.359	
.4907	.025	.374	
.4959	.040	.318	
.4978	.059	.290	
.5001	.063	.324	
.5054	.047	.389	
.5114	.026	.356	
.5138	.010	.403	
.5166	10.996	.375	
.5221	.993	.332	
.5236	11.001	.351	
.5252	.002	.374	
.5267	10.998	.335	
.5327	.987	.475	
.5356	11.009	.396	
.5381	.017	.348	
.5433	.023	.387	
.5448	.033	.449	
.5590	.027	.441	
.5611	.031	.437	
.5669	.038	.421	
.5746	.022	.362	
5766	10.965	.346	
.5785	.959	.348	
37339.3622	10.836	+0.209	
.3637	.803	.237	
.3675	.729	.229	
.3691	.661	.180	
.3704	.630	.200	
.3738	.586	.181	
37339.3755	10.454	+0.224	

J.D. 2400000+	V	(B-V)	(U-B)
37339.3773	10.378	+0.273	
.4202	.249	.182	
.4215	.211	.140	
.4246	.192	.150	
.4251	.194	.132	
.4274	.234	.091	
.4305	.251	.095	
.4319	.264	.085	
.4332	.264	.086	
.4366	.286	.080	
.4380	.295	.077	
.4395	.309	.068	
.4433	.329	.068	
.4450	.337	.070	
.4467	.357	.071	
.4503	.392	.130	
.4520	.390	.142	
.4538	.392	.148	
.4578	.407	.195	
.4602	.446	.149	
.4614	.461	.211	
.4645	.455	.205	
.4686	.507	.185	
.4718	.533	.189	
.4764	.527	.213	
.4780	.528	.217	
.4796	.536	.207	
.4836	.569	.256	
.4851	.590	.289	
.4865	.603	.275	
.4902	.613	.246	
.4917	.622	.231	
.4933	.603	.264	
.4969	.648	.236	
.4987	.647	.206	
.5004	.655	.231	
.5039	.656	.266	
.5056	.681	.243	
.5076	.679	.229	
.5129	.699	.226	
.5143	.714	.141	
.5156	.731	.268	
.5184	.749	.281	
.5198	.775	.289	
.5212	.741	.293	
.5242	.744	.301	
.5277	.746	.264	
.5346	.805	.271	
.5360	.808	.306	
.5374	.825	.315	
.5402	.787	.358	
.5416	.792	.330	
.5430	.783	.337	
.5464	.820	.304	

J.D. 2400000+	V	(B-V)	(U-B)
37339.5478	10.825	+0.346	
.5492	.839	.352	
.5526	.838	.331	
.5540	.840	.347	
.5555	.845	.339	
.5598	.845	.375	
.5612	.865	.384	
.5628	.864	.365	
.5670	.870	.344	
.5692	.868	.392	
.5707	.887	.336	
.5744	.874	.314	
.5759	.856	.351	
.5774	.865	.316	
.5912	.917	.354	
.5966	.941	.412	
.6009	.958	.420	
.6022	.957	.402	
.6037	.968	.364	
.6077	.986	.355	
.6092	11.013	.381	
.6109	.012	.376	
.6146	.023	.362	
.6161	.021	.414	
.6176	.034	.454	
.6214	.057	.447	
.6227	.053	.449	
.6242	.062	.442	
.6436	.061	.380	
.6450	.049	.401	
.6486	.059	.403	
.6536	.048	.420	
.6573	.066	.351	
37344.4091	11.159	+0.196	
.4132	.157	.356	
.4154	.156	.263	
.4217	.086	.321	
.4231	.080	.481	
.4247	.085	.413	
.4281	.029	.369	
.4297	.001	.382	
.4316	.031	.581	
.4426	.018	.334	
.4440	.025	.259	
.4479	.060	.233	
.4493	.092	.329	
.4511	.124	.445	
.4544	.153	.392	
.4558	.145	.431	
.4573	.144	.340	
.4606	.157	.357	
.4643	.152	.340	
.4675	.166	.370	
.4691	.172	.387	

J.D. 2400000+	V	(B-V)	(U-B)
37344.4707	11.171	+0.391	
.4757	.177	.414	
.4772	.162	.360	
.4785	.162	.328	
.4827	.157	.355	
.4843	.162	.358	
.4857	.152	.357	
.4941	.089	.401	
.4954	.078	.393	
.4968	.077	.406	
.4998	.034	.314	
.5012	.020	.316	
.5025	.000	.346	
.5052	10.934	.333	
.5066	.933	.290	
.5080	.928	.362	
.5110	.861	.326	
.5125	.831	.296	
.5137	.804	.311	
.5163	.751	.296	
.5177	.707	.245	
.5192	.666	.292	
.5219	.586	.208	
.5234	.511	.180	
.5248	.467	.188	
.5274	.405	.175	
.5287	.368	.162	
.5300	.344	.108	
.5329	.285	.012	
.5344	.253	.047	
.5360	.224	.053	
.5389	.154	.055	
.5401	.114	.054	
.5413	.077	.041	
.5440	.043	.045	
.5454	.030	.059	
.5466	.032	.041	
.5479	.021	.038	
.5491	.030	.027	
.5503	.027	.041	
.5517	.023	.055	
.5541	.016	.066	
.5553	.024	.063	
.5568	.030	.040	
.5600	.049	.054	
.5614	.055	.065	
.5630	.064	.070	
.5659	.080	.084	
.5673	.085	.090	
.5687	.094	.099	
.5762	.143	.075	
.5781	.156	.101	
.5796	.176	.091	
.5827	.200	.060	

J.D. 2400000+	V	(B-V)	(U-B)
37344.5841	10.201	+0.093	
.5857	.220	.089	
.5888	.252	.068	
.5903	.259	.112	
.5919	.266	.124	
.5961	.329	.082	
.5991	.349	.081	
.6017	.363	.105	
.6166	.454	.146	
.6182	.464	.171	
.6199	.485	.205	
.6244	.512	.215	
.6264	.512	.169	
.6282	.530	.202	
.6354	.525	.205	
.6371	.521	.197	
.6393	.545	.137	
.6440	.583	.162	
.6454	.612	.131	
.6467	.630	.148	
37345.4085	11.186	+0.349	
.4102	.188	.319	
.4120	.179	.368	
.4182	11.153	+0.392	
.4215	.127	.414	
.4232	.137	.414	
.4249	.119	.369	
.4278	.095	.381	
.4285	.079	.340	
.4305	.063	.333	
.4337	.050	.319	
.4349	.029	.315	
.4363	.019	.340	
.4392	10.965	.377	
.4406	.947	.369	
.4422	.929	.358	
.4469	.858	.222	
.4481	.831	.239	
.4492	.802	.243	
.4518	.764	.199	
.4529	.727	.214	
.4542	.689	.195	
.4568	.634	.285	
.4580	.579	.197	
.4593	.564	.342	
.4614	.515	.403	
.4625	.479	.342	
.4637	.413	.160	
.4658	.359	.169	
.4670	.334	.142	
.4682	.299	.166	
.4700	.234	.141	
.4713	.221	.168	
.4725	.185	.090	

J.D. 2400000+	V	(B-V)	(U-B)
37345.4747	10.129	+0.083	
.4757	.098	.076	
.4768	.065	.028	
.4782	.045	.056	
.4795	.030	.033	
.4808	.020	.057	
.4822	.009	.053	
.4844	9.998	.054	
.4856	.985	.057	
.4870	.980	.058	
.4892	.994	.043	
.4904	10.013	.015	
.4915	.022	.015	
.4942	.019	.029	
.4956	.024	.025	
.4970	.030	.031	
.4996	.054	.056	
.5008	.068	.046	
.5021	.073	.033	
.5046	.084	.065	
.5059	.091	.073	
.5070	.114	.081	
.5096	.123	.072	
.5110	.155	.088	
.5123	.160	.086	
.5152	.201	.121	
37353.4083	10.803	+0.280	
.4132	.698	.257	
.4149	.665	.234	
.4181	.496	.124	
.4194	.445	.148	
.4210	.417	.127	
.4243	.288	.164	
.4255	.241	.211	
.4269	.116	.148	
.4300	.123	.103	
.4315	.106	.122	
.4327	.075	.173	
.4369	9.959	.142	
.4384	.941	.095	
37358.3889	11.026	+0.402	
.3908	.020	.488	
.3928	.037	.528	
.3972	.061	.349	
.3993	.081	.412	
.4016	.086	.523	
.4071	.116	.466	
.4089	.118	.512	
.4107	.116	.494	
.4149	.130	.473	
.4164	.125	.356	
.4185	.138	.363	
.4231	.145	.393	
.4247	.145	.413	

J.D. 2400000+	V	(B-V)	(U-B)
37358.4263	10.133	+0.423	
.4301	.122	.432	
.4343	.131	.425	
.4380	.115	.435	
.4396	.102	.429	
.4411	.101	.383	
.4462	.119	.398	
.4479	.127	.384	
.4493	.108	.392	
.4530	.087	.418	
.4546	.100	.384	
.4562	.114	.430	
.4599	.120	.385	
.4613	.080	.405	
.4630	.075	.430	
.4668	.065	.406	
.4683	.089	.371	
.4700	.072	.415	
.4745	.068	.420	
.4761	.114	.485	
.4777	.118	.418	
.4841	.085	.413	
.4858	.100	.500	
.4881	.156	.409	
.4919	.117	.385	
.4962	.113	.496	
.4983	.182	.327	
.5032	.232	.384	
.5052	.212	.385	
.5076	.239	.314	
.5133	.232	.416	
.5151	.214	.397	
.5165	.208	.350	
.5205	.248	.391	
.5224	.265	.346	
.5242	.209	.342	
.5287	.224	.367	
.5305	.206	.412	
.5323	.208	.450	
.5378	.190	.408	
.5399	.149	.424	
.5416	.127	.378	
.5457	.076	.326	
.5476	.025	.290	
.5495	10.988	.260	
.5550	.886	.207	
.5563	.873	.197	
.5576	.838	.165	
.5628	.634	.197	
.5643	.573	.222	
.5660	.520	.262	
.5751	.241	.181	
.5785	.136	.180	
.5799	.113	.184	

J.D. 2400000+	V	(B-V)	(U-B)
37358.5818	10.083	+0.160	
.5835	.053	.163	
.5846	.038	.159	
.5859	.008	.165	
.5873	9.979	.149	
.5987	.966	.154	
.5901	.963	.145	
.5933	.966	.120	
.5949	.956	.101	
37360.3754	11.188	+0.297	
.3784	.207	.364	
.3800	.236	.527	
.3846	.199	.370	
.3868	.211	.335	
.3890	.199	.311	
.3927	.188	.332	
.3943	.203	.333	
.3960	.206	.283	
.4006	.239	.517	
.4023	.210	.319	
.4041	.203	.356	
.4083	.253	.352	
.4102	.165	.355	
.4121	.165	.349	
.4163	.098	.377	
.4182	.094	.398	
.4200	.093	.356	
.4244	.003	.189	
.4260	10.976	.179	
.4277	.931	.233	
.4315	.806	.180	
.4332	.654	.168	
.4345	.577	.158	
.4361	.516	.091	
.4377	.438	.104	
.4391	.379	.108	
.4406	.325	.033	
.4441	.211	.038	
.4457	.166	.033	
.4471	.148	.050	
.4490	.098	.016	
.4506	.049	.052	
.4522	.009	.038	
.4537	9.991	.008	
.4569	.939	.015	
37360.4586	9.921	-0.033	
.4601	.921	.023	
.4619	.923	.040	
.4678	.903	.076	
.4713	.912	.129	
.4730	.924	.075	
.4748	.928	.070	
.4807	.977	+0.030	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
37360.4824	9.994	+0.064		37360.6597	10.987	+0.361	
.4845	10.017	.042		.6630	.986	.332	
.4881	.054	.080		.6645	.992	.349	
.4897	.078	.047		.6660	.995	.354	
.4913	.089	.056		.6690	11.030	.340	
.4950	.139	-0.020					
.4967	.132	.013		37365.3912	11.060	+0.389	
.4983	.127	+0.015		.3943	.088	.468	
.5020	.113	.073		.3960	.093	.462	
.5039	.126	.047		.3998	.108	.472	
.5052	.102	-0.015		.4016	.114	.476	
.5116	.152	+0.098		.4032	.118	.470	
.5140	.213	.104		.4068	.104	.480	
.5161	.235	.145		.4085	.121	.422	
.5201	.269	.171		.4102	.128	.451	
.5218	.283	.191		.4137	.142	.485	
.5236	.283	.223		.4151	.132	.421	
.5307	.349	.129		.4169	.138	.445	
.5330	.377	.128		.4205	.151	.510	
.5351	.391	.111		.4220	.155	.501	
.5426	.442	.185		.4236	.147	.451	
.5445	.452	.214		.4270	.152	.444	
.5463	.478	.221		.4288	.155	.436	
.5564	.521	.221		.4304	.152	.406	
.5589	.521	.218		.4351	.165	.412	
.5619	.555	.289		.4367	.170	.414	
.5666	.566	.199		.4384	.159	.336	
.5688	.585	.205		.4425	.178	.403	
.5704	.634	.200		.4437	.184	.429	
.5765	.655	.290		.4455	.189	.449	
.5785	.666	.265		.4487	.192	.468	
.5816	.662	.331		.4633	.143	.377	
.5876	.720	.259		.4648	.126	.325	
.5901	.714	.273		.4723	.114	.476	
.5923	.723	.280		.4737	.110	.475	
.6965	.724	.290		.4750	.109	.465	
.6030	.734	.295		.4781	.120	.457	
.6052	.745	.314		.4797	.132	.462	
.6089	.776	.312		.4813	.133	.393	
.6108	.809	.293		.4846	.163	.444	
.6149	.831	.324		.4861	.159	.379	
.6179	.843	.304		.4877	.165	.380	
.6213	.858	.304		.4915	.164	.367	
.6310	.915	.347		.4930	.160	.371	
.6330	.933	.323		.4945	.166	.436	
.6350	.933	.359		.4977	.159	.479	
.6396	.934	.387		.4992	.162	.531	
.6418	.932	.378		.5008	.142	.437	
.6439	.936	.388		.5057	.131	.354	
.6480	.935	.319		.5071	.140	.361	
.6499	.943	.338		.5086	.147	.346	
.6519	.953	.354		.5149	.209	.477	
.6560	.973	.337		.5166	.206	.404	
.6581	.981	.369		.5194	.222	.412	

J.D. 2400000+	V	(B-V)	(U-B)
37365.5208	11.225	+0.404	
.5222	.226	.387	
.5257	.219	.431	
.5270	.227	.426	
.5284	.224	.426	
.5312	.218	.428	
.5326	.226	.491	
.5340	.227	.514	
.5368	.204	.395	
.5382	.191	.324	
.5395	.207	.427	
.5427	.219	.467	
.5444	.227	.485	
.5461	.234	.482	
.5490	.244	.431	
.5506	.240	.359	
.5520	.270	.441	
.5572	.210	.408	
.5592	.189	.438	
.5608	.157	.387	
.5642	.111	.412	
.5655	.090	.414	
.5667	.077	.430	
.5700	.016	.402	
.5715	10.985	.352	
.5729	.966	.382	
.5760	.896	.298	
.5773	.860	.291	
.5785	.821	.273	
.5810	.735	.287	
.5825	.673	.255	
.5839	.625	.231	
.5866	.475	.216	
.5879	.413	.162	
.5892	.365	.166	
.5930	.243	.150	
.5944	.196	.120	
.5958	.149	.115	
.5973	.109	.095	
.5987	.085	.119	
.6001	.058	.103	
.6016	.029	.095	
.6046	9.986	.067	
.6060	.974	.066	
.6076	.963	.065	
.6091	.945	.061	
.6107	.924	.037	
.6120	.916	.035	
.6134	.916	.046	
.6162	.919	.022	
.6177	.926	.027	
.6191	.937	.039	
.6226	.960	.001	
.6242	.959	-0.006	

J.D. 2400000+	V	(B-V)	(U-B)
37365.6259	9.967	-0.014	
.6290	.990	+0.008	
.6304	.995	-0.006	
.6319	.998	+0.003	
.6350	10.011	.038	
37376.3026	11.129	+0.309	
.3061	.123	.293	
.3076	.122	.309	
.3107	.121	.352	
.3124	.116	.349	
.3139	.113	.347	
.3174	.090	.302	
.3187	.081	.305	
.3203	.068	.321	
.3255	.050	.302	
37376.3274	.048	.311	
.3291	.049	.357	
.3323	.030	.347	
.3339	.003	.273	
.3362	10.974	.289	
.3392	.908	.289	
.3406	.863	.247	
.3419	.829	.285	
.3448	.746	.297	
.3461	.696	.271	
.3476	.653	.247	
.3503	.548	.153	
.3524	.481	.138	
.3544	.422	.158	
.3571	.329	.107	
.3583	.278	.091	
.3596	.242	.095	
.3610	.190	.148	
.3623	.133	.148	
.3633	.093	.085	
.3645	.071	.108	
.3657	.053	.081	
.3671	.040	.096	
.3684	.014	.051	
.3697	.001	.058	
.3723	9.986	.113	
.3735	.972	.059	
.3748	.974	.092	
.3760	.978	.092	
.3773	.978	.085	
.3785	.979	.065	
.3799	.985	.061	
.3829	.995	.035	
.3843	10.003	.037	
.3858	.012	.045	
.3983	.078	.071	
.3997	.078	.032	
.4025	.098	.082	
.4039	.102	.069	

J.D. 2400000+	V	(B-V)	(U-B)
37376.4053	10.109	+0.058	
.4080	.115	.024	
.4094	.125	.030	
.4108	.136	.058	
.4136	.148	.065	
.4150	.157	.052	
.4164	.162	.042	
.4198	.177	.051	
.4212	.192	.099	
.4226	.207	.150	
.4254	.219	.137	
.4268	.214	.077	
.4282	.222	.086	
.4317	.239	.085	
.4330	.256	.151	
.4344	.270	.196	
.4394	.293	.187	
.4431	.311	.185	
.4454	.345	.307	
.4492	.341	.179	
.4510	.344	.143	
.4528	.374	.221	
37395.5334	10.644	+0.217	
.5347	.621	.206	
.5365	.579	.222	
.5402	.472	.186	
.5415	.430	.171	
.5429	.381	.168	
.5466	.325	.174	
.5481	.312	.188	
.5497	.295	.148	
.5540	.248	.078	
.5554	.238	.103	
.5570	.216	.087	
.5597	.197	.105	
.5610	.190	.094	
.5625	.190	.105	
.5641	.194	.129	
.5655	.197	.129	
.5670	.196	.114	
.5687	.200	.119	
.5720	.207	.100	
.5736	.221	.151	
.5750	.224	.147	
.5785	.236	.152	
.5800	.239	.142	
.5816	.241	.110	
37396.4202	11.060	+0.373	
.4220	.050	.318	
.4240	.039	.286	
.4287	.023	.300	
.4306	.020	.352	
.4323	10.995	.268	

J.D. 2400000+	V	(B-V)	(U-B)
37396.4367	10.988	+0.340	
.4384	.983	.347	
.4398	.971	.321	
.4455	.928	.314	
.4474	.908	.348	
.4489	.901	.339	
.4739	.559	.195	
.4772	.483	.190	
.4816	.402	.141	
.4828	.381	.174	
.4841	.357	.169	
.4867	.321	.162	
.4883	.298	.145	
.4897	.285	.144	
.4935	.243	.124	
.4950	.231	.109	
.4973	.217	.114	
.5020	.230	.119	
.5035	.230	.111	
.5051	.232	.110	
.5104	.248	.110	
.5122	.249	.092	
.5172	.262	.082	
37397.3265	11.106	+0.338	
.3293	.121	.417	
.3307	.116	.409	
.3346	.093	.336	
.3361	.094	.386	
.3377	.093	.409	
.3409	.067	.321	
.3429	.061	.331	
.3443	.072	.413	
.3477	.058	.336	
.3493	.045	.344	
.4190	10.354	.141	
.4216	.322	.143	
.4229	.301	.110	
.4262	.273	.133	
.4278	.254	.105	
.4293	.242	.102	
.4326	.232	.123	
.4342	.224	.105	
.4358	.225	.118	
.4391	.226	.140	
.4409	.228	.124	
.4427	.230	.112	
.4466	.243	.107	
.4487	.247	.091	
.4512	.255	.080	
.4563	.276	.088	
.4603	.297	.099	
.4677	.339	.148	
.4711	.357	.170	

J.D. 2400000+	V	(B-V)	(U-B)
37397.4783	10.376	+0.110	
.4817	.387	.084	
.4843	.401	.144	
.4943	.435	.127	
.5000	.467	.188	
.5043	.489	.207	
.5104	.504	.153	
.5135	.534	.257	
.5163	.541	.230	
.5187	.550	.232	
.5202	.557	.243	
.5235	.562	.208	
.5255	.567	.206	
.5275	.573	.206	
.5370	.631	.328	
.5386	.629	.282	
.5403	.633	.258	
.5441	.649	.278	
.5455	.647	.240	
.5500	.667	.241	
.5532	.678	.242	
.5547	.690	.274	
.5562	.700	.270	
.5593	.703	.263	
.5610	.716	.306	
.5625	.720	.311	
.5680	.734	.283	
.5704	.747	.307	
.5725	.753	.308	
.5781	.777	.327	
.5801	.783	.325	
.5816	.785	.312	
.5852	.801	.315	
.5981	.853	.391	
.6035	.856	.308	
.6050	.864	.317	
.6063	.884	.399	
37397.6093	.873	.283	
.6107	.893	.363	
.6125	.902	.377	
.6167	.906	.323	
37399.4761	10.866	+0.382	
.4791	.854	.270	
.4814	.863	.276	
.4903	.894	.312	
.4922	.897	.295	
.4943	.913	.364	
.4990	.912	.356	
.5019	.917	.353	
.5038	.922	.365	
.5082	.933	.380	
.5103	.935	.374	
.5122	.939	.368	

J.D. 2400000+	V	(B-V)	(U-B)
37399.5163	10.942	+0.366	
.5182	.947	.377	
.5201	.951	.381	
.5242	.955	.383	
.5261	.955	.372.5279	
.5279	.961	.394	
.5329	.970	.397	
.5351	.972	.395	
.5373	.974	.380	
.5418	.978	.362	
.5439	.989	.407	
.5465	.995	.405	
.5576	11.025	.444	
.5597	.026	.425	
.5622	.028	.405	
.5668	.038	.403	
.5685	.038	.394	
.5708	.041	.391	
.5829	.058	.396	
.5845	.064	.429	
.5883	.064	.396	
.5903	.069	.412	
.5925	.069	.396	
.5971	.074	.400	
.5989	.072	.377	
.6005	.072	.368	
.6045	.083	.424	
.6064	.075	.374	
.6080	.078	.396	
.6131	.072	.397	
.6157	.071	.411	
37402.3334	10.970	+0.387	
.3354	.974	.388	
.3375	.973	.393	
.3421	.975	.380	
.3445	.975	.375	
.3466	.978	.385	
.3521	.976	.334	
.3545	.979	.319	
.3568	.984	.331	
.3618	.995	.349	
.3640	11.000	.344	
.3664	.019	.336	
.3718	.028	.462	
.3746	.018	.367	
.3782	.038	.467	
.3879	.035	.412	
.3896	.014	.314	
.3921	.025	.405	
.3976	.036	.384	
.3994	.042	.404	
.4015	.041	.395	
.4059	.040	.368	

J.D. 2400000+	V	(B-V)	(U-B)
37402.4079	11.038	+0.341	
.4112	.042	.347	
.4153	.044	.341	
.4181	.045	.353	
.4196	.044	.355	
.4245	.046	.369	
.4273	.045	.370	
.4301	.042	.359	
.4345	.042	.356	
.4364	.037	.334	
.4381	.045	.383	
.4420	.038	.347	
.4438	.036	.340	
.4455	.042	.385	
.5356	10.897	.216	
.5374	.890	.280	
.5389	.867	.230	
.5426	.840	.305	
.5442	.824	.299	
.5460	.793	.250	
.5499	.748	.261	
.5518	.722	.248	
.5539	.695	.240	
.5577	.643	.223	
.5596	.617	.224	
.5618	.582	.211	
.5659	.531	.160	
.5677	.494	.139	
.5698	.479	.183	
.5731	.439	.123	
.5750	.422	.183	
.5769	.385	.097	
.5805	.350	.089	
.5822	.333	.102	
.5843	.329	.117	
.5880	.296	.032	
.5898	.291	.023	
.5917	.302	.110	
.5957	.310	.092	
.5975	.320	.056	
.5993	.322	.073	
.6034	.354	.152	
.6053	.349	.039	
37404.4505	10.354	+0.113	
.4533	.342	.113	
.4548	.320	.122	
.4564	.337	.145	
.4578	.328	.109	
.4592	.324	.093	
.4624	.330	.124	
.4642	.333	.115	
.4658	.339	.126	
.4676	.341	.128	

J.D. 2400000+	V	(B-V)	(U-B)
37404.4775	10.371	+0.177	
.4789	.367	.146	
.4805	.365	.126	
.4846	.378	.152	
.4868	.379	.123	
.4888	.395	.185	
.4927	.410	.208	
.4944	.410	.191	
.4998	.423	.177	
.5034	.430	.160	
.5053	.438	.167	
.5075	.447	.181	
.5118	.466	.209	
.5138	.467	.172	
.5157	.476	.190	
.5195	.485	.190	
.5210	.496	.222	
.5320	.524	.218	
.5353	.531	.214	
.5368	.542	.249	
.5383	.547	.254	
.5416	.555	.255	
.5475	.575	.262	
.5490	.580	.265	
.5506	.587	.270	
.5549	.599	.263	
.5565	.609	.283	
.5585	.622	.307	
.5630	.638	.305	
.5647	.644	.309	
.5666	.650	.293	
.5710	.650	.223	
37406.4665	10.750	+0.271	
.4680	.755	.272	
.4698	.762	.289	
.4734	.777	.315	
.4750	.774	.272	
.4772	.782	.296	
.4811	.797	.321	
.4832	.802	.317	
.4852	.809	.331	
.4902	.832	.385	
.4930	.835	.355	
.4968	.844	.352	
.5056	.867	.359	
.5150	.889	.342	
.5165	.900	.381	
.5206	.901	.324	
.5230	.909	.326	
.5257	.928	.406	
.5305	.940	.408	
.5322	.932	.354	
.5422	.942	.359	

J.D. 2400000+	V	(B-V)	(U-B)
37406.5465	10.936	+0.325	
.5592	.934	.324	
.5606	.943	.379	
.5644	.949	.404	
37411.3828	11.007	+0.381	
.3841	10.993	.356	
.3853	.987	.362	
.3882	.959	.296	
.3896	.963	.347	
.3915	.959	.343	
.3967	.956	.348	
37411.3980	10.956	+0.351	
.3994	.951	.331	
.4021	.944	.322	
.4036	.959	.363	
.4050	.944	.342	
.4078	.941	.350	
.4091	.944	.379	
.4105	.935	.348	
.4140	.924	.334	
.4157	.918	.334	
.4175	.911	.321	
.4209	.901	.332	
.4225	.883	.298	
.4239	.881	.322	
.4274	.854	.309	
.4289	.839	.278	
.4303	.828	.278	
.4333	.804	.279	
.4346	.790	.254	
.4361	.772	.246	
.4390	.766	.237	
.4406	.721	.207	
.4424	.709	.221	
.4453	.684	.219	
.4465	.676	.238	
.4478	.665	.248	
.4505	.631	.229	
.4517	.615	.209	
.4529	.599	.211	
.4556	.523	.202	
.4568	.546	.197	
.4579	.534	.202	
.4600	.514	.189	
.4615	.498	.168	
.4629	.487	.184	
.4643	.479	.195	
.4667	.446	.155	
.4680	.428	.152	
.4695	.416	.163	
.4710	.403	.182	
.4723	.387	.181	
.4737	.379	.178	

J.D. 2400000+	V	(B-V)	(U-B)
37411.4750	10.374	+0.174	
.4774	.374	.176	
.4787	.373	.163	
.4800	.372	.159	
.4835	.374	.155	
.4858	.373	.138	
.4880	.376	.150	
.4924	.379	.157	
.4938	.380	.149	
.4960	.382	.150	
.5006	.388	.145	
.5020	.390	.144	
.5035	.389	.138	
.5066	.400	.173	
.5081	.399	.163	
.5097	.403	.165	
.5134	.410	.166	
.5149	.415	.175	
.5174	.426	.199	
.5212	.438	.187	
.5230	.448	.191	
.5245	.454	.182	
.5285	.485	.213	
.5301	.496	.212	
.5350	.523	.197	
.5365	.535	.208	
37418.3288	11.027	+0.071	
.3364	.036	.354	
.3386	.035	.370	
.3428	.037	.400	
.3451	.033	.351	
.3502	.039	.367	
.3521	.039	.353	
.3545	.042	.328	
.3591	.064	.374	
.3612	.093	.388	
.3633	.079	.388	
.3679	.078	.318	
.3697	.078	.313	
.3718	.084	.343	
.4498	10.848	.260	
.4527	.826	.298	
.4541	.812	.305	
.4555	.799	.292	
.4584	.768	.262	
.4597	.759	.265	
.4610	.740	.229	
.4639	.718	.242	
.4653	.701	.210	
.4669	.687	.208	
.4700	.658	.221	
.4716	.637	.209	
.4730	.620	.200	

J.D. 2400000+	V	(B-V)	(U-B)
37418.4746	10.603	+0.175	
.4761	.582	.187	
.4778	.565	.162	
.4809	.547	.186	
.4826	.520	.147	
.4845	.498	.181	
.4865	.469	.169	
.4887	.435	.136	
.4944	.358	.096	
.4976	.337	.173	
.5005	.315	.186	
.5020	.309	.179	
.5036	.308	.190	
.5052	.306	.181	
.5086	.304	.164	
.5104	.309	.175	
.5124	.311	.161	
.5139	.314	.151	
.5155	.319	.154	
.5190	.333	.145	
.5206	.337	.127	
.5225	.344	.116	
.5260	.356	.090	
.5276	.371	.124	
.5294	.382	.140	
37424.4007	11.018	+0.359	
.4042	.022	.372	
.4095	.026	.350	
.4145	.033	.365	
.4164	.038	.393	
.4207	.033	.377	
.4226	.034	.382	
.4256	.032	.382	
.4304	.026	.380	
.4328	.023	.386	
.4345	.021	.379	
.4385	.015	.362	
.4412	.012	.359	
.4441	.013	.378	
.4475	.016	.394	
.4560	.020	.367	
.4595	.031	.380	
.4658	.036	.346	
.4697	.049	.383	
.4725	.055	.401	
.4774	.067	.429	
.4846	.078	.389	
.5064	.083	.369	
.5096	.060	.319	
.5112	.052	.329	
.5160	.037	.358	
.5184	.037	.366	
.5224	.021	.338	

J.D. 2400000+	V	(B-V)	(U-B)
37424.5288	10.991	+0.309	
.5315	.972	.273	
.5351	.947	.303	
.5404	.892	.259	
.5430	.830	.318	
.5455	.805	.280	
.5507	.726	.282	
.5544	.670	.304	
.5562	.644	.259	
.5596	.583	.218	
.5612	.564	.192	
.5630	.539	.197	
.5666	.473	.164	
.5687	.434	.143	
.5704	.417	.127	
.5741	.367	.144	
.5756	.361	.123	
.5772	.317	.099	
.5799	.260	.147	
.5811	.255	.106	
.5824	.243	.092	
.5852	.231	.118	
37443.3284	9.974	+0.079	
.3321	.988	.075	
.3341	10.007	.092	
.3465	.100	.114	
.3480	.114	.109	
.3494	.122	.111	
.3530	.168	.130	
.3549	.193	.135	
.3566	.204	.105	
.3601	.224	.106	
.3617	.233	.089	
.3634	.250	.148	
.3674	.285	.115	
37443.3692	10.303	+0.165	
.3711	.308	.161	
.3753	.367	.200	
.3773	.374	.212	
.3791	.379	.200	
.3826	.415	.185	
.3847	.421	.178	
.3868	.431	.171	
.3910	.469	.196	
.3933	.496	.211	
.3955	.512	.212	
.4000	.518	.211	
.4021	.537	.206	
.4042	.548	.219	
.4226	.658	.265	
.4242	.680	.259	
.4257	.698	.247	
.4310	.734	.295	

J.D. 2400000+	V	(B-V)	(U-B)
37443.4330	10.740	+0.288	
.4396	.761	.326	
.4430	.821	.382	
.4486	.817	.363	
.4518	.823	.351	
.4535	.833	.366	
.4556	.839	.364	
.4597	.844	.341	
.4615	.850	.361	
.4639	.856	.353	
.4678	.879	.360	
.4697	.895	.404	
.4715	.903	.372	
.4754	.908	.363	
.4774	.926	.379	
.4800	.931	.379	
.4864	.955	.369	
.4891	.965	.346	
.4928	.979	.249	
.5000	11.003	.367	
.5040	.034	.341	
.5068	.060	.352	
37456.3611	11.163	+0.471	
.3639	.170	.419	
.3654	.171	.409	
.3666	.165	.384	
.3680	.144	.371	
.3705	.104	.386	
.3718	.069	.355	
.3730	.057	.364	
.3753	.030	.367	
.3768	10.989	.299	
.3780	.956	.369	
.3808	.889	.370	
.3832	.806	.294	
.3857	.727	.273	
.3878	.592	.213	
.3908	.474	.140	
.3917	.411	.206	
.3936	.352	.114	
.3946	.335	.134	
.3968	.276	.187	
.3977	.229	.168	
.4002	.134	.108	
.4010	.111	.094	
.4042	9.966	-0.052	
.4051	.928	.041	
37463.3994	10.967	+0.303	
.4021	.896	.267	
.4035	.864	.313	
.4048	.799	.311	
.4075	.679	.235	
.4088	.629	.223	

J.D. 2400000+	V	(B-V)	(U-B)
37463.4101	10.543	+0.235	
.4126	.454	.187	
.4141	.375	.111	
.4154	.305	.144	
.4180	.242	.135	
.4192	.224	.124	
.4207	.165	.097	
.4236	.077	.048	
.4250	.051	.056	
.4264	.042	.082	
.4292	.018	.057	
.4306	9.999	.041	
.4320	.986	.037	
.4348	.961	-0.005	
.4362	.964	+0.025	
.4378	.964	.044	
.4408	.974	.074	
.4426	.971	.045	
.4444	.985	.093	
.4476	.991	.033	
.4494	10.001	.023	
.4528	.033	.088	
.4542	.034	.060	
.4557	.043	.060	
.4588	.063	.084	
.4606	.070	.078	
.4624	.082	.075	
.4658	.113	.141	
37652.5210	10.056	+0.239	
.5218			-0.107
.5255	9.948	.198	
.5262			+0.026
.5275	.956	.142	
.5281			.027
.5293	.982	.110	
.5298			.091
.5332	.980	.122	
.5338			.016
.5350	.984	.134	
.5357			-0.076
.5369	10.005	.089	
.5375			.155
.5407	.035	.089	
.5417			.172
.5435	.037	.092	
.5442			.195
.5456	.053	.107	
.5462			.170
.5501	.067	.102	
.5509			.071
.5522	.085	.097	
.5528			.055
.5542	.090	.144	

J.D. 2400000+	V	(B−V)	(U−B)
37652.5550			−0.142
.5585	10.113	+0.133	
.5592			+0.066
.5606	.115	.130	
.5612			−0.032
.5627	.129	.155	
.5638			.048
.5678	.140	.173	
.5685			+0.005
.5698	.168	.135	
.5706			−0.017
.5720	.198	.144	
.5728			+0.022
.5770	.234	.167	
.5778			−0.004
.5792	.248	.170	
.5800			+0.042
.5928	.316	.179	
.5935			.065
.5967	.333	.145	
.5976			.025
.5998	.347	.186	
.6010			.065
.6040	.349	.221	
.6057			.063
.6118	.368	.277	
.6130			.054
.6155	.389	.229	
.6165			.112
.6192	.428	.184	
.6207			.044
.6275	.479	.258	
.6282			.001
.6300	.503	.219	
.6310			.024
.6337	.536	.247	
.6343			.032
.6377	.546	.246	
.6383			−0.072
.6399	.552	.273	
.6406			.117
.6418	.564	.271	
.6424			.147
.6460	.593	.267	
.6468			.108
.6480	.594	.271	
.6487			.052
.6500	.604	.273	
.6505			.034
.6536	.616	.299	
.6541			.024
37668.4602	10.182	+0.186	
.4606			−0.014
37668.4638	10.201	+0.206	
.4642			−0.043
.4655	.218	.222	
.4662			+0.040
37668.4693	10.254	+0.171	
.4700			+0.050
.4715	.288	.161	
.4725			−0.004
.4741	.324	.172	
.4746			.009
.4777	.332	.179	
.4783			+0.041
.4801	.336	.182	
.4810			.075
.4823	.350	.198	
.4829			−0.018
.4868	.370	.227	
.4874			.063
.4889	.401	.151	
.4895			.045
.4930	.370	.263	
.4936			.175
.4949	.400	.211	
.4954			.038
.5020	.420	.262	
.5026			.157
.5040	.434	.205	
.5047			.005
.5085	.446	.269	
.5093			−0.079
.5111	.458	.265	
.5118			.126
.5152	.484	.253	
.5157			.059
.5464			+0.024
.5471	.585	.317	
.5504			−0.002
.5510	.581	.354	
.5523			.008
.5528	.595	.314	
.5561			.020
.5568	.606	.328	
.5579			+0.007
.5585	.619	.252	
.5622			−0.001
.5628	.652	.275	
.5643			+0.022
.5650	.659	.318	
.5686			−0.067
.5692	.677	.313	
.5705			.016
.5717	.699	.282	
.5759			+0.030
.5766	.714	.269	

J.D. 2400000+	V	(B-V)	(U-B)
37668.5782			+0.001
.5788	-10.709	+0.269	
.5838			-0.007
.5844	.748	.257	
.5858			.010
.5864	.760	.261	
.5904			.038
.5910	.732	.251	
.6011			.020
.6017	.812	.300	
.6059			.031
.6065	.802	.330	
.6081			.035
.6089	.798	.305	
.6121			+0.008
.6127	.832	.345	
.6140			-0.012
.6147	.845	.348	
.6184			.019
.6190	.859	.336	
.6201			.037
.6208	.863	.336	
.6247			+0.050
.6255	.863	.333	
37672.5145	11.024	+0.345	
.5188			-0.119
.5195	.038	.377	
.5211			.089
.5222	.050	.368	
.5279			.097
.5285	.043	.344	
.5300			+0.012
.5309	.038	.282	
.5350			-0.074
.5358	.076	.372	
.5377			.163
.5384	.057	.414	
.5428			.193
.5434	.104	.415	
.5447			.156
.5455	.080	.461	
.5502			.160
.5510	.095	.496	
.5531			.079
.5542	.093	.391	
.5583			.076
.5592	.024	.400	
.5608			.067
.5615	.048	.365	
.5658			.052
.5666	.027	.335	
.5678			.050
.5686	.027	.337	

J.D. 2400000+	V	(B-V)	(U-B)
37672.5726			-0.078
.5738	10.968	+0.341	
.5754			.028
.5760	.961	.372	
.5797			.017
.5802	11.010	.373	
37680.4659			+0.031
.4670	11.058	0.350	
.4721			-0.051
.4758	.072	.365	
.4822			.041
.4834	.037	.339	
.4947	.097	.329	
.4980	.080	.442	
.4998	.091	.416	
.5081			.046
.5092	.057	.372	
.5113			.012.
.5123	.048	.378	
.5183			.053
.5198	.017	.302	
.5227			.064
.5237	.000	.378	
.5293			.084
.5305	10.989	.372	
.5326			.078
.5335	.960	.373	
.5386			.036
.5398	.966	.363	
.5423			.015
.5433	.931	.182	
.5534	.936	.283	
.5539			.008
.5556	.931	.295	
.5566			.017
.5612	.852	.302	
.5619			.096
.5640	.828	.318	
.5647			.114
.5659	.795	.316	
.5665			+0.023
.5705	.790	.286	
.5712			.093
.5728	.782	.239	
.5735			.034
.5769	.751	.237	
.5775			.055
.5789	.718	.220	
.5796			.070
.5810	.692	.270	
.5816			.018
.5850	.648	.249	
.5858			-0.015

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
37680.5875	11.619	+0.258		37702.5778			-0.059
.5881			+0.015	.5790	11.861	+0.297	
.5896	.579	.288		.5795			.097
.5903			.018	.5826	.784	.286	
.5939	.556	.178		.5832			.032
37680.5944			-0.023	.5852	.809	.195	
.5957	.494	.151		.5858			.090
.5964			.024	.5869	.745	.291	
.5980	.470	.242		.5875			.006
.5988			.040	.5909	.491	.295	
.6030	.414	.222		.5916			.051
.6038			.029	.5928	.488	.222	
.6052	.386	.221		.5933			.059
.6058			.039	.5945	.510	.172	
.6070	.373	.209		.5951			.072
.6077			.050	.5982	.414	.168	
.6112	.378	.200		.5988			.017
.6119			.016	.6001	.381	.178	.021
.6135	.372	.218		.6024	.318	.162	
.6142			.008	.6031			.031
.6157	.389	.168		.6066	.223	.162	
.6165			.017	.6073			.053
.6208	.365	.255		.6087	.178	.189	
.6216			.020	.6093			.044
.6234	.359	.140		.6106	.147	.159	
.6242			.033	.6113			+0.007
.6258	.351	.157		.6152	.116	.102	
.6265			.016	.6158			.041
.6309	.364	.148		.6174	.098	.133	
.6316			.014	.6183			-0.005
.6331	.375	.129		.6198	.095	.138	
.6338			.022	.6206			0.000
.6355	.377	.124		.6246	.109	.142	
.6373			.033	.6253			0.000
.6432	.382	.155		.6270	.147	.128	
.6444			.073	.6278			+0.007
.6520	.401	.258		.6295	.152	.119	
.6528			.026	.6303			-0.030
.6580	.445	.234		.6345	.173	.164	
.6590			-0.021	.6360			.050
.6610	.457	.218		.6398	.201	.152	
.6620			.011	.6409			+0.025
.6676	.465	.222		.6424	.217	.144	
.6688			+0.007	.6429			-0.003
.6706	.520	.181		.6464	.228	.134	
.6714			.092	.6471			+0.022
.6766	.498	.228		37732.3670	11.092	+0.414	
.6776			.047	.3686			-0.036
37702.5708	11.042	+0.212		.3737	.094	.371	
.5716			-0.104	.3745			.061
.5753	10.923	.280		.3763	.076	.387	
.5760			.036	.3771			.015
.5772	.896	.268		.3820	.100	.376	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
37732.3828			-0.024	37732.5254			+0.008
.3845	11.123	+0.394		.5266	11.106	+0.383	
.3853			.042	.5271			-0.010
.3900	.151	.437		.5282	.076	.395	
.3909			+0.015	.5287			+0.030
.3930	.182	.416		.5319	11.034	+0.314	
.3940			-0.163	.5323			+0.009
.3997	.231	.465		.5334	.001	.269	
.4006			.034	.5338			-0.014
.4026	.202	.409		.5350	10.941	.317	
.4037			+0.010	.5357			+0.014
.4092	.188	.392		.5386	.902	.351	
.4101			.012	.5392			-0.050
.4120	.141	.440		.5402	.922	.327	
.4129			.035	.5408			.060
.4180	.162	.442		.5493			.004
.4192			-0.022	.5498	.402	.217	
.4217	.175	.440		.5509			+0.003
.4224			.031	.5515	.346	.180	
.4276	.170	.459		.5530			.023
.4287			.062	.5535	.259	.195	
.4312	.163	.470		.5569			-0.024
.4320			.103	.5575	.126	.140	
.4365	.165	.432		.5586			.019
.4373			+0.012	.5592	.084	.086	
.4730	.216	.395		.5604			.024
.4737			.026	.5610	.048	.107	
.4751	.183	.450		.5650			.102
.4758			-0.043	.5655	+9.957	.069	
.4812	.236	.376		.5665			.016
.4818			.073	.5669	.943	.063	
.4832	.223	.392		.5681			.004
.4840			.028	.5686	.922	.044	
.4887	.208	.424		.5717			.014
.4894			.039	.5721	9.904	+0.052	
.4908	.206	.409		.5732			-0.023
.4915			.027	.5737	.901	.050	
.4965	.211	.382		.5753			.038
.4971			+0.041	.5758	.886	.094	
.4985	.206	.410		.5787			.055
.4991			-0.035	.5792	.911	.096	
.5034	.195	.406		.5822			.045
.5040			.063	.5830	.931	.092	
.5055	.189	.399		.5846			.046
.5061			.009	.5852	.940	.097	
.5120	.190	.403		.5891			.010
.5127			.022	.5897	.964	.064	
.5140	.200	.429		.5999			.001
.5147			.064	.6006	10.029	.094	
.5188	.177	.407		.6018			.008
.5195			+0.022	.6024	.047	.099	
.5210	.176	.435		.6053			.004
.5215			-0.047	.6058	.070	.129	
.5249	.132	.393		.6070			+0.001

J.D. 2400000+	V	(B-V)	(U-B)
37732.6076	10.080	+0.135	
.6089			-0.005
.6095	.108	.121	
.6129			.009
.6135	.127	.130	
.6148			.004
.6154	.137	.148	
.6167			.014
.6173	.149	.150	
.6214			.001
.6220	.171	.162	
.6235			+0.005
.6242	.184	.152	
.6256			.012
.6262	.195	.133	
.6295			.003
.6305	.251	.121	
.6320			-0.035
.6327	.252	.141	
.6408			.014
.6412	.310	.186	
.6444			.018
.6450	.331	.212	
37756.3730	10.987	+0.360	
.3735			+0.021
.3771	.985	.364	
.3776			.067
.3788	.990	.345	
.3794			.016
.3829	.966	.374	
.3835			-0.032
.3850	.959	.346	
.3856			.001
.3869	.940	.363	
.3875			.014
.3912	.927	.359	
.3918			.014
.3932	.903	.339	
.3937			.003
.3950	.892	.366	
.3957			+0.002
.3991	.853	.354	
.3997			.026
.4010	.832	.266	
.4017			-0.013
.4032	.818	.250	
.4038			.003
.4072	.704	.192	
.4077			+0.075
.4096	.731	.149	
.4104			.040
.1425			.045
.4156	.517	.244	

J.D. 2400000+	V	(B-V)	(U-B)
37756.4162			+0.012
.4174	10.481	+0.209	
.4180			-0.014
.4195	.417	.216	
.4203			+0.005
.4240	.376	.201	
.4244			-0.033
.4256	.337	.187	
.4263			.018
.4278	.296	.180	
.4284			.004
.4318	.247	.130	
.4324			.003
.4336	.201	.149	
.4342			.024
.4353	.153	.162	
.4358			.032
.4394	.130	.132	
.4401			.032
.4418	.164	.151	
.4424			.026
.4439	.164	.168	
.4446			.027
.4482	.198	.131	
.4487			.032
.4501	.187	.160	
.4508			.018
.4523	.191	.139	
.4529			.024
.4565	.204	.167	
.4570			.050
.4585	.207	.169	
.4593			.012
.4654	.229	.151	
.4658			+0.024
.4691	.252	.166	
.4697			-0.015
.4711	.268	.179	
.4717			.007
.4730	.275	.165	
.4736			+0.030
.4774	.295	.193	
.4782			0.000
.4796	.305	.214	
.4808			-0.024
.4830	.318	.193	
.4838			.016
.4885	.335	.189	
.4892			+0.013
.4921	.343	.221	
.4930			.011
.4974	.362	.215	
.4987			.018
.5028	.381	.246	

J.D. 2400000+	V	(B-V)	(U-B)
37756.5044			-0.020
.5554	10.625	+0.287	
.5570			+0.028
.5580	.644	.313	
.5633			-0.007
.5643	.660	.303	
.5668			.046
.5681	.670	.315	
.5730			+0.004
.5739	.680	.362	
.5760			-0.011
.5768	.703	.327	
.5815			+0.025
.5826	.735	.319	
.5859			.027
.5872	.753	.309	
.5936			-0.026
.5945	.747	.317	
.5968			+0.033
.5982	.779	.348	
.6036			-0.051
.6052	.809	.398	
.6080			.070
.6100	.833	.394	
.6138			.035
.6146	.854	.390	
37769.4873			-0.125
.4880	10.935	+0.406	
.4894			.087
.4898	.984	.372	
.4913			.081
.4960			.071
.4965	.973	.277	
.4979			.110
.4987	.923	.337	
.5003			.127
.5041			+0.052
.5046	.777	.243	
.5062			-0.007
.5071	.778	.265	
.5085			+0.022
.5093	.742	.274	
.5125			-0.001
.5130	.711	.268	
.5142			.026
.5147	.700	.276	
.5163			.069
.5173	.648	.247	
.5222			+0.093
.5236	.586	.293	
.5270			-0.004
.5279	.505	.203	
.5307			.104

J.D. 2400000+	V	(B-V)	(U-B)
37769.5313	10.441	+0.256	
.5360			-0.042
.5372	.391	.151	
.5394			.095
.5404	.380	.198	
.5420			.011
.5431	.326	0.179	
.5468			.129
.5476	.322	.216	
.5498			.127
.5504	.333	.190	
.5521			.017
.5528	.336	.182	
.5568			.026
.5577	.337	.153	
.5594			.001
.5604	.349	.196	
.5624			+0.010
.5631	.364	.226	
.5674			.038
.5683	.348	.182	
37780.3021	10.398	+0.167	
.3027			+0.271
.3071	.337	.130	
.3076			.176
.3088	.326	.126	
.3094			.020
.3139	.329	.117	
.3145			.052
.3166	.318	.127	
.3174			-0.092
.3213	.331	.098	
.3220			.037
.3236	.360	.114	
.3244			.045
.3276	.346	.133	
.3286			.049
.3306	.331	.186	
.3314			.046
.3388	.358	.237	
.3399			.091
.3434	.353	.241	
.3449			+0.073
.3478	.387	.212	
.3494			.096
.3552	.439	.169	
37806.4290	11.125	+0.348	
.4300			-0.250
.4366	.130	.304	
.4377			.146
.4397	.154	.400	
.4409			.225
.4427	.193	.451	

J.D. 2400000+	V	(B-V)	(U-B)
37806.4436			-0.215
.4514			.128
.4524	11.196	+0.408	
.4549			.132
.4563	.161	.441	
.4581			.227
.4590	.141	.381	
.4676	.130	.445	
.4685			.213
.4705	.104	.419	
.4715			.283
.4734	.088	.468	
.4745			.235
.4758	.069	.430	
.4765			.163
.4770			+0.015
.4784	10.991	.467	
.4862	.989	.373	
.4870			.015
.4885	.970	.316	
.4893			.028
.4910	.847	.361	
.4918			.023
.4937	.780	.320	
.4970			.050
.4978	.739	.234	
.4994			.067
.5002	.640	.262	
.5019			-0.005
.5038	.481	.269	
.5048			.028
.5064	.387	.245	
.5123	.226	.125	
.5136			.145
.5147	.109	.142	
.5161			.107
.5177	.053	.219	
.5230			+0.076
.5238	.007	.242	
.5253	9.959	.127	
.5260			-0.027
.5278	.953	.163	
.5286			.027
.5300	.933	.107	
.5308			+0.112
.5348	.990	.090	
.5363			-0.043
.5370	10.002	.102	
.5385			+0.113
.5392	.006	.094	
.5408			.092
.5417	.028	.087	
.5435			-0.047
.5444	.047	.081	
37806.5490			-0.135
.5498	10.103	+0.079	
.5533	.097	-0.004	
37808.3439	11.136	+0.469	
.3445			-0.090
.3466	.126	.429	
.3477			.028
.3495	092	.430	
.3501			.164
.3515	.085	.377	
.3523			+0.029
.3558	.017	.425	
.3578	10.986	.373	
.3584			-0.003
.3598	.982	.329	
.3605			.237
.3626	.912	.316	
.3633			.087
.3648	.864	.310	
.3689	.759	.250	
.3710	.664	.224	
.3716			.181
.3730	.567	.242	
.3751			.141
.3778	.404	.170	
.3797			.128
.3815	.242	.156	
.3862	.121	.081	
.3870			+0.008
.3883	.044	.108	
.3890			.043
.3905	9.986	.067	
.3911			-0.065
.3925	.949	.097	
.3960	.935	.104	
.3980	.916	.120	
.3987			.074
.4002	.910	.112	
.4008			.018
.4022	.920	.104	
.4030			.063
.4044	.910	.064	
.4078	.924	.132	
.4084			.082
.4098	.945	.118	
.4109			.124
.4126	.960	.134	
.4133			.103
.4148	.975	.116	
.4154			.070
.4168	.992	.131	
.4210	10.024	.139	
.4230	.040	.134	

J.D. 2400000+	V	(B-V)	(U-B)
37808.4237			-10.050
.4252	10.070	+0.117	
.4258			.041
.4272	.083	.137	
.4280			.020
.4294	.104	.134	
.4300			.027
.4315	.132	.146	
.4321			.041
.4335	.147	.141	
.4341			.062
.4360	.174	.109	
37813.3688			-0.062
.3695	11.134	+0.344	
.3710			.044
.3716	.153	.336	
.3730			+0.065
.3737	.124	.398	
.3751			-0.069
.3757	.123	.407	
.3813	.134	.412	
.3820			.041
.3834	.137	.437	
.3841			.076
.3855	.136	.420	
.3862			.072
.3883			.066
.3931			.114
.3938	.066	.413	
.3953			.118
.3959	.060	.435	
.3973			.140
37813.3980	11.086	+0.225	
.3994			.127
.4001	.093	.395	
.4042	.114	.457	
.4050			.176
.4063	.131	.454	
.4070			.165
.4092			.160
.4112			.037
.4153			.014
.4160	.129	.369	
.4174			-0.040
.4181	.125	.348	
.4195			.183
.4203	.134	.401	
.4216			.107
.4223	.133	.422	
.4264	.128	.423	
.4274			.050
.4285	.132	.416	
.4293			.053

J.D. 2400000+	V	(B-V)	(U-B)
37813.4306	11.141	+0.426	
.4313			-0.060
.4327	.141	.438	
.4334			.083
.4376			.043
.4383	.140	.397	
.4396			.088
.4403	.163	.367	
.4417			.108
.4424	.174	.352	
.4438			.035
.4445	.169	.357	
.4487	.214	.282	
.4494			.037
.4507	.197	.345	
.4514			+0.026
.4528	.174	.372	
.4535			-0.052
.4549	.192	.395	
.4556			.091
.4598			.205
.4605	.204	.516	
.4620			.057
.4626	.210	.491	
.4640			.033
.4646	.250	.424	
.4660			.099
.4667	.268	.365	
.4710	.207	.417	
.4716			.142
.4730	.224	.411	
.4737			.136
.4751	.244	.398	
.4757			.127
.4771	.255	.463	
.4778			.133
.5050			.086
.5056	.023	.450	
.5098	.023	.396	
.5105			+0.098
.5119	.037	.360	
.5127			-0.053
.5244			+0.018
.5251	10.543	.220	
.5264			-0.068
.5270	.446	.180	
.5286			.054
.5293	.345	.118	
.5327			.101
.5334	.157	.058	
.5348			.087
.5355	.121	.122	
.5390			.216
.5397	9.988	.104	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
37813.5410			-0.195	37815.4456	9.957	+0.119	
.5417	9.959	+0.134		.4463			+0.013
.5331			.138	.4478	.976	.147	
.5438	.987	.163		.4484			-0.073
.5473			.147	.4498	10.026	.150	
.5480	.949	.188		.4540	.096	.125	
.5493			.116	.4554			+0.003
.5500	.974	.142		.4560	.095	.107	
37815.3818	10.939	+0.371		.4567			-0.017
.3824			-0.281	.4582	.100	.132	
.3838	.971	.442		.4588			.041
.3849			.301	.4602	.130	.100	
.3866	.995	.287		.4610			+0.002
.3873			.119	.4651	.148	.120	
.3888	.880	.318		.4672	.181	.092	
.3897			.168	.4678			.102
.3915	.760	.318		.4692	.152	.110	
.3921			.116	.4700			.141
.3935	.722	.159		.4714	.168	.067	
.3942			.101	.4720			.097
.3956	.527	.241		.4735	.186	.089	
.3992	.375	.204		.4790	.239	.152	
.3998			.053	.4796			.109
.4012	.291	.194		.4810	.241	.084	
.4019			.093	.4817			.148
.4032	.229	.197		.4832	.241	.152	
.4043			.068	.4838			.079
.4060	.135	.148		.4852	.274	.137	
.4068			.114	.4860			.056
.4103	.006	.181		.4874	.301	.152	
.4124	9.991	.118		.4880			.041
.4130			.142	.4895	.317	.198	
.4145	.948	.103		.4901			-0.030
.4151			.100	.4915	.341	.178	
.4165	.919	.097		.4956	.375	.220	
.4171			.094	.4963			.024
.4185	.897	.062		.4978	.384	.237	
.4192			.102	.4984			.016.
.4206	.866	.112		.4998	.424	.228	
.4213			.084	.5004			.056
.4228	9.873	.080		.5020	.448	.226	
.4234			-0.065	.5027			-0.006
.4275	.909	.072		.5060	.462	.205	
.4296	.945	.061		.5082	.481	.162	
.4303			.044	.5088			+0.202
.4318	.949	.103		.5102	.486	.179	
.4324			.056	37829.3622	11.116	+0.283	
.4345	.935	.085		.3629			-0.184
.4352			.050	.3670	.148	.393	
.4366	.922	.120		.3679			.364
.4408	.930	.157		.3709			.394
.4422			+0.041	.3734	.125	.361	
.4428	.934	.083		.3740			.307

J.D. 2400000+	V	(B-V)	(U-B)
37829.3755	11.130	+0.349	
.3792			-0.072
.3802	.089	.314	
.3820			.143
.3834	.100	.259	
.3851			+0.049
.3858	.082	.389	
.3880			-0.038
.3886	.093	.441	
.3948			+ .037
.3970	.057	.358	
.3978			.149
.3997			.033
.4017			-0.082
.4050	.083	.310	
.4101			.255
.4108	.045	.319	
.4123			.333
.4129	10.967	.213	
.4145			.080
.4156	11.048	.338	
.4174			0.000
.4234	10.888	.424	
.4240			+0.098
.4255	.849	.373	
.4261			.040
.4275	.755	.394	
.4281			.102
.4295	.716	.293	
.4302			.185
.4316	.680	.231	
.4351			.063
.4358	.477	.241	
.4372			.069
.4379	.354	.228	
.4393			.164
.4413			-0.029
.4441	.124	.194	
.4470			.018
.4484	.003	.192	
.4490			+0.027
.4505	9.983	.106	
.4511			-0.098
.4525	.884	.139	
.4535			+0.040
.4552	.808	.181	
.4580			.037
.4588	.792	.117	
.4601			.021
.4608	.777	.130	
.4622			-0.117
.4630	.807	.169	
.4643			.116
.4650	.899	.136	

J.D. 2400000+	V	(B-V)	(U-B)
37829.4698	9.995	+0.146	
.4705			-0.176
.4720	10.006	.193	
.4726			.086
.4740	.012	.187	
.4747			.088
.4761	.037	.186	
.4767			.063
.4780	.088	.134	
.4816			.065
.4837			+0.278
.4845	.145	.004	
38003.6085	10,944	+0.256	
.6093			-0.565
.6140	.826	.209	
.6151			+0.005
.6203	.545	.231	
.6210			-0.128
.6224	.473	.195	
.6231			.132
.6279	.237	.170	
.6287			.007
.6300	.197	.073	
.6307			.034
.6363	9.991	.122	
.6370			.108
.6387	.947	.107	
.6397			.047
.6418	.930	.056	
.6429			.032
.6471	.894	.070	
.6487			.090
.6508	.897	.083	
.6519			.084
.6540	.913	.082	
.6550			.070
.6593	.916	.079	
.6603			.070
38019.5001	10.115	+0.095	
.5008			-0.019
.5044	.086	.150	
.5050			.043
.5058	.080	.119	
.5065			.027
.5100	.093	.131	
.5109			.013
.5128	.132	.118	
.5135			.036
.5183	.181	.124	
.5190			.055
.5211	.171	.154	
.5218			.018
.5268	.173	.176	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
38019.5277			-0.028	38415.5446			-0.017
.5294	10.220	+0.170		.5553	10.992	+0.401	
.5302			.034	.5565			+0.008
.5323	.228	.176		.5599	.991	.383	
.5333			.013	.5609			-0.027
.5378	.252	.186		.5633	.979	.370	
.5392			.010	.5640			+0.056
.5416	.268	.192		.5658	11.007	.355	
.5427			.010	.5668			-0.069
.5475	.321	.154		.5727	.016	.351	
.5483			.016	.5738			.008
.5507	.343	.161		.5751	.035	.351	
.5517			+0.026	.5762			.017
.5569	.357	.129		.5821	.012	.375	
.5580			-0.018	.5832			.008
.5600	.367	.130		.5855	.003	.291	
.5607			.038	.5866			+0.030
.5670			+0.028	.6002	.014	.341	
.5679	.408	.239		.6012			.042
.5690	.414	.241		.6038	10.996	.354	
.5697			-0.010	.6051			-0.059
.5767	.456	.232		.6127	.982	.205	
.5777			+0.037	.6137			.081
.5805	.485	.198		.6157	11.003	.363	
.5815			.091	.6168			.058
.5899	.523	.250		.6221	10.994	.396	
.5905			.007	.6248			+0.010
.5930	.507	.241		.6280	11.016	.353	
.5940			.050	.6286			.013
.6030	.575	.272		.6329	.003	.379	
.6039			-0.034	.6339			.005
.6069	.607	.241		.6355	.014	.389	
.6080			+0.010	.6362			-0.017
.6146	.629	.323		38051.6408	11.001	+0.376	
.6155			-0.067	.6418			0.082
.6169	.645	.281		.6435	.009	.398	
.6176			,042	.6450			.027
.6232	.646	.250		.6498	.009	.363	
.6247			.096	.6512			.022
.6666			+0.143	.6536	.001	.380	
.6683	.922	.272		.6547			.047
.6750			.118	.6605	.035	.351	
.6760	.906	.323		.6616			.068
.6776			.118	.6648	.038	.337	
.6791	.929	.312		.6668			.087
.6862			.065	.6724	.040	.459	
.6875	.866	.443		.6734			.097
.6930			-0.122	.6755	.061	.356	
.6961	.896	.408		.6766			.069
.7037			.083	.6807	10.979	.429	
.7048	.964	.397		.6818			.085
.7065			.048	38415.4282	10.816	+0.411	
.7090	.971	.412		.4343			-0.197
38051.5433	10.987	+0.414					

J.D. 2400000+	V	(B-V)	(U-B)
38415.4350	10.766	+0.238	
.4373	.722	.260	
.4436	.649	.257	
.4445			-0.010
.4530			+0.062
.4538	.471	.229	
.4580			.048
.4590	.431	.197	
.4610			.028
.4616	.407	.157	
.4635			-0.012
.4645	.388	.218	
.4695			.074
.4702	.320	.109	
.4722			.011
.4729	.319	.157	
.4780			+0.011
.4790	.298	.135	
.4807			.028
.4815	.298	.136	
.4867			.048
.4875	.290	.166	
.4934			.042
.4943	.297	.213	
.4998	.319	.175	
.5047			+0.057
.5075	.336	.205	
.5129	.360	.202	
.5142			.020
.5160	.390	.164	
.5218	.415	.192	
.5246		.261	.038
.5317	.449	.157	
.5380			.086
38457.4764			-0.052
.4770	11.229	+0.442	
.4816			.052
.4826	.181	.465	
.4840			.139
.4847	.204	.398	
.4888			.143
.4895	.162	.447	
.4917			.141
.4923	.169	.438	
.4974			.066
.5020			.127
.5027	.173	.469	
.5073			.067
.5100			.032
.5110	.160	.423	
.5166			.074
.5173	.140	.492	
.5340			+0.027

J.D. 2400000+	V	(B-V)	(U-B)
38457.5347	11.135	+0.402	
.5395			-0.024
.5406	.112	.472	
.5423			+0.014
.5430	.117	.443	
.5478			.052
.5485	.062	.414	
.5548			-0.050
.5555	.052	.386	
.5597			+0.008
.5603	10.993	.360	
.5617			-0.108
.5624	.949	.310	
.5657			.058
.5664	.868	.304	
.5684			.001
.5697	.758	.308	
.5730			.093
.5737	.561	.302	
.5750			.032
.5757	.465	.230	
.5778			+0.056
.5784	.344	.198	
.5826			.068
.5833	.129	.108	
.5847			.032
.5854	.102	.190	
.5867			.028
.5874	.009	.169	
.5917			-0.016
.5924	9.925	.085	
.5937			.020
.5944	.908	.122	
.5962			+0.021
.5972	.863	.093	
.6013			.016
.6020	.877	.095	
.6034			.039
.6041	.879	.067	
.6090			.056
.6100	.892	.100	
.6117			.046
.6124	.912	.102	
.6166			.069
.6173	.926	.095	
38496.3838	10.910	+0.318	
.3886	.885	.263	
.3906	.900	.259	
.3913			-0.087
.3955			.109
.3969	.849	.196	
.3977			.013
.4990	.815	.229	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
38496.3997			-0.095	38503.4621			+0.094
.4031	10.741	+0.232		.4628	11.302	+0.201	
.4038			.109	.4643			.068
.4066	.682	.245		.4649	.289	.204	
.4073			.104	.4718			.083
.4123	.637	.185		.4725	.301	.206	
.4129			+0.095	.4740			.064
.4150			.121	.4746	.288	-133	
.4177	.559	.252		.4795			.046
.4184			.020	.4803	.293	0.131	
.4198	.517	.277		.4817			+0.072
.4205			-0.010	.4823	.246	.160	
.4240	.471	.287		.4857			0.088
.4247			+0.007	.4864	.284	.170	
.4261	.467	.195		.4878			.126
.4268			.030	.4889	.320	.152	
.4317			.032	.4927			.062
.4330	.435	.129		.4934	.340	.174	
.4337			+0.096	.5850	.652	.344	
.4380	.340	.148		39548.3807	10.353	+0.220	
.4387			-0.054	.3814			.006
.4400	.297	.117		.3848	.256	.125	
.4407			+0.120	.3855			.066
.4455			.036	.3867	.173	.050	
.4477			.036	.3874			.062
.4525	.329	.170		.3887	.136	.085	
.4531			.071	.3892			.019
.4545	.333	.219		.3925	.051	.060	
.4552			.044	.3932			.080
.4608	.390	.125		.3946	9.999	.054	
.4615			.047	.3953			.094
.4629	.374	.165		.3967	.962	.072	
.4637			.005	.3973			.128
.4677	.413	.176		.4015	.937	.041	
.4684			.057	.4022			.056
38503.3778	11.026	+0.420		.4036	.934	.030	
.4267			+0.066	.4043			.051
.4278	.771	.240		.4057	.936	.066	
.4316			.127	.4064			.019
.4323	.668	.279		.4105	.929	-0.002	
.4337			.029	.4113			.103
.4343	.660	.230		.4133	.873	+0.014	
.4357			.086	.4140			.148
.4364	.631	.235		.4154	.963	.017	
.4420			.025	.4161			.122
.4427	.535	.247		.4196	.975	.066	
.4441			.027	.4203			.127
.4448	.511	.240		.4217	.989	.073	
.4497			-0.003	.4223			.081
.4503	.566	.211		.4265	10.029	.065	
.4517			+0.013	.4273			.002
.4524	.447	.186		.4390	.077	.049	
.4545			.036	.4397			.045
.4552	.418	.175		.4446	.132	.033	.172

J.D. 2400000+	V	(B-V)	(U-B)
38047.5468	10.045	+0.005	
.5512	.119	.022	
.5530	.161	.075	
.5544	.183	.076	
.5585	.237	.034	
.5600	.214	.010	
.5637	.264	-0.011	
.5655	.264	.061	
.5675	.289	.045	
.5718	.328	.032	
.5738	.319	.040	
.5752	.340	.019	
.5783	.344	.050	
.5800	.343	.057	
.5818	.354	+0.018	
.5856	.357	-0.006	
.5877	.355	.022	
.5894	.365	+0.051	
.5943	.354	.033	
.5971	.335	.009	
.5995	.338	.010	
.6036	.315	-0.013	
.6065	.274	.056	
.6092	.274	.033	
.6137	.270	.036	
.6158	.265	.030	
.6186	.255	.030	
.6228	.247	.015	
.6248	.257	+0.001	
.6266	.268	.051	
.6308	.229	.032	
.6328	.238	.080	
.6353	.221	.044	
.6620	.071	-0.038	
.6658	.063	.047	
.6728	.024	+0.023	
.6748	.019	.031	
.6765	9.986	.010	
.6842	.993	.070	
38085.4372	9.231	-0.044	
.4408	.261	.161	
.4422	.284	.212	
.4455	.375	.017	
.4470	.451	.011	
.4487	.419	.086	
.4529	.576	.054	
.4550	.684	.048	
.4595	9.899	+0.046	
.4615	.829	-0.047	
.4633	.814	.117	
.4650	.932	.029	
.4698	10.242	+0.081	
.4715	.338	.042	

J.D. 2400000+	V	(B-V)	(U-B)
38085.4755	10.588	-0.025	
.4768	.679	+0.013	
.4796	.695	-0.115	
.4817	.774	.050	
.4845	.814	.193	
.4858	.872	.050	
.4897	.907	.017	
.4915	.953	+0.128	
.4935	.921	-0.054	
.4966	.866	.175	
.4987	.882	.028	
.5018	.874	.180	
.5032	.892	.146	
.5074	.844	.033	
.5088	.924	+0.088	
.5130	.736	-0.043	
.5150	.723	.059	
.5209	.572	.071	
38086.3820	9.387	-0.069	
.3857	.451	.062	
.3880	.489	.041	
.3907	.569	.028	
.3927	.599	.062	
.3948	.708	+0.017	
.3980	.782	-0.091	
.4001	.860	.082	
.4018	.912	.093	
.4052	10.156	.139	
.4067	.293	.109	
.4087	.386	.056	
.4123	.564	.103	
.4137	.643	.088	
.4154	.708	.067	
.4198	.837	.093	
.4209	.866	.083	
.4227	.893	.074	
.4261	.922	.048	
.4275	.921	.070	
.4292	.926	.060	
.4323	.938	.014	
.4337	.926	.059	
.4362	.912	-0.075	
.4400	.892	.066	
.4421	.891	.052	
.4453	.845	.060	
.4497	.795	.044	
.4515	.786	.043	
.4532	.777	.037	
.4567	.770	+0.018	
.5289	.059	.020	
.5465	9.864	.131	
.5587	.804	.107	
.5688	.628	.198	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
38086.5775	9.603	-0.130		38090.6287	10.719	-0.042	
38089.4180	9.609	-0.071		.6301	.766	-	
.4225	.625	.048		.6337	.848	.044	
.4264	.662	+0.034		.6350	.852	.069	
.4319	.637	-0.023		.6363	.862	.093	
.4354	.631	+0.011		.6391	.902	.049	
.4385	.570	-0.079		.6405	.884	.085	
.4458	.544	.042		.6422	.880	.073	
.4503	.947	.027		.6454	.877	.069	
.4535	.552	+0.013		.6467	.886	.094	
.4607	.509	-0.048		.6481	.881	.082	
.4663	.512	.051		.6523	.864	.061	
.4694	.525	.009		.6537	.847	.056	
.4743	.509	.019		.6551	.837	.063	
.4765	.502	.008		.6583	.823	.093	
.4836	.499	+0.045		38104.3770	9.867	-0.100	
.5378	.335	-0.057		.3808	.831	.118	
.5400	.351	.025		.3844	.763	.105	
.5458	.335	.100		.3916	.728	.128	
.5486	.356	.055		.3937	.654	.236	
.5542	.364	.062		.3955	.633	.253	
.5576	.363	.103		.3993	.608	.105	
.5618	.388	.101		.4010	.501	+0.048	
.5771	.344	.057		.4027	.525	-0.051	
.5792	.375	.056		.4062	.542	.014	
.5864	.390	+0.007		.4083	.538	+0.046	
.5907	.401	.023		.4104	.518	.068	
38089.5933	9.362	-0.048		.4152	.567	-0.034	
;5983	.368	.025		.4173	.540	+0.011	
38090.5377	9.375	-0.038		.4190	.564	-0.125	
.5413	.353	.022		.4225	.545	.036	
.5433	.341	.030		.4243	.524	.032	
.5471	.300	.102		.4260	.512	.021	
.5492	.312	.071		.4302	.523	.054	
.5509	.312	.116		.4322	.522	.044	
.5551	.323	.067		.4340	.530	.264	
.5569	.328	.048		.4375	.514	.192	
.5590	.329	.111		.4479	.555	.238	
.5631	.312	.050		.4496	.530	.138	
.5954	.387	.030		.4552	.458	.128	
.5988	.476	+0.028		.4569	.503	.257	
.6018	.304	-0.040		.4600	.481	.295	
.6037	.540	.056		.4622	.387	.071	
.6076	.682	.048		.4645	.458	.277	
.6093	.756	.034		.4684	.461	.249	
.6107	.851	.032		.4700	.431	.217	
.6141	10.031	+0.032		.5645	.294	+0.080	
.6155	.108	-0.046		.5718	.361	-0.259	
.6170	.199	.064		38114.4486	9.552	-0.034	
.6211	.443	.045		.4531	.569	.019	
.6225	.508	.027		.4556	.587	.029	
.6238	.558	.053		.4587	.598	.023	
.6273	.689	.011		.4608	.616	.012	

J.D. 2400000+	V	(B-V)	(U-B)	J.D. 2400000+	V	(B-V)	(U-B)
38114.4625	9.642	+0.003					
.4663	.664	-0.047					
.4684	.686	.050					
.4702	.721	.033					
.4742	.807	.023					
.4760	.849	.008					
.4774	.918	.003					
.4810	10.025	-0.056					
.4823	.079	.042					
.4840	.153	.026					
.4878	.264	.042					
.4896	.320	.014					
.4913	.367	.008					
.4955	.453	.065					
.4973	.504	.041					
.4990	.529	.040					
.5031	.598	.045					
.5045	.620	.038					
.5067	.614	.032					
.5104	.625	.015					
.5125	.622	.020					
.5142	.598	.021					
.5178	.613	.015					
.5198	.611	.012					
.5219	.611	.004					
.5260	.590	.016					
.5295	.556	.042					
.5320	.554	.021					
.5357	.536	.029					
.5371	.526	.012					
.5392	.510	+0.002					
.5431	.471	-0.030					
.5448	.464	.013					
.5466	.460	.004					
.5497	.447	.006					
.5510	.445	+0.017					
.5528	.427	.013					
.5560	.397	-0.004					

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TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

Nr. 70.

L. SZABADOS

PHOTOELECTRIC UBV PHOTOMETRY OF NORTHERN CEPHEIDS I.

BUDAPEST, 1977.

Felelős kiadó: Detre László

778956 MTA KESZ Sokszorosító. F. v.: Szabó Gyula

PHOTOELECTRIC UBV PHOTOMETRY OF NORTHERN CEPHEIDS I.

ABSTRACT

New UBV photoelectric observational data on 38 northern cepheids with periods of less than 5 days are presented. The period changes of the observed cepheids are investigated. Four variables (SU Cyg, DT Cyg, V 532 Cyg, SZ Tau) show a period jump and a subsequent "rejump" to the earlier value of the period, which results in the overall constancy of the period. DT Cyg pulsates with the same period for at least the fourth time which is in keeping with the recent hypothesis on the evolution of cepheids along the lines of constant period in the HRD. AU Peg, a Population II variable, shows extremely strong period changes.

In three cases, secular light curve variation was discovered. The amplitude of the light variation of AS Per is decreasing; the other type of light curve variation is the variation in the steepness of the rising branch (SU Cyg, FF Aql). The effect of the orbital motion on the O-C diagram is also investigated for FF Aql.

Finally, the instability of the period for different types of cepheids is discussed.

INTRODUCTION

This paper is the first part of a series dealing with the new UBV photometry of northern cepheids started at the Konkoly Observatory in 1971 and it contains the observational data and O-C diagrams of cepheids with periods of less than 5 days. The following papers in the series will deal with the photometry of northern cepheids with periods greater than 5 days. Observations on about 70 variables are in progress.

Although in several respects broad-band UBV photometry cannot compete with observations made using intermediate band systems (e.g. Pel 1976), the UBV system is still the most generally used photometric system so the major part of the observations on cepheids have been made in this way. With this large amount of homogeneous observations it is possible to investigate the cepheids from several different points of view. Nevertheless, the available photoelectric observational material on cepheid variables is not sufficient. Three UBV photoelectric observational series on northern cepheids were made in the fifties almost simultaneously (Bahner et al. 1962, Walraven et al. 1958, Weaver et al. 1960). Even more cepheids were observed by Mitchell et al. (1964). Since then no extensive northern cepheid photometry has been carried out. The cepheid programme of Wisniewski and Johnson (1968) and that of Takase (1969) contained a small number of northern cepheids. It was therefore desirable to collect a new set of observations on a comparatively large number of northern cepheids.

The main purposes of the present programme are as follows:

1/ To search for double mode cepheids in the northern sky;

2/ To investigate period changes;

3/ To examine secular variations of the light curves provided that they can be determined;

4/ To obtain photoelectric light curves from those cepheids which have not previously been observed photoelectrically.

During the course of the first part of this work, 40 cepheids and 3 stars which proved to be misclassified variables were observed. 19 stars were observed in 3 colours of Johnson UBV system, the other 24 stars in B and in V light only.

THE OBSERVATIONS

The programme stars were selected from the General Catalogue of Variable Stars (Kukarkin et al. 1969-1970), its 1st and 2nd Supplements (Kukarkin et al. 1971, 1974) and from the current astronomical literature (newly discovered cepheids), with the restrictions that their declination should be north of 0° and B magnitude (or m_{pg} for lack of photoelectric observations) at light minimum brighter than $12\overset{m}{.}5$. The first part of the programme contains cepheids of both populations with a period of less than 5 days. Only α UMi (Polaris) was omitted because of its brightness (there being no suitable nearby comparison star) and very small amplitude. These two factors did not allow a reliable light curve to be obtained.

The stars investigated are listed in Table 1. The number of observations on each star, the colours, serial numbers of the pages where the individual observations and the O-C diagram with additional remarks on the given star can be found, are indicated

Table 1 The programme

Star	N	Col.	Page obs.	Page rem.	Remarks	Star	N	Col.	Page obs.	Page rem.	Remarks
DQ And	20	BV	11	57		V 1334 Cyg	22	UBV	22	63	
FF Aql	21	UBV	11	92		BC Dra	102	BV	—	6	RR Lyrae type star
V 572 Aql	11	BV	12	68	the light curve is not complete	AD Gem	17	BV	22	70	
Y Aur	20	BV	12	77		BB Gem	22	BV	23	43	
RT Aur	20	UBV	13	65		DX Gem	19	BV	23	53	
SU Cas	28	UBV	13	38		BL Her	23	BV	23	33	
SY Cas	27	BV	14	82		V Lac	22	UBV	24	102	
TU Cas	311	UBV	—	6	double mode cepheid	Y Lac	21	UBV	25	86	
XY Cas	17	BV	14	95		BE Mon	17	BV	25	50	
BD Cas	22	BV	15	64		V 465 Mon	21	BV	25	51	
BY Cas	24	BV	15	59		V 508 Mon	17	BV	26	84	
DF Cas	24	BV	16	72		AU Peg	45	UBV	26	44	
V 395 Cas	15	BV	17	81		SX Per	21	BV	27	85	
V 445 Cas	50	BV	—	6	eclipsing binary	AS Per	29	BV	28	100	
IR Cep	52	UBV	17	42		V 361 Per	56	UBV	—	6	irregular variable
BD+56°2806	32	BV	18	52		BQ Ser	122	BV	—	6	double mode cepheid
SU Cyg	21	UBV	19	73		ST Tau	20	UBV	28	80	
VZ Cyg	25	UBV	19	96		SW Tau	40	UBV	29	36	
DT Cyg	27	UBV	20	47		SZ Tau	20	UBV	29	55	
V 402 Cyg	16	BV	20	88		EU Tau	28	UBV	30	41	
V 532 Cyg	36	BV	21	62		T Vul	19	UBV	31	89	
V 1154 Cyg	26	UBV	21	99							

in the successive columns. The total number of observations is more than 1500. Most of the observations were made in the years 1972-1974, but some cepheids with changing period were reobserved in 1976-1977.

Three variables proved to be misclassified. The star V445 Cas is an eclipsing binary of β Lyrae type with a period of $0^d.67352$ (Szabados 1974a); V361 Per is an irregular variable in the cluster h and χ Per (Szabados 1974b); the third misclassified variable is BC Dra. This last star was announced as being a double mode cepheid (Szabados 1976a), but a recent more precise period analysis has shown that it is, in fact, an RR Lyrae type variable with a period of $0^d.71957$ (Szabados, Stobie and Pickup 1976). The observational data on these misclassified variables as well as on the double mode cepheids are not given here.

There are two double mode cepheids in the northern sky, namely TU Cas and BQ Ser. The stars SW Tau and V 439 Oph classified as double mode cepheids (Latyshev 1963 and Gusev 1967, respectively) are simple cepheids of Population II with a long flat light maximum. The present set of observations has clearly shown that there are not more double mode cepheids among the known northern cepheid variables brighter than $B = 12^m.5$ in minimum light. The observations and a detailed analysis of the data on TU Cas and BQ Ser will be published elsewhere. Short communications have been published on the recent photometry of these stars (Illés and Szabados 1976, Szabados 1976a).

All the observations were made with two telescopes of the Konkoly Observatory:

1/ The 24 in. reflector (Budapest, Szabadsághegy) combined with an unrefrigerated EMI 9502B photomultiplier;

2/ The 20 in. Cassegrain reflector (Piszkéstető Mountain Station) combined with an integrating photometer equipped with an unrefrigerated EMI 9058QB photomultiplier.

The standard UBV photometric system was realised with the aid of the following Schott filters:

	20 in. telescope	24 in. telescope
U	UG 2 2mm	UG 1 2mm
B	BG12 1mm + GG13 2mm	BG12 1mm + GG13 2mm
V	GG11 2mm	GG11 2mm

Because of the changeable sky conditions differential photometry was performed with a nearby comparison star being selected for each programme star. As a means of verifying the constancy of the comparison stars, check stars were regularly observed. The V magnitudes and the colour indices of the comparison and check stars are listed in Table 2. The data concerning the double mode cepheids and misclassified variables are omitted. The tie-in observations were made with the aid of UBV standard stars taken from the catalogue of Blanco et al. (1968). An asterisk instead of the name of the star in Table 2 denotes that the star is not in the Bonner Durchmusterung in which case the identification charts in Fig. 1a-f should be consulted. In these charts the letter *a* denotes the comparison star and the star marked *b* is the check one. (The size of the charts is about 25" x 25" , north is at the top.)

Each observation of a cepheid is a result of at least 15 individual measurements or 80 sec of integration in each colour. One complete measurement of the variable, background and comparison star took on average of about twenty minutes. The mean error of an observation is about $0^{m}_{.}010$ in V and B and $0^{m}_{.}020$ in U.

When the distance between the comparison star and the variable was greater than 1°, the effect of the atmospheric extinction was removed. The observational data have been transformed from the instrumental to the international UBV system using average values of transformation coefficients determined for both telescopes. After having transformed the data no systematic differences were found between the observations made with the 20" and those with the 24" telescope. The observations made with the 20" telescope are marked with asterisks in Table 3.

The comparison between my photometric system (UBV_{sz}) and Schaltenbrand and Tammann's (1971) standard one (UBV_{scht}) gives the following transformation formulae:

$V_{sz} \approx V_{scht}$ (on the basis of 25 common stars)

$(B-V)_{sz} = 1.034(B-V)_{scht} - 0.066$ (25 common stars)

$(U-B)_{sz} = 0.90\ (U-B)_{scht} + 0.04$ (13 common stars)

The present V magnitudes and B-V colour indices are in good agreement with the standard values, while the deviation of $(U-B)_{sz}$ from the standard U-B colour index may be explained by the fact

Table 2

Variable	Comp.	V	B-V	U-B	Check	V	B-V	U-B	Remark
DQ And	*	$10^{m}.86$	$1^{m}.04$		$+44^{\circ}$ 212	$10^{m}.57$	$0^{m}.54$		
FF Aql	$+17^{\circ}$ 3779	5.69	1.09	$1^{m}.06$	$+17^{\circ}$ 3778	6.69	-0.05	$-0^{m}.32$	
V 572 Aql	$+0^{\circ}$ 4391	10.50	1.27		$+0^{\circ}$ 4397	10.46	0.82		
Y Aur	$+42^{\circ}$ 1288	9.48	0.38		$+42^{\circ}$ 1297	10.16	0.25		1
RT Aur	$+29^{\circ}$ 1154	4.33	1.02	0.80	$+29^{\circ}$ 1190	6.45	0.05	-0.05	
SU Cas	$+67^{\circ}$ 215	6.64	0.47	0.25	$+67^{\circ}$ 224	5.95	0.21	0.17	
SY Cas	$+57^{\circ}$ 41	9.44	1.12		$+57^{\circ}$ 38	9.28	1.70		
XY Cas	$+59^{\circ}$ 119	8.74	0.50		$+59^{\circ}$ 132	8.70	0.40		
BD Cas	*	11.88	1.55		*	11.38	1.65		1
BY Cas	$+60^{\circ}$ 345	9.77	0.58		$+60^{\circ}$ 346	9.90	1.24		
DF Cas	$+60^{\circ}$ 558	10.19	0.52		*	11.20	0.47		1
V 395 Cas	$+62^{\circ}$ 356	10.01	1.15		$+62^{\circ}$ 359	9.18	1.86		
IR Cep	$+60^{\circ}$ 2324	8.90	0.15	0.12	$+60^{\circ}$ 2320	7.93	-0.03	-0.27	
BD$+56^{\circ}$ 2806	$+56^{\circ}$ 2815	8.67	0.15		$+56^{\circ}$ 2808	9.38	0.11		
SU Cyg	$+28^{\circ}$ 3447	6.54	0.35	0.28	$+29^{\circ}$ 3724	8.08	0.20	0.28	
VZ Cyg	$+42^{\circ}$ 4226	7.68	0.94	0.65	$+42^{\circ}$ 4225	9.39	1.14	0.95	
DT Cyg	$+29^{\circ}$ 4324	5.63	-0.08	-0.31	$+30^{\circ}$ 4322	7.56	-0.14	-0.59	2
V 402 Cyg	$+36^{\circ}$ 3898	9.92	1.20		$+36^{\circ}$ 3904	9.51	0.46		
V 532 Cyg	$+45^{\circ}$ 3498	9.59	1.10		$+45^{\circ}$ 3496	9.85	0.50		
V 1154 Cyg	$+42^{\circ}$ 3473	9.25	1.23	0.99	$+42^{\circ}$ 3472	8.37	0.38		
V 1334 Cyg	$+36^{\circ}$ 4470	6.07	0.29	0.21	$+36^{\circ}$ 4557	5.92	-0.02	-0.84	

Table 2 (cont.)

Variable	Comp.	V	B-V	U-B	Check	V	B-V	U-B	Remark
AD Gem	$+21^{\circ}$ 1358	$8^{m}.96$	$1^{m}.10$		$+21^{\circ}$ 1355	$9^{m}.35$	$1^{m}.86$		
BB Gem	$+13^{\circ}$ 1315	10.49	1.28		$+13^{\circ}$ 1309	9.72	0.23		
DX Gem	*	10.44	0.45		*	10.92	1.50		
BL Her	$+19^{\circ}$ 3491	10.27	0.41		*	11.65	0.61		3
V Lac	$+55^{\circ}$ 2824	9.57	0.49	$0^{m}.12$	$+55^{\circ}$ 2819	9.33	1.14	$0^{m}.50$	
Y Lac	$+50^{\circ}$ 3582	8.71	0.12	0.13	$+50^{\circ}$ 3596	8.26	0.01	-0.25	
BE Mon	$+ 7^{\circ}$ 1388	9.75	0.41		$+ 7^{\circ}$ 1390	10.63	0.13		
V 465 Mon	$+ 0^{\circ}$ 1811	10.53	0.09		$+ 0^{\circ}$ 1809	9.40	0.84		
V 508 Mon	$+ 4^{\circ}$ 1437	10.25	0.01		$+ 3^{\circ}$ 1398	8.56	0.49		
AU Peg	$+17^{\circ}$ 4575	9.29	0.97	0.70	$+18^{\circ}$ 4788	8.79	0.29	-0.03	
SX Per	$+41^{\circ}$ 841	10.73	0.73		*	11.09	0.54		
AS Per	$+48^{\circ}$ 1075	9.45	1.37		$+48^{\circ}$ 1074	10.51	1.12		
ST Tau	$+13^{\circ}$ 974	8.78	0.19	-0.21	$+12^{\circ}$ 889	7.44	0.80	0.45	
SW Tau	$+ 3^{\circ}$ 596	8.11	0.98	0.56	$+ 4^{\circ}$ 683	8.81	0.50	-0.09	
SZ Tau	$+19^{\circ}$ 744	6.34	0.74	0.33	$+19^{\circ}$ 731	7.11	0.46	0.08	
EU Tau	$+18^{\circ}$ 966	7.79	1.10	1.04	$+18^{\circ}$ 959	7.53	0.14	0.17	
T Vul	$+26^{\circ}$ 4017	4.57	0.84	0.46	-				

Remarks: 1 The comparison star has a faint companion within the edge of the diaphragm.

2 The comparison star is identical with V 389 Cyg, but the star seems to be non-variable (see page 47).

3 The comparison star slightly varies.

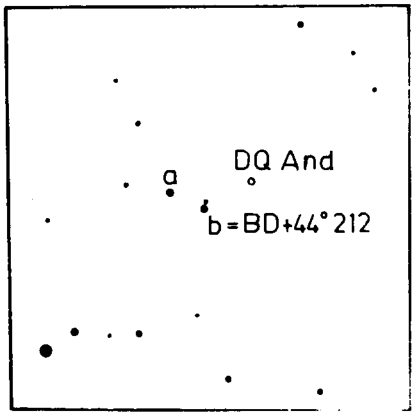

Fig. 1a DQ And

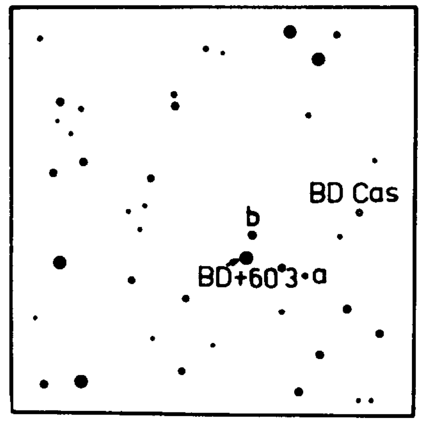

Fig. 1b BD Cas

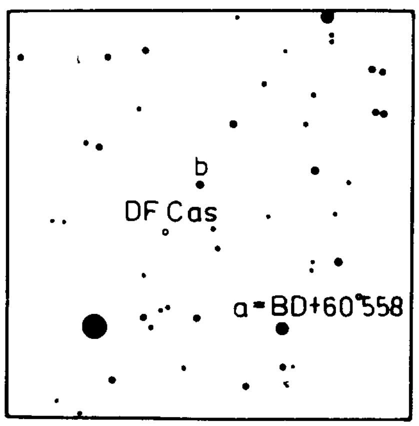

Fig. 1c DF Cas

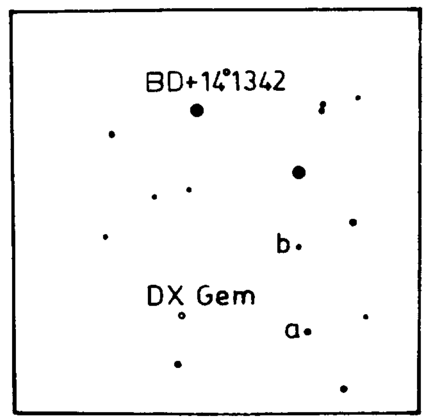

Fig. 1d DX Gem

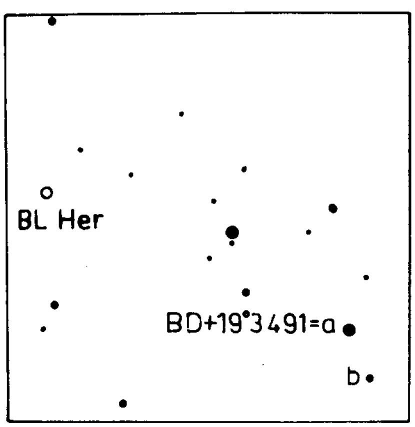

Fig. 1e BL Her

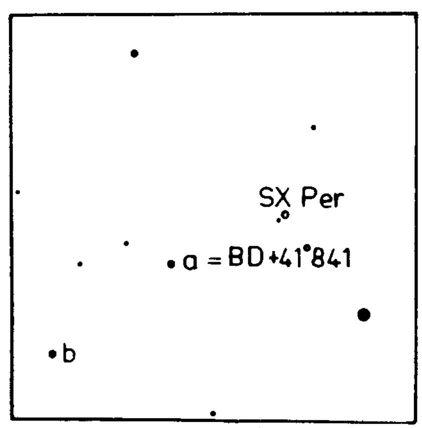

Fig. 1f SX Per

Figure 1a-f Identification charts

Table 3 The observations

DQ Andromedae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1567.523*	11.85	0.80		1918.531*	11.46	0.58	
1596.415*	11.87	0.80		1921.368*	11.27	0.49	
1597.450*	11.98	0.84		1921.518*	11.34	0.55	
1625.339*	11.91	0.86		1944.375*	11.60	0.67	
1650.248*	11.66	0.74		2008.560*	11.63	0.72	
1651.244*	11.97	0.85		2095.225*	11.74	0.73	
1651.382*	11.99	0.84		2273.336*	11.28	0.52	
1688.242*	11.56	0.61		2276.342*	11.54	0.52:	
1898.518*	11.81	0.77		2276.474*	11.32	0.54	
1918.347*	11.38	0.54		2426.210*	12.03	0.81	

FF Aquilae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1392.586	5.28	0.73	0.45	1459.544	5.34	0.68	0.48
1396.589	5.45	0.74	0.47	1466.435	5.47	0.83	0.50
1399.558	5.53	0.82		1467.498	5.53	0.77	0.53
1400.621	5.51	0.76	0.52	1472.478	5.46	0.77	
1401.577	5.31	0.70	0.43	1487.468	5.29	0.69	0.46
1412.510	5.49	0.81	0.49	1489.534	5.55	0.79	0.56
1415.507	5.21	0.69	0.43	1501.409	5.38	0.75	0.52
1436.440	5.52	0.80	0.52	1529.389	5.56	0.78	
1437.471	5.24	0.70	0.45	1554.312	5.25	0.66	0.46
1438.437	5.33	0.77		1758.629	5.44	0.76	0.52
1439.546	5.47	0.81	0.53				

Observations in 1953

J.D.hel. 2430000+	Δv	Δb	J.D.hel. 2430000+	Δv	Δb
4583.367	-0.520	-1.042	4588.408	-0.641	-1.086
4585.392	-0.378	-0.685	4590.451	-0.266	-0.562

Table 3 (cont.)

(FF Aql)

J.D.hel. 2430000+	Δv	Δb	J.D.hel. 2430000+	Δv	Δb
4591.404	-0.257	-0.620	4623.440	-0.348	-0.794
4596.368	-0.334	-0.772	4624.451	-0.562	-0.945
4597.406	-0.547	-1.030	4625.401	-0.328	-0.658
4598.406	-0.365	-0.755	4626.384	-0.201	-0.533
4600.397	-0.219	-0.529	4628.425	-0.425	-1.021
4602.458	-0.415	-0.822	4629.354	-0.435	-0.847
4608.381	-0.218	-0.498	4630.357	-0.280	-0.583
4609.520	-0.270	-0.605	4654.314	-0.285	-0.626
4614.435	-0.409	-0.759	4656.328	-0.381	-0.755
4619.366	-0.542	-0.975	4660.319	-0.493	-0.929
4621.427	-0.265	-0.547	4663.303	-0.286	-0.618
4622.410	-0.221	-0.452	4664.310	-0.578	-1.015

<u>V 572 Aquilae</u>

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1567.365*	11.05	0.86		1918.325*	11.01	0.88	
1568.291*	11.08	0.85		1921.335*	11.15	0.89	
1896.479*	11.20	0.98		1944.280*	11.04	0.86	
1897.371*	11.40	1.08		2194.520*	11.29	1.02	
1898.422*	11.23	0.97		2224.508*	11.28	1.00	
1917.365*	11.23	0.92					

<u>Y Aurigae</u>

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1292.471	9.75	1.07		1401.352	9.99	1.04	
1332.565	9.93	1.01		1402.362	9.67	0.87	
1336.587	9.85	0.94		1679.540	9.97	1.06	
1352.547	9.17	0.70		1682.524	9.82	1.04	
1389.423	9.89	1.04		1694.462	9.93	1.04	
1394.365	9.89	1.07		1696.485	9.28	0.79	

Table 3 (cont.)

(Y Aur)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1939.471	9.23	0.71		1990.399	9.52	0.92	
1961.494	9.94	1.09		1990.577	9.60	0.97	
1981.458	9.39	0.74		2039.378	9.29	0.73	
1982.492	9.43	0.90		2141.295	9.63	0.95	

RT Aurigae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1292.586	5.54	0.71		1697.402	5.12	0.45	0.28
1331.520	5.74	0.73	0.41	1758.360	5.44	0.67	0.39
1332.539	5.10	0.49	0.29	1990.478	5.76	0.76	0.47
1336.610	5.20	0.59		1990.660	5.77	0.77	0.55
1352.519	5.63	0.75	0.43	2018.648	5.15	0.52	0.28
1610.636	5.77	0.79	0.53	2066.404	5.20	0.55	0.32
1682.551	5.07	0.43	0.26	2100.296	5.01	0.43	0.28
1695.468	5.61	0.73	0.48	2108.301	5.27	0.54	0.35
1696.507	5.82	0.77	0.49	2148.281	5.47	0.59	0.19:
1697.358	5.20	0.45	0.26	2159.303	5.65	0.67	0.38

SU Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1301.349	5.93	0.75		1401.381	6.12	0.86	0.54
1352.578	6.15	0.80		1402.379	5.79	0.67	0.50
1389.450	6.09	0.83	0.49	1403.366	6.13	0.84	0.52
1390.447	5.80	0.68	0.44	1408.387	5.85	0.72	
1391.386	6.10	0.81	0.54	1415.371	6.07	0.81	0.50
1392.404	5.76	0.71	0.45	1608.475	5.99	0.76	0.48
1393.385	6.11	0.83	0.49	1617.369	6.05	0.82	0.50
1394.388	5.77	0.69	0.45	1672.267	6.14	0.83	0.45
1396.420	5.76	0.65	0.49	1673.283	5.77	0.68	0.48
1399.363	6.11	0.82		1682.567	5.93	0.77	0.43

Table 3 (cont.)

(SU Cas)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1694.441	5.82	0.71	0.49	1758.379	6.11	0.81	0.46
1695.441	6.09	0.82	0.50	1988.658	5.94	0.72	0.44
1753.396	5.81	0.73	0.44	1989.389	5.91	0.74	0.46
1754.334	6.12	0.84	0.58	1989.534	5.98	0.77	0.50

SY Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1302.383	10.16	1.12		1934.490	9.51	0.75	
1586.499*	10.05	1.11		1942.372	9.76	0.92	
1589.518*	9.76	1.01		1954.360	10.02	1.06	
1594.472	9.96	1.06		1959.451	9.53	0.83	
1596.463*	9.58	0.85		1960.414	9.90	1.01	
1597.462*	9.66	0.92		1961.365	10.12	1.12	
1606.455	9.91	1.09:		2008.506*	9.61	0.90	
1631.395	10.06	1.06:		2070.213	9.82	0.99	
1634.345	9.75	0.95		2990.528	9.89	1.08:	
1681.254	10.18	1.08		3045.535	9.96	0.94	
1682.250	9.42	0.79		3048.541	10.16	1.06:	
1689.227*	10.17	1.16:		3050.525	9.59	0.84	
1917.528*	10.16	1.08		3078.380	9.55	0.80	
1918.499*	9.44	0.80					

XY Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1589.548*	10.00	1.21		1651.351*	9.66	1.01	
1596.448*	10.05	1.11		1688.223*	9.86	1.14	
1597.473*	9.67	1.01		1689.242*	10.04	1.25	
1625.386*	9.91	1.14		1898.530*	9.69	1.01	
1647.344*	9.77	1.07		1918.519*	10.03	1.18	
1650.363*	10.11	1.19		1948.292*	9.62	0.98	

Table 3 (cont.)

(XY Cas)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
2095.247 *	10.16	1.23		2276.492 *	9.83	1.05	
2275.542 *	10.17	1.21		2424.343 *	10.19	1.20	
2276.351 *	9.92	1.07					

Observations in 1967-1968

J.D.hel. 2430000+	Δv	Δb	J.D.hel. 2430000+	Δv	Δb
9777.620	1.181	0.730	9806.350	0.864	0.351
9787.385	0.648	0.050	9807.660	1.068	0.576
9791.406	1.020	0.497	9808.502	1.255	0.859
9795.344	1.246	0.890	9810.287	0.666	0.023
9796.489	0.639	0.007	9821.351	1.174	0.829
9799.305	1.199	0.875	9864.284	0.689	0.052

BD Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1566.517 *	10.88	1.52		1651.296 *	10.95	1.46	
1567.445 *	10.96	1.54		1651.370 *	10.95	1.53	
1568.410 *	11.15	1.61		1688.206 *	11.05	1.57	
1596.323 *	10.87	1.48		1689.203 *	11.17	1.62	
1596.400 *	10.91	1.48		1896.490 *	11.04	1.63	
1596.510 *	10.93	1.52		1897.463 *	11.12	1.55:	
1597.420 *	11.10	1.63		1898.374 *	10.95	1.61	
1597.513 *	11.11	1.64		1949.304 *	10.99	1.58	
1625.369 *	10.85	1.50		2008.462 *	10.84	1.50	
1629.262 *	10.89	1.51		2299.441 *	11.05	1.62	
1650.372 *	10.89	1.57		2299.595 *	11.04	1.57	

BY Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1586.530*	10.31	1.23		1594.492	10.42	1.19	

Table 3 (cont.)

(BY Cas)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1596.524*	10.25	1.16		1682.267	10.46:	1.36:	
1606.472	10.23:	1.14:		1933.445	10.56	1.30	
1625.353*	10.31	1.18		1935.378	10.14	1.15	
1631.411	10.41	1.31		1935.535	10.16	1.19	
1634.383	10.56	1.31		1949.413*	10.47	1.28	
1647.391*	10.51	1.26		1961.511	10.23	1.18	
1650.273*	10.55	1.29		3045.560	10.59	1.28	
1651.400*	10.24	1.17		3048.552	10.53	1.26	
1662.283	10.41	1.28		3050.537	10.18	1.13	
1680.271	10.32:	1.11:		3078.316	10.56	1.30	
1681.267	10.28	1.23		3140.259	10.34	1.19	

Observations in 1967

J.D.hel. 2430000+	Δv	Δb	J.D.hel. 2430000+	Δv	Δb
9763.519	-0.196	-0.216	9791.423	-0.265	-0.302
9769.494	-0.385	-0.437	9795.531	-0.289	+0.020
9770.458	-0.067	+0.008	9796.469	-0.002	-0.325
9776.494	-0.175	+0.151	9799.324	-0.113	+0.072
9777.528	+0.017	-0.144	9810.303	-0.106	-0.137
9787.363	+0.021	+0.120			

DF Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1330.355	10.97	1.25		1679.271	11.02	1.21	
1594.518	10.90	1.15		1680.294	11.09	1.28	
1596.546*	10.85	1.15		1681.300	10.55	0.95	
1634.430	11.14	1.19		1682.298	10.79	1.12	
1650.308*	10.71	1.07		1689.323*	10.56	1.04	
1650.453*	10.60	0.99		1917.555*	11.04	1.25	
1651.323*	10.66	1.09		1921.536*	11.10	1.23	
1651.427*	10.68	1.10		1960.430	11.04	1.21	
1662.323	10.53	1.00		1978.454	11.07	1.[illegible]	

Table 3 (cont.)

(DF Cas)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1981.403	10.81	1.19		3140.278	11.14	1.27:	
2101.330	11.08	1.11:		3162.384	11.07	1.12	
3078.332	11.02	1.24		3202.315	10.89	1.08:	

V 395 Cassiopeiae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1596.483*	10.92	1.26		1917.541*	10.46	1.07	
1597.500*	10.83	1.22		1918.567*	10.74	1.22	
1625.463*	10.92	1.27		1921.377*	10.40	1.05	
1650.261*	10.64	1.14		2008.572*	10.95	1.26	
1650.423*	10.52	1.05		2276.502*	10.39	1.00:	
1651.309*	10.55	1.10		2299.490*	10.95	1.24	
1651.411*	10.57	1.11		2302.423*	10.75	1.21	
1688.293*	10.71	1.20					

IR Cephei

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1407.620	7.85	0.75		1881.423	7.85	0.88	0.53
1415.557	7.62	0.71	0.43	1882.538	7.59	0.73	0.44
1436.527	7.61	0.68	0.42	1897.475*	7.61	0.68	0.40
1495.507	7.68	0.75	0.39	1898.542*	7.91	0.86	
1554.447	7.92	0.80	0.44	1904.505	7.82	0.84	0.52
1579.341	7.91	0.90	0.52	1905.583	7.77	0.76	0.46
1584.343	7.68	0.73	0.45	1906.440	7.71	0.81	0.48
1586.390*	7.71	0.73	0.43	1907.415	7.90	0.86	0.55
1617.300	7.94	0.89	0.55	1907.529	7.88	0.81	0.64
1629.277*	7.68	0.76	0.43	1908.531	7.77	0.76	0.51
1651.252*	7.99	0.87		1911.393	7.99	0.88	0.56
1803.520*	7.96	0.89		1911.579	7.93	0.88	0.55
1807.563	7.90	0.89	0.61	1917.386*	7.89	0.84	

Table 3 (cont.)

(IR Cep)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1917.489 *	7.92	0.86	0.47	1944.299 *	7.70	0.76	0.42
1917.588 *	7.96	0.85		1960.280	7.91	0.83	0.56
1918.309 *	7.75	0.76	0.38	1960.446	7.85	0.81	0.48
1918.541 *	7.61	0.67	0.40	1961.289	7.68	0.78	0.48
1921.354 *	7.79	0.80	0.44	1965.292	7.61	0.75	
1921.472 *	7.85	0.83		1965.494	7.73	0.75	0.46
1921.569 *	7.89	0.83		1981.248	7.95	0.87	0.55
1932.510	7.97	0.87	0.60	1983.349	7.93	0.92	0.56
1933.333	7.59	0.67	0.44	2939.440	7.74	0.71	0.54
1933.422	7.59	0.68	0.50	3045.500	7.59	0.72	0.44
1934.373	7.90	0.85	0.64	3050.482	7.87	0.85	0.56
1934.470	7.93	0.87	0.53	3064.338	7.61	0.69	0.47
1935.497	7.55	0.76	0.38	3078.299	7.96	0.85	0.48

BD +56° 2806 (Cep)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
2634.479	9.28	0.79		2720.376	9.53	0.89	
2635.405	9.52	0.85		2728.315 *	9.54	0.97	
2636.519	9.41	0.81		2738.372	9.28	0.80	
2639.355	9.38	0.86		2743.344 *	9.33	0.88	
2640.358	9.30	0.83		2756.239	9.53	0.97	
2642.393	9.30	0.84		2767.190	9.50	0.85	
2645.477	9.26	0.79		2770.195	9.51	0.94	
2646.379	9.48	0.80		2776.185 *	9.56	0.98	
2669.406	9.55	0.94		2776.305 *	9.55	0.96	
2675.413	9.49	0.94:		2777.271 *	9.27	0.83	
2676.397	9.25	0.83		2782.204	9.55:	0.84:	
2685.490	9.40	0.82		2787.202	9.56	0.87	
2712.420 *	9.37	0.87		2939.453	9.47	0.91	
2714.374	9.58	0.92		2971.374	9.27	0.80	
2715.330	9.34	0.84		2990.444	9.28	0.81	
2715.433	9.31	0.81		3075.416	9.37	0.84	

Table 3 (cont.)

SU Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1412.596	7.16	0.68	0.43:	1880.362	6.90	0.63	0.46
1415.610	7.07	0.68	0.49	1881.375	7.16	0.68	0.40:
1436.484	6.67	0.43	0.42	1908.423	7.17	0.68	0.43
1476.478	6.86	0.65	0.47	1915.433	7.05	0.68	0.49
1495.446	6.81	0.60		1932.299	7.00	0.57	0.49
1554.349	7.09	0.66	0.44	1937.405	6.72	0.50	0.43
1561.482	6.98	0.66	0.46	1967.282	6.49	0.43	0.34
1584.309	6.96	0.62	0.51	1998.217	6.45	0.40	0.40
1606.325	6.53	0.46	0.41	1998.282	6.45	0.42	0.32
1610.294	6.59	0.46	0.42	2143.591	7.13	0.63	0.54
1789.582	7.16	0.69	0.54				

Observations in 1953

J.D.hel. 2430000+	Δv	Δb	J.D.hel. 2430000+	Δv	Δb
4584.492	0.097	0.383	4597.490	0.572	1.039
4585.496	0.428	0.906	4598.462	0.667	1.147
4590.530	0.614	1.184			

VZ Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1472.515	8.62	0.80		1898.354*	9.16	1.03	0.77
1589.443*	8.66	0.79	0.63:	1900.446	8.62	0.72	0.44
1594.448	8.74	0.77	0.51	1904.490	9.01	0.84	0.55
1596.370*	9.15	1.02	0.78	1914.398	8.86	0.76	0.42
1597.381*	9.24	1.03	0.75	1914.566	8.71	0.72	0.42
1629.236*	8.88	0.93	0.71	1929.338	8.64	0.70	0.42
1651.204*	9.18	0.99	0.60	1942.430	9.22	1.08	0.59:
1860.466	9.16	0.97	0.58	2939.470	9.25	1.03	0.61:
1887.452	9.01	0.94	0.58	3045.466	9.05	1.00	
1896.550*	8.83	0.91	0.68	3048.490	8.59	0.73	0.42
1897.344*	8.99	1.01	0.71	3064.324	8.91	0.90	0.68

Table 3 (cont.)

(VZ Cyg)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
3075.394	9.12	1.06		3140.209	8.88	0.77	0.50
3078.280	8.75	0.86	0.45:				

DT Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1467.511	5.73	0.45	0.25	1877.536	5.67	0.46	0.25
1472.494	5.70	0.46	0.25	1881.445	5.91	0.56	0.28
1476.512	5.87	0.54	0.29	1882.522	5.67	0.44	0.24
1487.537	5.68	0.45	0.24	1884.541	5.85	0.50	0.25
1495.466	5.63	0.42	0.23	1908.349	5.75	0.51	0.23
1544.442	5.88	0.55	0.26	1908.472	5.81	0.51	0.27
1554.506	5.86	0.51	0.24	1911.560	5.91	0.54	0.28
1562.337	5.75	0.47	0.23	2307.473	5.66	0.41	0.21
1562.520	5.70	0.43	0.21	2990.473	5.81	0.48	0.28
1583.274	5.73	0.46	0.21	3045.313	5.73	0.45	0.32:
1606.304	5.83	0.54	0.28	3046.333	5.92	0.51	
1613.247	5.71	0.47	0.20	3048.439	5.93	0.54	0.30
1634.272	5.94	0.56	0.25	3064.292	5.75	0.48	0.21
1860.531	5.67	0.45	0.23				

V 402 Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1415.590	9.76	0.95		1629.195*	9.62	0.96	
1487.520	10.07	1.16		1803.506*	9.56	0.93	
1544.473	10.13	1.13		1874.437*	9.82	1.06	
1589.372*	9.56	0.93		1900.369	9.78	1.03	
1596.305*	10.04	1.16		1901.521	10.00	1.18	
1597.351*	10.04	1.11		1902.439	10.17	1.16	
1606.369	9.92	0.99		1949.282*	9.97	1.15	
1617.273	9.91	1.11		1981.231	10.20	1.05:	

Table 3 (cont.)

V 532 Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1436.556	9.05	1.10		1904.520	9.07	1.13	
1437.556	8.87	1.09		1906.409	9.07	1.00	
1439.564	9.16	1.16		1907.550	9.00	1.06	
1476.494	8.92	1.05		1915.555	9.22	1.16	
1487.503	9.11	1.08		1917.470 *	9.00	1.12	
1541.390 *	9.15	1.12		1921.453 *	9.18	1.18	
1545.407	8.99	1.00		1930.389	8.92	1.08	
1589.424 *	9.09	1.14		1933.371	8.90	1.04	
1606.391	9.22	1.19		1934.441	9.12	1.22	
1803.561 *	9.19	1.21		1944.451 *	9.19	1.19	
1807.541	9.13	1.08		1961.270	9.21	1.21	
1808.565	8.85	1.08		1978.422	9.12	1.10:	
1869.479 *	9.19	1.18		2928.439	8.93	1.06	
1874.417 *	8.89	1.08		2990.490	8.92	1.03	
1897.328 *	8.89	1.07		3030.363	9.00	0.99	
1898.388 *	9.16	1.19		3045.355	9.10	1.17	
1901.544	9.16	1.16		3064.310	9.23	1.19	
1903.509	8.91	1.00		3075.381	8.99	1.07	

V 1154 Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1389.644	9.30	1.04		1412.488	9.20	1.02	0.89
1390.516	9.02	0.94		1415.459	8.95	0.89	0.52
1391.636	9.01	0.91	0.66	1436.403	9.03	0.95	
1392.557	9.14	1.04	0.83	1436.578	9.13	0.97	0.71
1393.614	9.27	1.09	0.91	1437.439	9.12	1.06	
1394.508	9.33	1.03	0.82	1437.587	9.19	1.09	
1396.538	9.01	0.91		1438.391	9.35	1.07	
1396.634	9.01	0.98		1439.396	9.17	0.99	
1399.539	9.37	0.96:		1466.409	9.15	1.11	0.70
1400.609	8.97	0.87		1475.503	9.10	0.81:	0.70:

Table 3 (cont.)

(V 1154 Cyg)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1487.448	9.27	1.08	0.89	1765.601	8.88	0.86	
1495.422	9.07	0.99	0.62	1808.549	9.25	0.97	0.70
1764.606	9.08	0.93		1900.426	9.15	1.12	0.79

V 1334 Cygni

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1554.404	5.78	0.52	0.19	1904.326	5.79	0.52	0.18
1561.501	5.80	0.54	0.19	1906.360	5.93	0.57	0.20
1562.377	5.93	0.56	0.19	1906.596	5.91	0.54	0.24
1579.296	5.96	0.56	0.17	1908.365	5.80	0.55	0.17
1606.347	5.94	0.57	0.18	1908.497	5.86	0.54	0.16
1607.354	5.80	0.53	0.20	1931.278	5.79	0.54	0.22
1853.517	5.89	0.52	0.21	1935.300	5.82	0.55	0.19
1877.397	5.78	0.54	0.17	1938.461	5.85	0.56	0.18
1881.389	5.80	0.53	0.19	1939.450	5.92	0.59	0.16
1900.331	5.83	0.57	0.14	1962.277	5.92	0.56	0.23
1903.332	5.90	0.55	0.19	1965.277	5.86	0.57	0.18

AD Geminorum

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1392.386	9.71	0.58		1954.643	10.11	0.81	
1393.367	10.02	0.71:		1982.645	9.73	0.55	
1394.334	10.20	0.77		1989.553	10.23	0.76	
1679.496	9.87	0.58		1990.607	9.62	0.49	
1680.490	9.78	0.63		2044.413	9.83	0.70	
1681.481	10.03	0.77		2066.469	9.64	0.51	
1682.489	10.16	0.80		2069.459	10.06	0.69	
1764.338	9.94	0.76		2100.275	9.59	0.49	
1766.319	10.20	0.72					

Table 3 (cont.)

BB Geminorum

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1608.599	11.56	0.89		1709.402	11.67	0.83	
1610.614	11.73	0.79:		1954.631	11.74	0.80:	
1634.552	11.00	0.64		1962.583	11.24	0.71	
1662.469	11.26	0.67		1980.614	10.85	0.61:	
1679.519	11.68	0.83		1982.629	11.34	0.62	
1680.394	10.75	0.56		1987.643	10.97	0.63	
1680.506	10.77	0.51		1988.592	11.57	0.80	
1681.365	11.52	0.76		1989.618	10.93	0.61	
1681.496	11.59	0.81		1990.524	11.37	0.81	
1682.396	11.68	0.85		2066.286	11.20	0.60	
1682.507	11.51	0.71		2069.298	11.52	0.85	

DX Geminorum

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1634.534	10.55	0.86		2018.468	10.83	0.91	
1662.490	10.65	0.91:		2018.624	10.86	0.94	
1679.400	10.72	0.95:		2039.548	10.55	0.88	
1680.412	10.90	0.98:		2101.302	10.85	0.83	
1681.402	10.57	0.89		3124.520	10.63	0.86	
1682.415	10.67	0.92		3138.489	10.80	0.90	
1709.389	10.72	0.85		3162.433	10.56	0.82	
1980.628	10.78	0.85:		3192.353	10.84	1.03	
1981.638	10.86	0.94:		3210.281	10.60	0.87	
1990.592	10.89	0.93					

BL Herculis

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1366.648	9.79	0.25		1390.632	10.03	0.40	
1390.618	10.03	0.40		1391.621	9.82	0.30	

Table 3 (cont.)

(BL Her)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1392.537	10.64	0.50		1932.328	10.48	0.51	
1396.566	10.43	0.46		1933.294	10.18	0.44	
1412.467	9.83:	0.19:		2132.616 *	10.50	0.51	
1415.486	10.03	0.44		2152.602	9.89	0.49	
1438.422	10.43	0.43		2159.524	10.27	0.49	
1753.603	10.04	0.35		2161.495	10.28	0.36	
1772.598	10.33	0.49		2255.366	10.51	0.56	
1887.372	9.98	0.39		2277.357	10.25:	0.63:	
1900.354	9.95	0.44		2314.302	10.57	0.56	
1932.278	10.39	0.58					

V Lacertae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1467.531	9.30	1.11	0.83:	1658.191	8.65	0.83	0.44
1475.517	8.89	0.91	0.41:	1900.561	9.16	1.13	0.71
1476.529	9.14	1.02:		1901.566	9.28	1.14	0.84:
1544.414	8.55	0.67	0.43:	1903.563	8.65	0.90	0.46
1545.517	8.88	1.02	0.58	1904.571	8.96	1.03	0.68
1589.465 *	8.62	0.82	0.45	1907.566	8.43	0.71	0.45
1594.433	8.61	0.82	0.55	2278.535	9.00	1.06	0.69
1597.407 *	9.32	1.13	0.57:	2297.493	8.77	0.93	0.48
1606.413	9.15	1.11	0.68	2316.475	8.42	0.72	0.41
1625.311 *	8.93	0.98	0.50	2350.274	9.30	1.07	0.63:
1634.236	8.60	0.80	0.46	2350.442	9.23	1.02	0.71

Observations in 1967

J.D.hel. 2430000+	Δv	Δb	Δu	J.D.hel. 2430000+	Δv	Δb	Δu
9720.526	-0.582	-0.363	0.460	9739.533	-0.209	+0.128	0.911
9724.510	-0.106	+0.249	1.028	9753.379	+0.228	+0.770	1.771
9726.476	-0.249	+0.153	0.985	9763.576	+0.208	+0.738	1.785
9731.498	-0.217	+0.175	1.278	9795.263	-0.586	-0.361	0.445
9732.447	+0.029	+0.525	1.657				

Table 3 (cont.)

Y Lacertae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1466.514	8.97	0.67	0.60	1902.402	8.75	0.52	0.52
1589.490*	9.45	0.74:	0.76:	1903.491	9.06	0.72	0.69
1594.410	9.42	0.80	0.67	1905.558	9.44	0.85	0.64
1596.388*	9.05	0.69	0.47:	1906.456	8.85	0.56	0.49
1597.394*	9.30	0.79	0.50:	1907.375	8.90	0.64	0.63
1604.414	8.82	0.60	0.48	1930.434	9.30	0.80	
1606.435	9.33	0.86	0.69	1931.332	9.40	0.86	0.62
1629.285*	9.32	0.76	0.44:	1932.473	8.82	0.56	0.47
1651.219*	9.05	0.59	0.45	1980.390	8.78	0.54	0.54
1860.501	9.13	0.73	0.66	2027.224	9.15	0.73	0.49
1882.443	9.21	0.78	0.61				

BE Monocerotis

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1329.470	10.67	1.24:		1982.599	10.66	1.08	
1608.622	10.84	1.15		2018.550	10.36	1.00	
1679.469	10.78	1.14		2044.369	10.79	1.19	
1680.470	10.45	1.01		2069.483	10.34	0.97	
1681.465	10.82	1.09		2070.358	10.53	1.04	
1682.474	10.55	1.00		2101.404	10.77	1.09	
1960.616	10.86	1.05:		2429.393	10.28	0.96	
1961.598	10.32	0.95		2429.470	10.24	0.93	
1981.625	10.71	1.24:					

V 465 Monocerotis

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1329.502	10.20	0.60		1679.441	10.23	0.59	
1331.493	10.47	0.72		1680.451	10.42	0.69	
1332.479	10.19	0.63		1681.445	10.54	0.70	

Table 3 (cont.)

(V 465 Mon)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1682.456	10.20	0.62		2044.520	10.50	0.80	
1961.611	10.23	0.60		2066.447	10.54	0.79	
1962.602	10.42	0.69		3124.537	10.58	0.68:	
1982.553	10.57	0.73		3138.474	10.44	0.80	
1988.575	10.30	0.59		3162.403	10.57	0.74	
1989.566	10.36	0.68		3209.293	10.38	0.68	
1990.558	10.54	0.83		3210.293	10.25	0.68	
2044.391	10.56	0.77					

V 508 Monocerotis

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1311.527	10.56	0.86		1982.567	10.74	0.94	
1679.423	10.53	0.90		1989.633	10.56	0.89	
1680.433	10.69	0.93		1990.643	10.65	1.01	
1681.423	10.76	0.90		2066.341	10.55	0.84	
1682.436	10.34	0.72		2066.514	10.44	0.81	
1764.311	10.66	0.79:		2070.378	10.55	0.83	
1765.308	10.32	0.78		2089.366	10.64	0.96	
1980.598	10.40	0.81		2148.302	10.70	0.96	
1981.570	10.55	0.95					

AU Pegasi

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1495.491	9.30	0.75		1613.227	9.33	0.78	
1561.409	9.23	0.64		1617.226	9.20	0.62	
1562.360	9.20	0.74	0.43:	1623.253*	9.47	0.84	0.51:
1589.399*	9.40	0.83	0.39:	1629.213*	9.14	0.73	0.44
1596.341*	9.32	0.83	0.51:	1853.536	9.38	0.75	
1597.364*	9.23	0.69	0.41:	1860.484	9.32	0.82	
1610.306	9.12	0.77		1869.501*	9.15	0.74	0.42:

Table 3 (cont.)

(AU Peg)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1874.453*	9.19	0.79	0.56:	1938.444	9.09	0.73	
1875.518*	9.42	0.78	0.48:	1942.407	9.46	0.79	
1897.360*	9.31	0.76	0.43	1944.436*	9.33	0.82	0.51
1898.336*	9.14	0.78		1960.300	9.09:	0.65:	
1900.468	9.15	0.65	0.39:	1961.379	9.32	0.87	
1904.451	9.38	0.81	0.35:	1978.247	9.36	0.80	
1906.396	9.45	0.78		1982.311	9.16	0.72	
1907.449	9.13	0.66		1983.304	9.35	0.88	
1917.457*	9.12	0.74	0.48	2939.489	9.38	0.77	
1921.440*	9.27	0.70	0.39	2990.461	9.14	0.64	
1928.441	9.42	0.77		3030.386	9.51	0.82	
1930.451	9.39	0.80		3045.344	9.34	0.67	
1931.353	9.18	0.64	0.29:	3048.425	9.12	0.68	0.37
1932.315	9.24	0.75		3075.368	9.20	0.80	
1933.355	9.39	0.71		3078.266	9.41	0.81	
1934.412	9.15	0.80					

<u>SX Persei</u>

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1304.349	11.02	1.19		1961.401	11.24	1.25	
1596.581*	11.18	1.35:		1980.457	11.19	1.20	
1650.492*	10.77	0.88		1980.586	11.05	1.10	
1651.478*	10.91	1.18:		1981.378	10.73	1.04	
1679.294	11.38	1.35:		1982.384	11.03	1.27	
1681.323	10.84	1.07		1988.607	11.45	1.32	
1682.315	11.14	1.26		1989.586	10.69	0.91	
1931.539	11.25	1.22		2039.336	11.39	1.27	
1932.583	11.38	1.32		2069.222	11.38	1.22	
1954.565	11.38	1.18		2101.351	10.68	1.07	
1960.508	10.96	1.12					

Table 3 (cont.)

AS Persei

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1304.404	9.94	1.61		2001.459	9.92	1.56	
1401.333	9.32	1.32		2066.272	9.85	1.50	
1402.342	9.60	1.50		2066.488	9.62	1.38	
1606.633	9.71	1.53		2070.399	10.02	1.57	
1634.453	9.20	1.21		2141.277	9.35	1.32	
1679.314	9.19	1.24		3078.406	9.75	1.47	
1680.522	9.54	1.46		3124.504	9.93	1.60	
1681.507	9.81	1.50:		3140.298	9.88	1.51	
1694.476	9.28	1.27		3162.342	9.53	1.45	
1772.308	10.01	1.57		3176.417	9.30	1.35	
1931.596	10.00	1.55		3178.223	9.81	1.50	
1935.460	9.80	1.55:		3191.239	9.22	1.37	
1935.612	9.90	1.61		3209.253	9.98	1.59	
1942.484	9.30	1.24		3210.313	9.51	1.28	
1963.476	9.42	1.39					

ST Tauri

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1302.503	7.89	0.78		1696.286	8.53	1.06	0.62
1352.433	8.39	0.99	0.69	1697.334	7.81	0.69	0.50
1366.311	8.04	0.77	0.48	1712.247	8.54	1.01	0.76:
1392.359	8.27	0.96	0.51:	1761.314	8.41	0.95	0.63
1608.578	7.81	0.71	0.45	1960.526	8.09	0.86	0.52
1610.554	8.37	1.01	0.58	1980.470	7.97	0.82	0.51
1673.347	7.81	0.68	0.49	1981.497	8.29	1.00	0.70:
1680.351	8.53	1.03	0.63	2018.424	8.45	1.04	0.66
1682.362	8.11	0.93	0.54	2018.581	8.50	1.02	0.61:
1695.416	8.41	1.03	0.66	2039.570	8.54	1.04	0.67:

Table 3 (cont.)

SW Tauri

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1303.532	9.87	0.70		1961.525	9.40	0.46	0.17
1352.378	9.81	0.52:		1961.570	9.41	0.44	0.20
1366.270	9.38	0.44	0.23	1961.631	9.40	0.45	0.19
1586.591*	9.48	0.58		1981.476	10.02	0.72	0.60:
1589.589*	9.34	0.49		1982.540	9.58	0.57	0.24:
1596.603*	9.93	0.75:	0.46:	1982.617	9.70	0.64	
1606.603	10.04	0.62		1984.534	9.94	0.69	
1606.609	9.96	0.68		1989.650	10.11	0.74	
1610.597	9.79	0.62	0.31	2018.446	9.52	0.47:	
1617.437	10.08	0.80		2039.358	9.39	0.43	0.17
1680.318	9.82	0.63		2039.418	9.49	0.48	0.19
1681.343	9.41	0.44		2044.285	9.54	0.60	0.24
1682.348	10.10	0.77		2044.335	9.68	0.58	0.22
1689.346*	9.37	0.45	0.39:	2044.439	9.77	0.62	0.45
1694.355	9.61	0.58		2066.381	9.46	0.50	
1695.333	9.81	0.60		2070.257	10.09	0.74	0.27
1695.341	9.78	0.56		3124.487	9.75	0.75:	
1929.592	10.17	0.70	0.30:	3162.323	9.60	0.56	0.36
1930.598	9.84	0.67	0.32:	3202.262	9.90	0.66	
1954.617	10.05	0.75	0.41:	3209.265	9.56	0.58	0.09

SZ Tauri

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1303.555	6.39	0.74		1694.369	6.41	0.80	0.43
1352.405	6.71	0.91	0.42:	1695.389	6.66	0.95	0.54
1366.293	6.34	0.77	0.42	1696.263	6.56	0.82	0.45
1608.646	6.39	0.75	0.41	1754.303	6.44	0.81	0.34:
1610.576	6.69	0.91	0.48	1954.594	6.50	0.81	0.41
1673.308	6.68	0.92	0.55	1966.565	6.68	0.91	0.43:
1680.334	6.60	0.84	0.43	1981.657	6.64	0.88	0.50
1682.331	6.59	0.89	0.49	1982.473	6.65	0.88	0.58:

Table 3 (cont.)

(SZ Tau)

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1984.492	6.51	0.89	0.45	1990.626	6.51	0.83	0.40
1989.505	6.42	0.78	0.39	2018.509	6.39	0.77	0.41

Observations in 1967

J.D.hel. 2430000+	Δv	Δb	Δu	J.D.hel. 2430000+	Δv	Δb	Δu
9770.518	0.049	0.104	0.165	9806.424	0.351	0.521	0.734
9776.536	0.029	0.061	0.130	9810.561	0.174	0.227	0.293
9777.504	0.252	0.379	0.522	9815.603	0.314	0.509	0.698
9782.598	0.060	0.116	0.199	9825.652	0.375	0.562	
9787.546	0.349	0.544	0.666	9838.491	0.274	0.389	0.469
9791.476	0.250	0.318	0.368	9845.373	0.088	0.120	0.222
9796.575	0.296	0.426	0.686				

EU Tauri

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1302.577	8.21	0.73		1962.546	8.29	0.74	0.58
1352.462	8.23	0.75		1966.584	8.27	0.76	0.53
1364.385	8.01	0.66	0.48	1980.658	8.08	0.68	0.54
1395.370	8.06	0.69	0.56	1981.553	8.29	0.72	0.56
1610.533	8.03	0.67	0.50	1982.660	8.04	0.67	0.53
1673.328	7.93	0.64		1984.568	8.02	0.62	
1680.375	8.20	0.72	0.52	2018.527	8.10	0.69	0.52
1681.360	8.05	0.63	0.46:	2035.413	8.13	0.69	
1682.377	8.19	0.71	0.54	2044.309	8.29	0.75	0.55
1694.425	7.98	0.62	0.47	2066.245	8.00	0.61	0.53:
1695.368	8.27	0.76		2066.427	7.96	0.62	0.48
1759.317	8.01	0.61		2069.316	8.23	0.73	0.54
1939.630	8.25	0.70	0.64:	2070.234	8.10	0.66	0.54
1961.552	8.02	0.65	0.50	2108.253	8.01	0.64	

Table 3 (cont.)

T Vulpeculae

J.D.hel. 2440000+	V	B-V	U-B	J.D.hel. 2440000+	V	B-V	U-B
1472.536	5.98	0.77	0.46	1617.239	5.61	0.59	0.27
1475.537	5.66	0.65	0.26:	1868.431	5.97	0.74	0.36
1476.547	5.92	0.75	0.49	1877.382	5.96	0.65	0.24:
1477.538	6.04	0.79	0.45	1880.378	5.97	0.74	0.47
1495.525	6.05	0.77	0.48	1900.544	5.46	0.50	0.24
1496.472	5.44	0.51	0.26	1904.430	5.59	0.49	0.23
1554.374	5.42	0.49	0.23	1905.324	5.54	0.56	0.30
1561.463	6.00	0.79	0.41	1906.377	5.82	0.71	0.42
1579.318	6.03	0.76	0.47	1935.279	5.71	0.60	0.28
1584.406	6.08	0.72	0.41				

Observations in 1953

J.D.hel. 2430000+	Δv	Δb	J.D.hel. 2430000+	Δv	Δb
4584.534	-0.470	+0.760	4597.559	-0.527	+0.550
4585.545	-0.684	+0.392	4608.546	-1.281	-0.492
4590.569	-1.187	-0.395	4609.540	-0.884	+0.010

that my observations were made at less than 1000 metres above sea level.

Table 3 contains the observations in alphabetical order of the constellations. Some unpublished observations made by Prof. L. Detre in 1953 and by Dr. J. Abaffy in 1967-1968 are also listed in Table 3. Unfortunately, since the comparison stars used by them are unknown in several cases these two sets of observations have not been transformed to the standard system, and only the magnitude differences are given in the instrumental system.

THE LIGHT CURVES AND PERIOD CHANGES OF THE INDIVIDUAL VARIABLES

This section contains the light curves, the tables and the graphs of the O-C values and some remarks on the observed cepheids.The variables were arranged according to the length of their period. Such a sequence is obvious because both the form of the light curve and the rate of the period changes vary with the period itself.

The light and colour curves are constructed from the observations listed in Table 3 using the actual periods available after constructing the O-C diagrams. The value of the actual period is indicated for each light curve.

All the available observational material on each cepheid has been gathered so that the period changes can be studied. If the individual observations are available in published form, they were plotted with an approximately correct value of the period and the moment of the normal light maximum was determined. The moment of the median brightness on the ascending branch could also be determined in several cases.The median brightness is the brightness at half the amplitude. The moment of median brightness on the ascending branch can be determined more precisely than can the moment of the maximum because of steep rise in the brightness on the ascending branch. If, however, a light curve of good quality is available the moment of median brightness can be determined accurately. In the case of visual and photographic light curves with large scatter I determined the moments of maxima by fitting the new photoelectric light curve. For the earlier photoelectric observations the light curve in band B (or the band closest to B) was used for the determination of moments of maximum and median brightnesses. The difference between the moments of maxima in B and V lights can be ignored. Although there is a systematic difference in the sense that the longer the wavelength the later the moment of the maximum takes place, the scatter of the points on the O-C diagram is much larger than this difference.

In the case of individual observations not having been published, the normal maximum taken from the original reference was used for constructing the O-C diagram. If more than one maximum in the same year is published, the yearly mean of the O-C values was determined from these maxima.

The O-C values determined on the basis of visual, photographic and photoelectric observations are marked with open circles, filled circles and triangles, respectively. The size of these marks denotes the weight of the O-C values to be found in the figures of this section.

The formulae by which the O-C residuals have been calculated are indicated at each variable. These formulae usually refer to maximum light. If O-C diagrams for both maximum and median brightnesses are presented the two different calculated ephemerides are marked with C_{max} and C_{med}, respectively. O-C diagrams for the median brightness are published here only if they are fairly complete.

BL Herculis

This is a short period Population II cepheid. Its light curve is typical of the class to which this star belongs. Unfortunate-

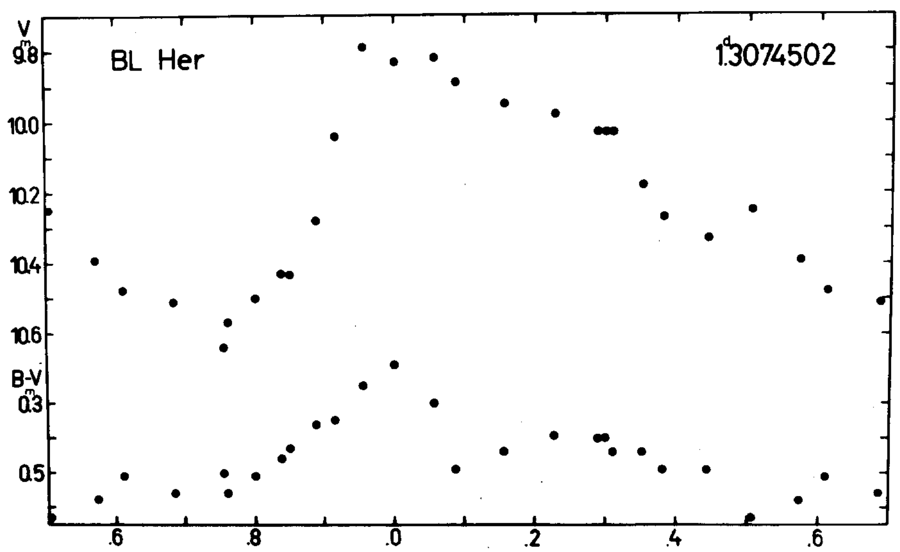

Figure 2 V and B-V curves of BL Her

ly, the comparison star BD +19° 3491 seems to be slightly variable in V light therefore the V light curve shows larger scatter than might otherwise have been expected due to the observational errors (see Fig. 2). The B light curve shows no mark of variability of the comparison star. According to Madore (1977), BL Her has a blue photometric companion.

The O-C residuals have been computed by the formulae:

$$C_{max} = 2441841.289 + 1\overset{d}{.}3074502E \ ;$$

Table 4 O-C residuals for BL Her

Obs.Max.J.D.	Obs.Med.J.D.	E	$(O-C)_{max}$	$(O-C)_{med}$	Type	w	Source
2415196.499		-20379	$-0^{d}.262$		phg	0.5	Jacchia (1940)
2420005.423		-16701	-0.140		phg	1	Parenago (1939a)
2426222.400		-11946	-0.089		vis	1	Esch (1933)
2426503.16		-11731	-0.43		vis	0	Jacchia (1931)
2428384.974		-10292	-0.038		phg	2	Wachmann (1940)
2428734.030		-10025	-0.071		phg	1	Parenago (1939a)
2428955.025	2428954.874	-9856	-0.035	$-0^{d}.070$	phg	2	Wachmann (1940)
2429481.898	2429481.805	-9453	-0.064	-0.042	phg	2	Binnendijk (1950)
2430353.989	2430353.874	-8786	-0.043	-0.043	phg	2	Binnendijk (1950)
2431994.845	2431994.743	-7531	-0.037	-0.023	phg	2	Binnendijk (1950)
2433661.858		-6256	-0.023		phg	1	Solov'yov (1957)
2433661.872		-6256	-0.009		phg	1	Borzdyko (1965)
2433816.153		-6138	-0.007		phel	3	Eggen et al. (1957)
2433860.612		-6104	-0.001		vis	0.5	Koval' (1957)
2433861.986		-6103	+0.066		phg	0.5	Tschuprina (1954)
2433948.198		-6037	-0.014		phg	0.5	Vasil'yanovsk. et al.(1970)
2434200.543		-5844	-0.007		phg	0.5	Mandel' (1970)
2434200.547		-5844	-0.003		vis	0.5	Koval' (1957)
2434584.916		-5550	-0.024		phg	0.5	Mandel' (1970)
2434903.950	2434903.844	-5306	-0.008	+0.001	phel	3	Abt, Hardie (1959)
2435457.028		-4883	+0.018		phg	0.5	Vasil'yanovsk. et al.(1970)
2435488.388		-4859	0.000		phg	0.5	Mandel' (1970)
2435667.508		-4722	-0.001		phel	3	Abt, Hardie (1959)

Table 4 (cont.)

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2435871.472		-4566	$+0\overset{d}{.}001$		phg	1	Borzdyko (1965)
2436023.157		-4450	+0.021		phg	0.5	Vasil'yanovsk. et al.[1](1970)
2436083.265		-4404	-0.013		phg	0.5	Mandel' (1970)
2436387.912		-4171	-0.002		phg	0.5	Mandel' (1970)
2436416.659		-4149	-0.019		phg	0.5	Mandel' (1970)
2436771.011		-3878	+0.014		phg	0.5	Mandel' (1970)
2436780.171		-3871	+0.022		phg	1	Borzdyko (1965)
2436832.457		-3831	+0.010		phg	0.5	Huth (1963c)
2437080.876		-3641	+0.013		phg	0.5	Mandel' 1970)
2437143.625		-3593	+0.005		phg	0.5	Mandel' (1970)
2437287.457		-3483	+0.017		phg	0.5	Vasil'yanovsk. et al.[1](1970)
2437454.801		-3355	+0.007		phel	2	Mitchell et al. (1964)
2437501.843		-3319	-0.019		phg	0.5	Mandel' (1970)
2437565.911		-3270	-0.016		phg	0.5	Borzdyko (1965)
2437871.855	2437871.746	-3036	-0.015	$-0\overset{d}{.}009$	phel	3	Michalowska-Smak, Smak(1965)
2437871.861		-3036	-0.009		phg	0.5	Mandel' (1970)
2438390.918		-2639	-0.010		phg	0.5	Mandel' (1970)
2438392.227		-2638	-0.008		phg	0.5	Mandel' (1970)
2438434.072		-2606	-0.002		phg	0.5	Vasil'yanovsk. et al.[1](1970)
2438967.514		-2198	+0.001		phg	0.5	Mandel' (1970)
	2439328.253	-1922		-0.002	phel	2	Preston, Kilston (1967)
2441841.293	2441841.180	0	+0.004	+0.006	phel	3	present paper

Remark: [1] Observer: Shakhovskaya.

$$C_{med} = 2441841.174 + 1\overset{d}{.}3074502E \ .$$

The O-C diagram (Fig. 3) for the maximum light can be interpreted in two different ways. It may consist of two straight lines, or can be represented by a negative parabola. This uncertainty results from the smallness of the period variation. Assuming the

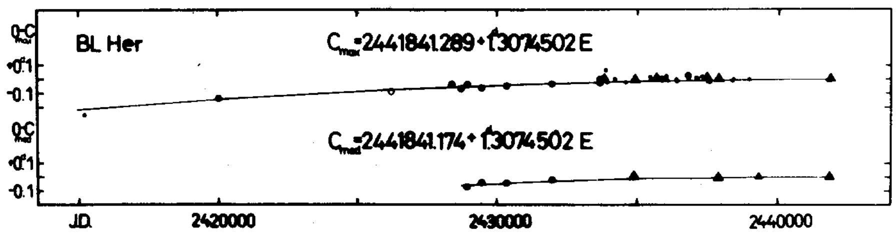

Figure 3 O-C diagram of BL Her

case of sudden period change the values of the period were $1\overset{d}{.}3074604$ before J.D. 2435000 and $1\overset{d}{.}3074502$ after J.D. 2435000. The approximation of the O-C diagram with a parabola is as follows:

$$C'_{max} = 2434999.402 + 1\overset{d}{.}307457E - 3\overset{d}{.}9 \cdot 10^{-10} E^2 \ .$$

SW Tauri

This star is a short period Population II cepheid. This classification is supported by the shape of the light curves and the phase shift between the minimum value of U-B colour index and the light maximum in V (see Fig. 4).According to Mandel's (1970) photographic observations there is a small bump on the light curve of SW Tau near its minimum brightness. Unfortunately, neither the photoelectric observations made by Milone (1970) nor the present observations provides enough data about the minimum, to prove the presence of this bump. Nevertheless, the photoelectric observations show a stable light curve though Latyshev (1963) listed SW Tau among double mode cepheids. SW Tau is a representative of short period flat-topped cepheids. The star reaches its light maximum after a very slow increase of brightness. The point of maximum is at the right end of the flat top. Earlier the maximum was thought to be at the mid-phase of the top, therefore a small correction has been applied in determining O-C residuals should the original observations not be pub-

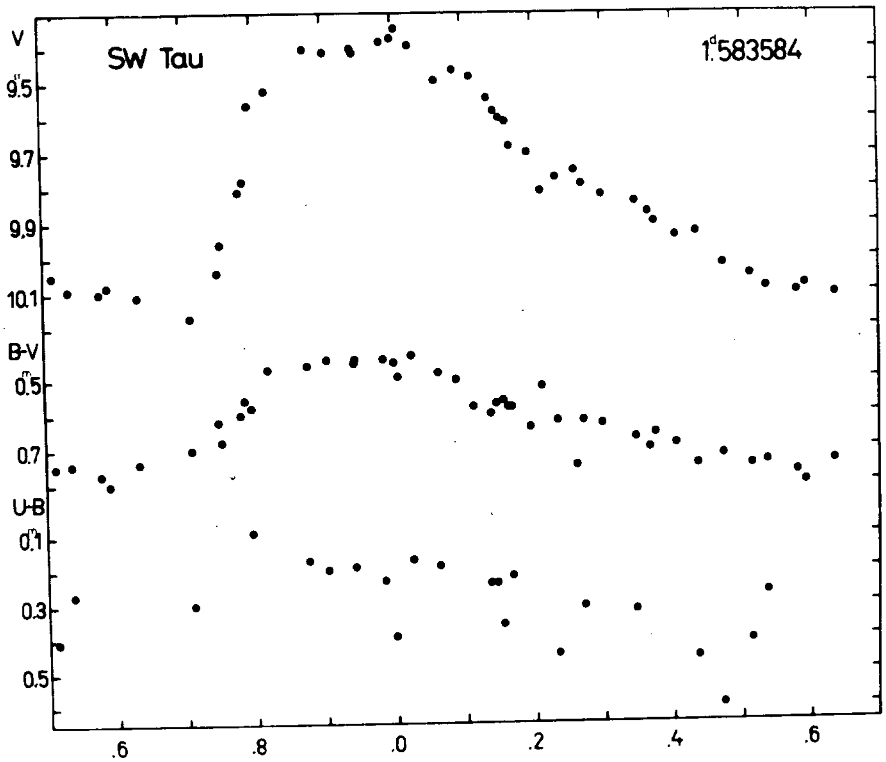

Figure 4 V, B-V and U-B curves of SW Tau

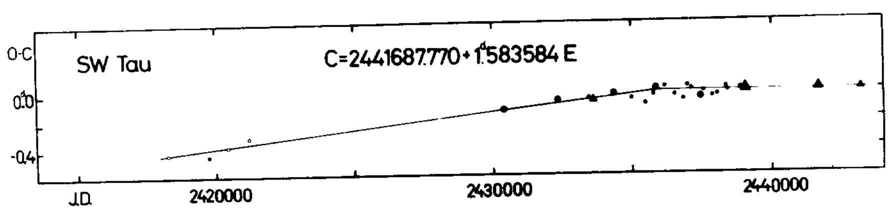

Figure 5 O-C diagram of SW Tau

Table 5 O-C residuals for SW Tau

Obs.Max.J.D.	E	O-C	Type	w	Source
2418240.787	-14806	-0.438 d	vis	0.5	Münch (1909)
2419730.929	-13865	-0.449	phg	0.5	Robinson (1930)
2420440.44	-13417	-0.38	vis	0.5	Hoffmeister (1919)
2420842.84	-13163	-0.21	vis	0	Hoffmeister (1919)
2421200.62	-12937	-0.32	vis	0.5	Hoffmeister (1919)
2430434.692	-7106	-0.130	phg	1	Solov'yov (1957)
2432354.063	-5894	-0.063	phg	1	Borzdyko (1965)
2433473.67	-5187	-0.05	phg	0.5	Vasil'yan. et al.(1970)
2433638.348	-5083	-0.065	phel	2	Eggen et al. (1957)
2434377.922	-4616	-0.024	phg	1	Borzdyko (1965)

Table 5 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2435000.23	-4223	$-0^{d}.06$	phg	0.5	Vasil'yan. et al.(1970)
2435502.195	-3906	-0.096	phg	0.5	Stilijanow (1966)
2435774.64	-3734	-0.03	phg	0.5	Vasil'yan. et al.(1970)
2435879.196	-3668	+0.012	phg	1	Borzdyko (1965)
2436197.508	-3467	+0.024	phg	0.5	Stilijanow (1966)
2436555.339	-3241	-0.035	phg	0.5	Mandel' (1970)
2436846.699	-3057	-0.055	phg	0.5	Stilijanow (1966)
2437003.558	-2958	+0.029	phg	0.5	Borzdyko (1965)
2437147.64	-2867	+0.01	phg	0.5	Vasil'yan. et al.(1970)
2437465.884	-2666	-0.051	phg	1	Mandel' (1970)
2437584.694	-2591	-0.010	phg	0.5	Stilijanow (1966)
2437907.713	-2387	-0.042	phg	0.5	Stilijanow (1966)
2438083.498	-2276	-0.035	phg	0.5	Stilijanow (1966)
2438376.52	-2091	+0.02	phg	0.5	Vasil'yan. et al.(1970)
2438441.416	-2050	-0.007	phg	0.5	Stilijanow (1966)
2438894.340	-1764	+0.012	phg	0.5	Mandel' (1970)
2439059.029	-1660	+0.008	phel	3	Milone (1970)
2439063.790	-1657	+0.019	phg	0.5	Stilijanow (1966)
2439078.025	-1648	+0.001	phel	3	Wamsteker (1972)
2441687.773	0	+0.003	phel	3	present paper
2443176.335	+940	-0.004	phel	2	present paper

lished. The true maximum in B is $0^{d}.1$ later than the mid-phase of the top.

The O-C residuals have been computed with the formula:

$$C = 2441687.770 + 1^{d}.583584E \ .$$

Figure 5 shows a period change at J.D. 2436000. Before this change the value of the period was $1^{d}.583623$, after J.D. 2436000 the period is $1^{d}.583584$.

SU Cassiopeiae

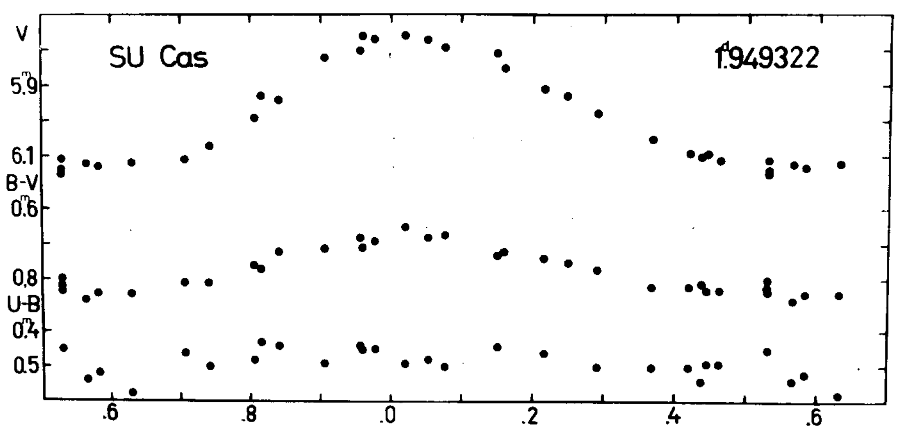

Figure 6 V, B-V and U-B curves of SU Cas

Table 6 O-C residuals for SU Cas

Obs.Max.J.D.	Obs.Med.J.D.	E	$(O-C)_{max}$	$(O-C)_{med}$	Type	w	Source
2417287.164	2417286.809	-12496	$-0^{d}.028$	$+0^{d}.005$	vis	1	Müller, Kempf (1907)
2417347.775		-12465	+0.164		vis	0	Münch (1910)
2417482.181		-12396	+0.067		vis	0.5	Müller, Kempf[1] (1907)
2417770.629	2417770.223	-12248	+0.015	-0.013	phg	2	Parkhurst (1908)
2417794.090		-12236	+0.084		vis	0.5	Zeipel (1908)
2418055.209		-12102	-0.006		vis	0.5	Nijland (1923)
2418873.924		-11682	-0.006		vis	0.5	Nijland (1923)
2420025.890		-11091	-0.090		vis	0.5	Hoffmeister (1915)
2421394.42		-10389	+0.02		vis	1	Vogelenzang (1922)
2422285.552		-9932	+0.308		vis	0	Ellsworth (1928)
2423115.771		-9506	+0.116		vis	0	Ellsworth (1928)
2423386.570		-9367	-0.041		vis	0.5	Hellerich (1926a)
2423677.080		-9218	+0.020		vis	0.5	Hopmann (1926a)
2424148.790	2424148.410	-8976	-0.006	-0.008	vis	1	Parenago (1938)
2424840.855	2424840.524	-8621	+0.050	+0.097	vis	0.5	Kukarkin (1940)
2425051.298	2425050.955	-8513	-0.034	+0.001	phg	1	Hellerich (1935)
2425096.155	2425095.820	-8490	-0.011	+0.032	vis	1	Parenago (1938)
2425283.360	2425282.981	-8394	+0.059	+0.058	vis	1	Kukarkin (1940)
2425630.257	2425629.916	-8216	-0.023	+0.014	vis	1	Zverev (1936)
2425698.552	2425698.248	-8181	+0.043	+0.119	vis	0.5	Kukarkin (1940)
2425747.254	2425746.862	-8156	+0.014	0.000	vis	1	Parenago (1938)
2425969.403		-8042	-0.059		vis	0.5	Florya, Kukarkina (1953)
2426086.404	2426086.094	-7982	-0.018	+0.050	vis	1	Zverev (1936)
2426560.123		-7739	+0.016		vis	0.5	Kukarkin (1940)
2426755.064	2426754.688	-7639	+0.025	+0.027	phg	1	Kox (1935)
2426766.766	2426766.362	-7633	+0.031	+0.005	vis	1	Florya, Kukarkina (1953)
2426895.330	2426894.938	-7567	-0.060	-0.074	phg	1	Hassenstein (1954)
2427127.283	2427126.900	-7448	-0.077	-0.082	vis	1	Parenago (1938)
2427881.760		-7061	+0.013		vis	1	Krebs (1937a)
2428144.865		-6926	-0.041		vis	1	Krebs (1937a)

Table 6 (cont.)

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2429181.912		-6394	$-0^{d}.033$		phg	1	Mandrykina (1949)
2430404.167	2430403.793	-5767	-0.003	$+0^{d}.001$	phel	3	Walter (1943)
2430905.119	2430904.784	-5510	-0.027	+0.016	phel	3	Groeneveld (1944)
2432639.97		-4620	-0.07		vis	0.5	Pohl[2] (1950)
2435755.041	2435754.663	-3022	-0.018	-0.018	phel	3	Prokof'yeva (1961)
2436199.516		-2794	+0.012		phel	2	Svolopoulos (1960)
2436836.942		-2467	+0.009		phel	2	Bahner et al. (1962)
2437439.297	2437438.927	-2158	+0.024	+0.032	phel	3	Mitchell et al. (1964)
2437987.089		-1877	+0.054		vis	0.5	Kunicki (1972)
2438384.671	2438384.291	-1673	-0.023	-0.025	phel	3	Wisniewski, Johnson (1968)
2439055.269	2439054.887	-1329	+0.008	+0.004	phel	3	Milone (1970)
2439361.299	2439360.919	-1172	-0.006	-0.008	phel	3	Takase (1969)
2439447.074	2439446.719	-1128	-0.001	+0.022	phel	3	Wamsteker (1972)
2439751.198	2439750.759	-972	+0.029	-0.032	phel	2	Sudzius (1969)
2439864.198	2439863.859	-914	-0.032	+0.007	phel	3	Reed (1968)
2441645.925	2441645.537	0	+0.015	+0.005	phel	3	present paper
2441930.480		+146	-0.021		phel	3	Gieren (1976)

Remarks:

[1] Observer: Graff
[2] Observer: Pocher

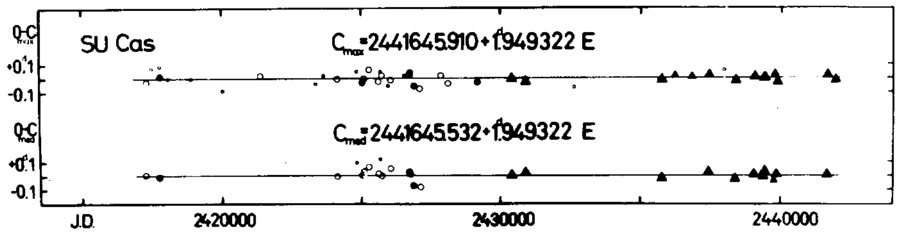

Figure 7 O-C diagram of SU Cas

This is a cepheid with small amplitude (see Fig. 6). According to Kukarkin et al. (1971) its period probably varies. However, neither the O-C diagram of the maximum brightness, nor that of the median brightness shows any changes in the period. The O-C residuals plotted in Fig. 7 have been computed with the formulae:

$$C_{max} = 2441645.910 + 1\overset{d}{.}949322E \; ;$$
$$C_{med} = 2441645.532 + 1\overset{d}{.}949322E \; .$$

The period of SU Cas has been constant since the discovery of its light variation.

EU Tauri

EU Tau is a cepheid with small amplitude (see Fig. 8). There are only four valuable sets of observations within a short time interval therefore the O-C residuals given in Table 7 are not plotted in a separate figure. The residuals have been derived using the formula:

$$C = 2441704.785 + 2\overset{d}{.}10248E \; .$$

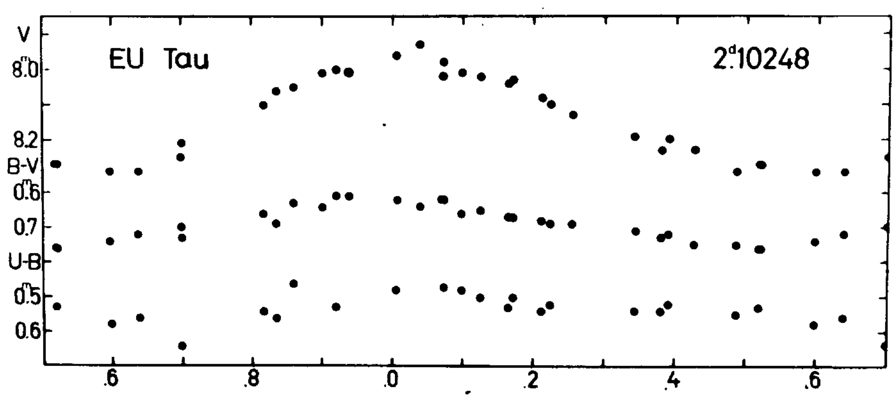

Figure 8 V, B-V and U-B curves of EU Tau

Table 7 O-C residuals for EU Tau

Obs.Max.J.D.	E	O-C	Type	w	Source
2438973.668	-1299	$+0^{d}.005$	phel	3	Guinan (1972)
2440998.346	-336	-0.006	phel	3	Wachmann (1976)
2441334.746	-176	-0.003	phel	3	Sanwal et al. (1974)
2441704.788	0	+0.003	phel	3	present paper

<u>IR Cephei</u>

The newly discovered cepheid variable IR Cep = HBV 476 belongs to the group of small amplitude cepheids (see Fig. 9). However,

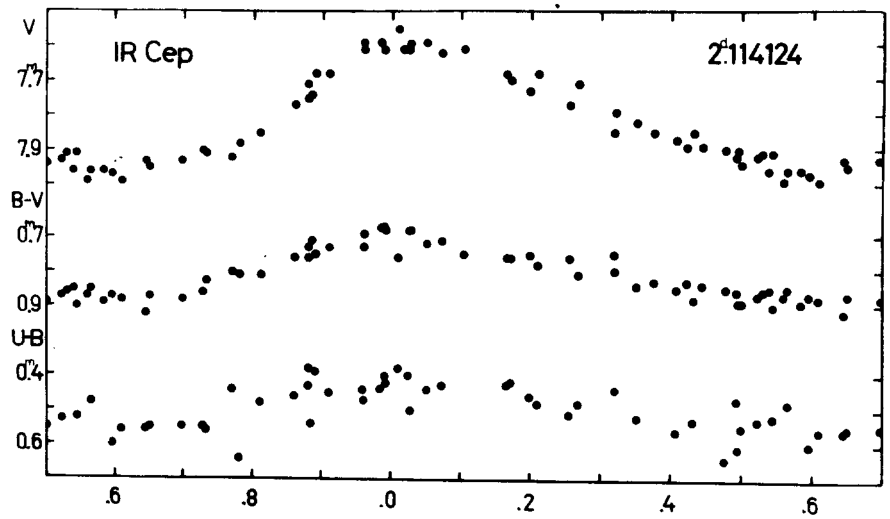

Figure 9 V, B-V and U-B curves of IR Cep

the light curve is not symmetrical (or "sinusoidal"), i.e. it differs markedly from the other small amplitude cepheids in the shape of the light curve. There are two possible explanations for resolving this difference:

1/ the variable star has a companion that reduces the amplitude of the light variation;

2/ the group of cepheids with small amplitude is not homogeneous, it includes cepheids with nearly symmetrical as well as non-symmetrical light curves.

In order to decide whether the first explanation is valid, spectroscopic observations are highly desirable.

The O-C residuals have been computed with the formula:

$$C = 2441696.582 + 2^{d}.114124E\ .$$

These residuals are plotted in Fig. 10. The period of IR Cep

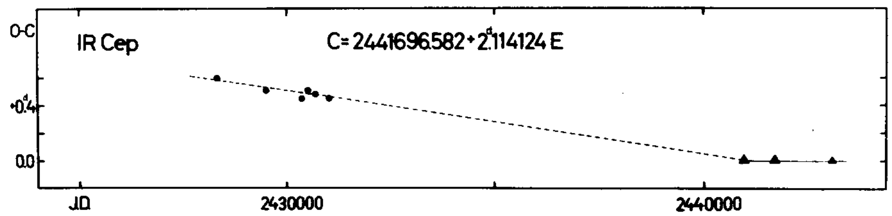

Figure 10 O-C diagram of IR Cep

Table 8 O-C residuals for IR Cep

Obs.Max.J.D.	E	O-C	Type	w	Source
2428335.914	-6320	$+0^{d}.596$	phg	1	Klawitter (1971)
2429515.512	-5762	+0.512	phg	1	Klawitter (1971)
2430373.783	-5356	+0.449	phg	1	Klawitter (1971)
2430517.605	-5288	+0.511	phg	1	Klawitter (1971)
2430703.620	-5200	+0.483	phg	1	Klawitter (1971)
2431033.395	-5044	+0.454	phg	1	Klawitter (1971)
2440965.096	-346	+0.001	phel	3	Wachmann (1976)
2441696.580	0	-0.002	phel	3	present paper
2443045.394	+638	+0.001	phel	2	present paper

shows one strong change. Before J.D. 2440900 the period was $2^{d}.114027$ or even smaller, after J.D. 2440900 the period is $2^{d}.114124$.

BB Geminorum

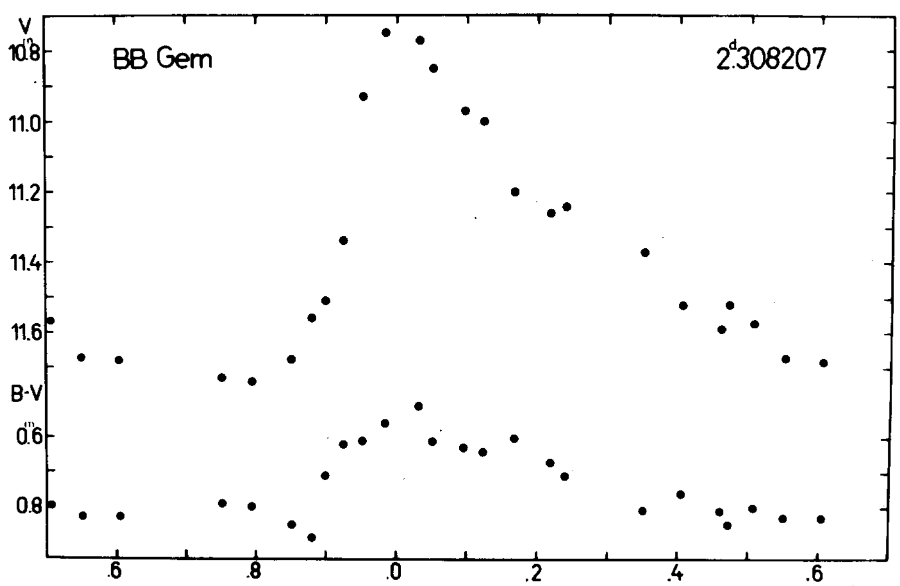

Figure 11 V and B-V curves of BB Gem

The star BB Gem is a Population II cepheid. According to Efremov (1968b) the maximum value of the light amplitude of classical cepheids in the blue band is about $0\overset{m}{.}85$ at $\ell og\,P = 0.36$. BB Gem has an amplitude of $1\overset{m}{.}27$ in band B (see Fig. 11). This extremely large amplitude supports the above-mentioned new classification for this cepheid.

The O-C residuals for this star have been obtained by the formula:

$$C = 2441839.695 + 2\overset{d}{.}308207E\ .$$

These residuals are plotted in Fig. 12. The period of BB Gem has remained constant for more than 7000 epochs.

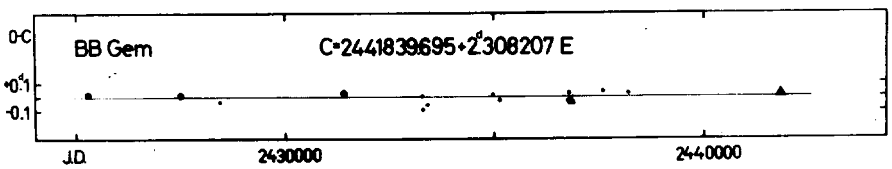

Figure 12 O-C diagram of BB Gem

Table 9 O-C residuals for BB Gem

Obs.Max.J.D.	E	O-C	Type	w	Source
2425296.787	-7167	$+0\overset{d}{.}012$	phg	2	Zonn (1935)
2427482.659	-6220	+0.012	phg	2	Zonn (1935)
2428454.365	-5799	-0.038	vis	0.5	Solov'yov (1940)
2431425.091	-4512	+0.026	phg	1	Teplitskaya (1951)
2433315.399	-3693	-0.088	phg	0.5	Satyvaldiev (1970)
2433317.80	-3692	+0.01	phg	0.5	Solov'yov (1951)
2433421.608	-3647	-0.056	phg	0.5	Borzdyko (1964)
2434975.100	-2974	+0.013	phg	0.5	Borzdyko (1964)
2435157.412	-2895	-0.024	phg	0.5	Satyvaldiev (1970)
2436784.690	-2190	-0.032	phg	0.5	Borzdyko (1964)
2436800.905	-2183	+0.026	phg	0.5	Satyvaldiev (1970)
2436849.315	-2162	-0.036	phel	2	Oosterhoff (1960)
2437606.48	-1834	+0.04	phg	0.5	Ahnert (1963)
2438201.986	-1576	+0.025	phg	0.5	Satyvaldiev (1970)
2441839.711	0	+0.016	phel	3	present paper

AU Pegasi

This is usually classified as a Population II cepheid (Kukarkin et al. 1969-1970, Opolski 1968, Petit 1960). Several authors (Gascoigne and Eggen 1957, Kolesnik and Kheilo 1970) classified it among classical cepheids. The phase shift between the maxima of its light and colour curves as the only population criterion at the small amplitude cepheids based on optical observations unambiguously shows that AU Peg belongs to Population II (see

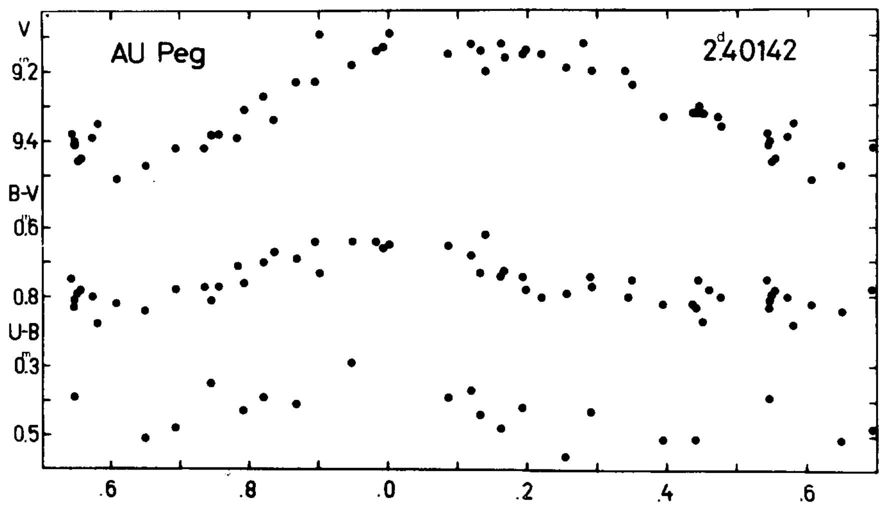

Figure 13 V, B-V and U-B curves of AU Peg

Fig. 13). Moreover, the strong changes in the period of AU Peg (see Fig. 14) also support this classification. The short period classical cepheids do not show such strong period changes.

The O-C diagram shows an interesting structure. It was computed with the ephemeris:

$$C = 2435801.832 + 2\overset{d}{.}390048E \ .$$

I was unable to find a unique representation of the O-C diagram. At earlier epochs two different O-C residuals are listed and plotted for each maximum. It is hard to decide which curve is the real one. However, the light curves plotted from the observations serving as a basis for computing O-C values show less scatter when using the smaller value of the period, i.e. the upper curve is more suitable. This curve shows a continuous increase of the period, but it cannot be approximated with a parabola. The minimum value of the period was about $2\overset{d}{.}3844$ at J.D. 2427000, the maximum value at present is $2\overset{d}{.}40142$. The total change of the period is about 1%. There are no other short period cepheids showing such a large period variation. For example, V1 in M15 has a quasi-parabolic O-C graph with considerable period change but the total change in its period is about 0.01% during 23000 days (Barlai 1977).

The central part of the O-C diagram in Fig. 14 is in accordance with the O-C diagram published by Kwee (1967).

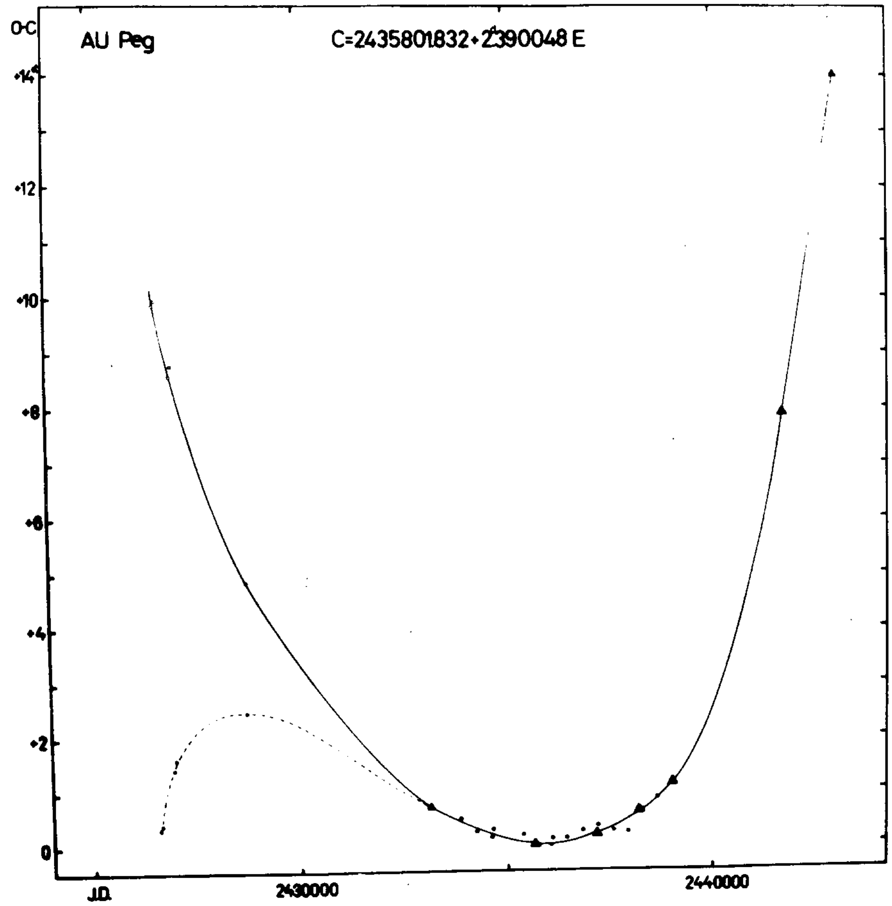

Figure 14 O-C diagram of AU Peg

Table 10 O-C residuals for AU Peg

Obs.Max.J.D.	E	O-C	Type	w	Source
2419080.201	?	?	phg	0.5	Parenago (1934)
2426578.959	{-3863 -3859	+9.882 +0.322}	vis	0.5	Florya (1933)
2426636.40	{-3839 -3835	+9.96 +0.40 }	vis	0.5	Lause (1932)
2426952.911	{-3706 -3703	+8.597 +1.427}	vis	0.5	Florya (1933)
2427000.90	{-3686 -3683	+8.78 +1.61 }	vis	0.5	Lause (1933)
2428729.76	{-2961 -2960	+4.86 +2.47 }	vis	0.5	Kukarkin (1938)
2433151.976	-1109	+0.709	phel	2	Eggen et al. (1957)
2433156.727	-1107	+0.678	phg	0.5	Vasil'yan. et al.[1] (1970)
2433875.952	-806	+0.499	phg	0.5	Vasil'yan. et al.[1] (1970)

Table 10 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2434258.118	-646	$+0^d.257$	phg	0.5	Vasil'yan. et al.[1] (1970)
2434614.133	-497	+0.155	phg	0.5	Vasil'yan. et al.[1] (1970)
2434654.90	-480	+0.29	phg	0.5	Günther (1955)
2435383.768	-175	+0.194	phg	0.5	Vasil'yan. et al.[1] (1970)
2435667.965	- 56	-0.024	phel	3	Walraven et al. (1958)
2435751.615	- 21	-0.026	phg	0.5	Vasil'yan. et al.[1] (1970)
2436076.678	+115	-0.010	phg	0.5	Vasil'yan. et al.[1] (1970)
2436093.540	+122	+0.122	phg	0.5	Korovkina (1958)
2436442.493	+268	+0.128	phg	0.5	Vasil'yan. et al.[1] (1970)
2436829.821	+430	+0.268	phg	0.5	Vasil'yan. et al.[1] (1970)
2437185.841	+579	+0.171	phel	3	Mitchell et al. (1964)
2437207.539	+588	+0.359	phg	0.5	Vasil'yan. et al.[1] (1970)
2437580.286	+744	+0.258	phg	0.5	Vasil'yan. et al.[1] (1970)
2437941.154	+895	+0.229	phg	0.5	Vasil'yan. et al.[1] (1970)
2438228.339	+1015	+0.608	phel	3	Kwee and Braun (1967)
2438300.062	+1045	+0.630	phg	0.5	Vasil'yan. et al.[1] (1970)
2438654.026	+1193	+0.867	phg	0.5	Vasil'yan. et al.[1] (1970)
2439039.083	+1354	+1.126	phel	3	Wamsteker (1972)
2441739.439	+2481	+7.898	phel	3	present paper
2443031.402	+3019	+14.015	phel	2	present paper

Remark: [1] Observer: Shakhovskaya

DT Cygni

This variable is a cepheid with small amplitude. The light and colour curves (Fig. 15) have no excess scatter in spite of the fact that the comparison star BD +29° 4324 is included in the GCVS as the variable V 389 Cygni. For this reason the check star BD +30° 4322 was observed at each observation of DT Cygni. The magnitude differences between the comparison and check stars indicate that one or other of the two stars varies. If the light curve of DT Cyg is constructed by using the magnitude differences between DT Cyg and the check star the scatter on the curve is much larger. Consequently, the check star BD +30° 4322 is a suspected variable and V 389 Cyg has a constant light. The constancy of the comparison star V 389 Cyg was also checked by observing DT Cyg at almost the same phases on different nights. In order to determine the nature of light variation of this new suspected variable further observations of BD +30° 4322 are planned.

As to the O-C diagram of DT Cyg, a new interpretation of period changes of this cepheid is proposed (see Fig. 16). During long intervals (2000-4000 days) the period is constant and has the same value, whereas during the intermediate intervals the

Table 11 O-C residuals for DT Cyg

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2424375.583	2424374.993	-6947	$-1^{d}.087$	$-1^{d}.117$	phel	3	Huffer (1928b)
2424695.538		-6819	-1.015		phel	2	Huffer (1928b)
2424785.340		-6783	-1.180		phg	1	Barabashev[1] (1928)
2425427.670		-6526	-1.114		vis	0.5	Kukarkin (1940)
2425802.466		-6376	-1.180		vis	0.5	Kukarkin (1940)
2425805.055		-6375	-1.090		vis	0.5	Zverev (1936)
2426047.562		-6278	-0.994		vis	0.5	Mustel' (1934)
2426344.978		-6159	-0.969		vis	0.5	Zverev (1936)
2426434.756		-6123	-1.156		vis	0.5	Kukarkin (1940)
2426922.178		-5928	-1.057		vis	0.5	Zverev (1936)
2427547.008	2427546.385	-5678	-0.997	-1.065	phel	2	Schneller (1936)
2427676.776		-5626	-1.182		vis	0.5	Krebs (1935)
2427976.728		-5506	-1.120		vis	0.5	Dziewulski (1962)
2428046.826		-5478	-0.996		vis	0.5	Krebs (1937a)
2428466.617		-5310	-1.051		vis	1	Kepinski (1937)
2432975.319	2432974.759	-3506	-0.693	-0.698	phel	2	Eggen (1951)
2433295.022		-3378	-0.872		vis	0	Dziewulski (1962)
2435259.67		-2592	-0.50		vis	1	Marks (1959)
2436099.527		-2256	-0.437		phel	2	Svolopoulos (1960)
2437176.700	2437176.118	-1825	-0.268	-0.295	phel	3	Mitchell et al. (1964)
2437579.091	2437578.504	-1664	-0.210	-0.162	phel	3	Johansen (1971)
2438496.241	2438495.722	-1297	-0.243	-0.207	phel	3	Johansen (1971)
2438871.112	2438870.575	-1147	-0.234	-0.216	phel	3	Wisniewski, Johnson (1968)
2441737.798	2441737.238	0	+0.005	0.000	phel	3	present paper
2443044.805		+523	-0.008		phel	2	present paper

Remark: [1] Observer: Shemejkin.

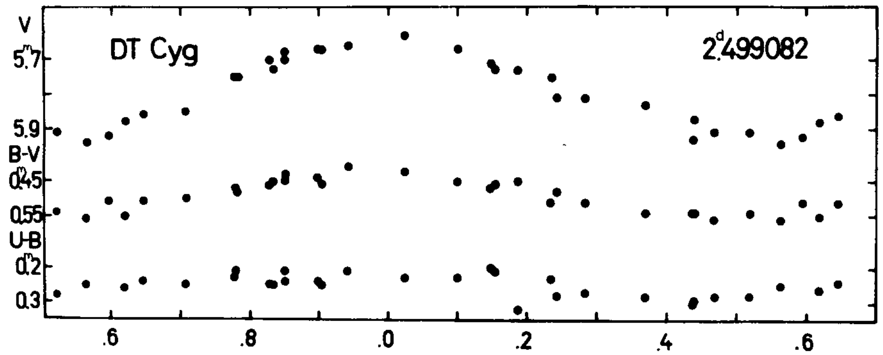

Figure 15 V, B-V and U-B curves of DT Cyg

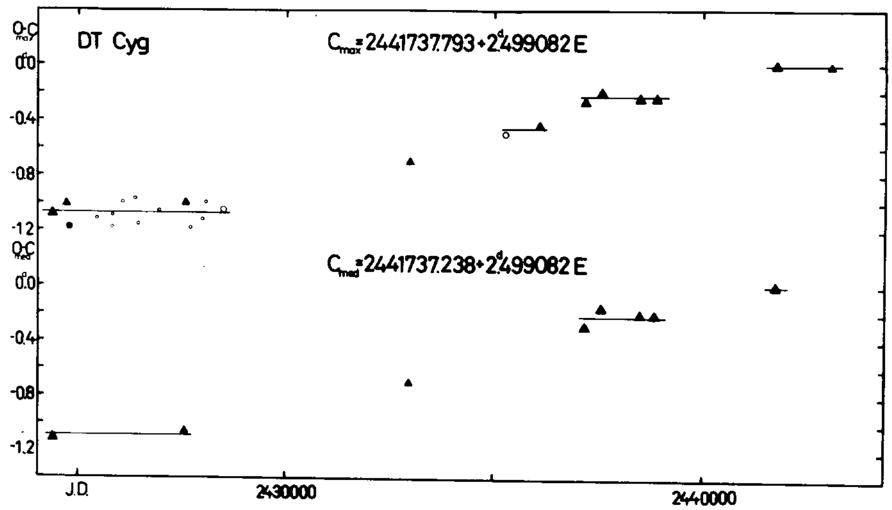

Figure 16 O-C diagram of DT Cyg

moments of maxima are submitted to phase shifts. The values of these shifts are $0^d.21$ - $0^d.23$ or their multiple. This gradual period change is very interesting and it is intended to continue observations on DT Cygni.

The O-C residuals given in Table 11 have been computed with the formulae:

$$C_{max} = 2441737.793 + 2^d.499082E \; ;$$
$$C_{med} = 2441737.238 + 2^d.499082E \; .$$

It is worthy of note that a change of -3 km/s in normal radial velocity occurred between J.D. 2432000 and J.D. 2433000 (Evans

1968), i.e. during the time of a phase lag of the maximum.

BE Monocerotis

Its light and colour curves are shown in Fig. 17. The O-C residuals have been computed with the formula:

$$C = 2441880.240 + 2\overset{d}{.}705510E \ .$$

These residuals are plotted in Fig. 18. The period of BE Mon is constant.

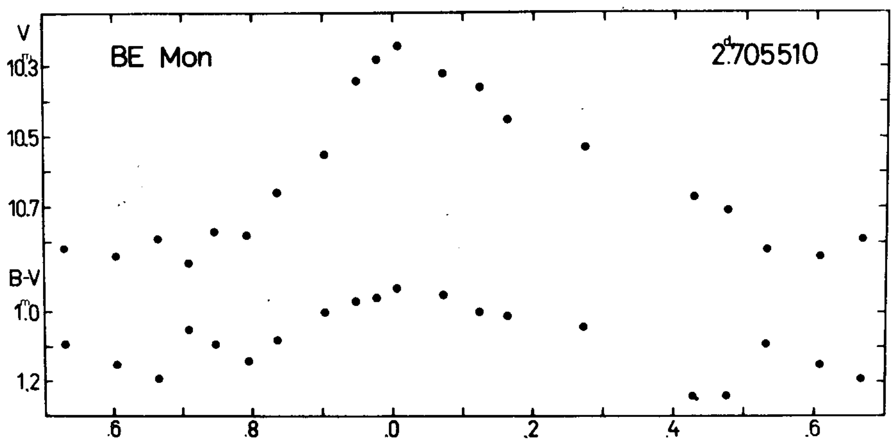

Figure 17 V and B-V curves of BE Mon

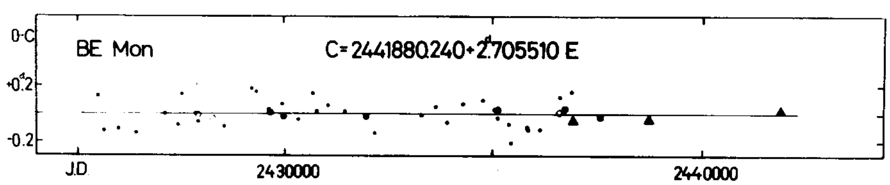

Figure 18 O-C diagram of BE Mon

Table 12 O-C residuals for BE Mon

Obs.Max.J.D.	E	O-C	Type	w	Source
2425506.624	-6052	$+0\overset{d}{.}131$	phg	0.5	Busch, Häussler (1963)
2425644.35	-6001	-0.12	phg	0.5	Ahnert[1] (1960)
2425974.73	-5879	-0.11	phg	0.5	Ahnert[1] (1960)
2426407.29	-5719	-0.14	phg	0.5	Ahnert[1] (1960)
2427124.38	-5454	-0.01	phg	0.5	Ahnert[1] (1960)
2427397.56	-5353	-0.08	phg	0.5	Ahnert[1] (1960)
2427516.83	-5309	+0.14	phg	0.5	Ahnert[2] (1960)
2427849.47	-5186	0.00	phg	0.5	Ahnert[3] (1960)
2427863.20	-5181	+0.21	vis	0.5	Kukarkin (1960)
2427892.751	-5170	-0.002	vis	1	Solov'yov (1952a)
2427914.34	-5162	-0.06	phg	0.5	Ahnert[2] (1960)
2428206.89	-5054	+0.30	phg	0	Ahnert[1] (1960)

Table 12 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2428260.667	-5034	$-0\overset{d}{.}036$	vis	1	Solov'yov (1952a)
2428547.40	-4928	-0.09	phg	0.5	Ahnert[1] (1960)
2429229.46	-4676	+0.18	phg	0.5	Ahnert[1] (1960)
2429313.305	-4645	+0.159	phg	0.5	Busch, Häussler (1963)
2429629.72	-4528	+0.03	phg	0.5	Ahnert[1] (1960)
2429667.572	-4514	+0.004	phg	1	Kapko (1963)
2429943.60	-4412	+0.07	phg	0.5	Ahnert[1] (1960)
2429989.503	-4395	-0.021	phg	1	Kapko (1963)
2430346.61	-4263	-0.04	phg	0.5	Ahnert[1] (1960)
2430698.52	-4133	+0.15	phg	0.5	Ahnert[1] (1960)
2430790.37	-4099	+0.02	phg	0.5	Ahnert[2] (1960)
2431050.14	-4003	+0.06	phg	0.5	Ahnert[3] (1960)
2431466.75	-3849	+0.02	phg	0.5	Ahnert[1] (1960)
2431986.169	-3657	-0.021	phg	1	Kapko (1963)
2432188.96	-3582	-0.14	phg	0.5	Ahnert[1] (1960)
2433306.47	-3169	-0.01	phg	0.5	Ahnert[2] (1960)
2433658.25	-3039	+0.05	phg	0.5	Ahnert[4] (1960)
2433934.10	-2937	-0.06	phg	0.5	Ahnert[5] (1960)
2434307.59	-2799	+0.07	phg	0.5	Ahnert[5] (1960)
2434778.38	-2625	+0.10	phg	0.5	Ahnert[5] (1960)
2435062.38	-2520	+0.03	phg	0.5	Ahnert[5] (1960)
2435143.551	-2490	+0.031	phg	1	Kapko (1963)
2435146.20	-2489	-0.03	phg	0.5	Ahnert[6] (1960)
2435395.06	-2397	-0.07	phg	0.5	Ahnert[2] (1960)
2435454.46	-2375	-0.19	phg	0.5	Ahnert[7] (1960)
2435841.45	-2232	-0.09	phg	0.5	Ahnert[2] (1960)
2435860.367	-2225	-0.113	phg	0.5	Busch, Häussler (1963)
2436144.45	-2120	-0.11	phg	0.5	Ahnert[3] (1960)
2436612.62	-1947	+0.01	vis	1	Ahnert (1960)
2436615.44	-1946	+0.12	phg	0.5	Ahnert[1] (1960)
2436731.692	-1903	+0.038	phg	1	Kapko (1963)
2436899.56	-1841	+0.16	phg	0.5	Ahnert[2] (1960)
2436929.104	-1830	-0.053	phel	3	Detre, Chang (1960)
2437578.454	-1590	-0.025	phg	1	Ahnert (1963)
2438741.808	-1160	-0.040	phel	3	Buchancowa et al.(1972)
2441880.253	0	+0.013	phel	3	present paper

Remarks: [1] Observer: Busch; [2] Obs.: Löchel; [3] Obs.: Busch and Löchel; [4] Obs.: Busch and Götz; [5] Obs.: Busch, Götz and Löchel; [6] Obs.: Götz and Löchel; [7] Obs.: Götz.

V 465 Monocerotis

This star is a cepheid with small amplitude (see Fig. 19). The O-C residuals have been calculated with the formula:

$$C = 2441698.687 + 2\overset{d}{.}713176E \ .$$

The O-C diagram plotted in Fig. 20 shows two period changes. Before J.D. 2432000 the value of the period was uncertain; between J.D. 2432000 and J.D. 2441600 , $P = 2\overset{d}{.}713668$; after J.D. 2441600 , $P = 2\overset{d}{.}713176$.

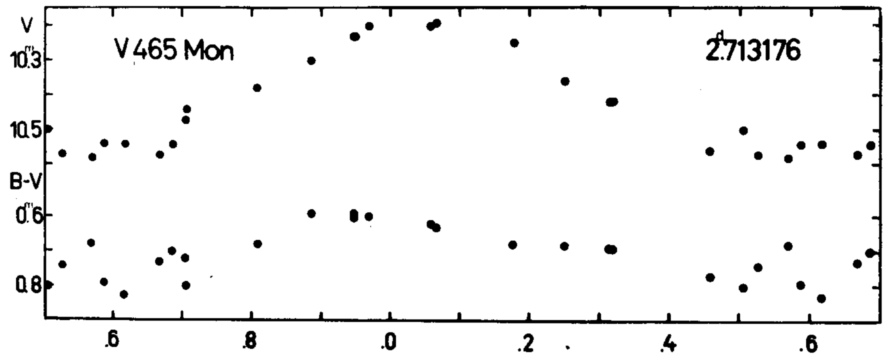

Figure 19 V and B-V curves of V 465 Mon

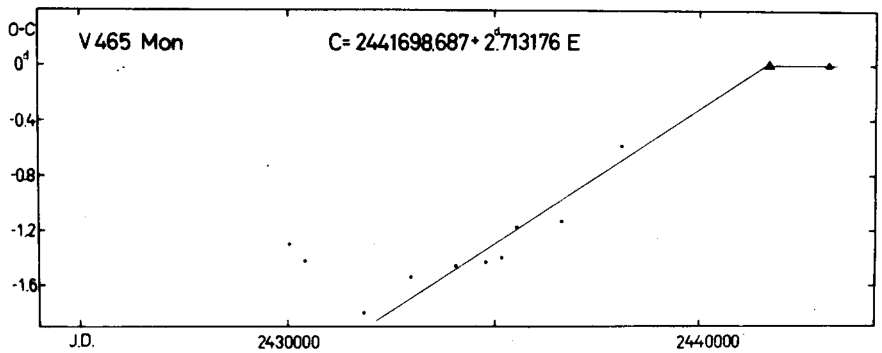

Figure 20 O-C diagram of V 465 Mon

Table 13 O-C residuals for V 465 Mon

Obs.Max.J.D.	E	O-C	Type	w	Source
2430025.3	-4302	$-1^{d}.3$	phg	0.5	Wachmann (1964)
2430421.308	-4156	-1.420	phg	0.5	Satyvaldiev (1970)
2431845.3	-3631	-1.8	phg	0.5	Wachmann (1964)
2432968.864	-3217	-1.536	phg	0.5	Satyvaldiev (1970)
2434040.646	-2822	-1.458	phg	0.5	Satyvaldiev (1970)
2434773.23	-2552	-1.43	phg	0.5	Wachmann (1964)
2435169.4	-2406	-1.4	phg	0.5	Wachmann (1964)
2435541.315	-2269	-1.176	phg	0.5	Satyvaldiev (1970)
2436632.053	-1867	-1.134	phg	0.5	Satyvaldiev (1970)
2438067.872	-1338	-0.586	phg	0.5	Satyvaldiev (1970)
2441698.687	0	0.000	phel	3	present paper
2443166.515	+541	0.000	phel	2	present paper

<u>BD +56° 2806</u>

Its variability was discovered by Fernie and Hube (1971); the first determination of its period was published by Szabados (1976b). The bump after the minimum light mentioned at the same

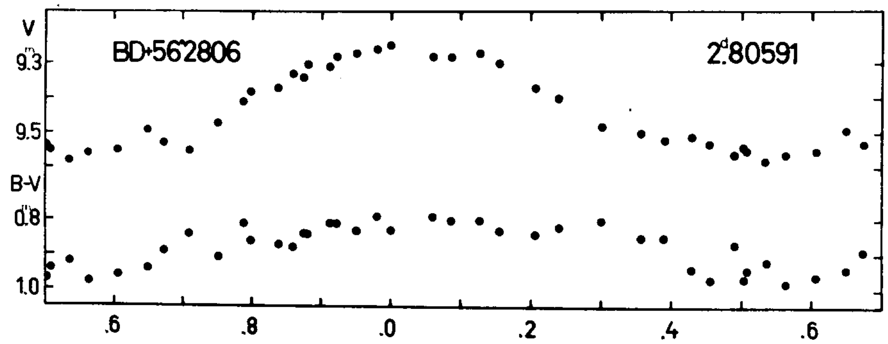

Figure 21 V and B-V curves of BD +56° 2806

paper may be not real. The light curve of BD +56° 2806 is presented in Fig. 21. The O-C curve cannot be constructed for lack of earlier observations. The observations made by Percy (1975) were used to improve the value of the period determined from the present observations. The O-C residuals have been computed with the formula:

$$C = 2442676.397 + 2^{d}.80591E \ .$$

Table 14 O-C residuals for BD +56° 2806

Obs.Max.J.D.	E	O-C	Type	w	Source
2442031.038	-230	0.000 (d)	phel	2	Percy (1975)
2442676.397	0	0.000	phel	3	present paper

DX Geminorum

This is a cepheid with small amplitude (see Fig. 22). The O-C residuals have been computed with the formula:

$$C = 2441866.664 + 3^{d}.137486E \ .$$

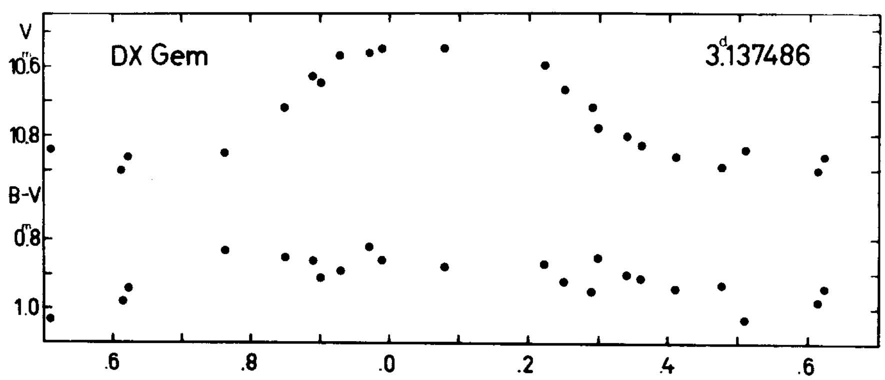

Figure 22 V and B-V curves of DX Gem

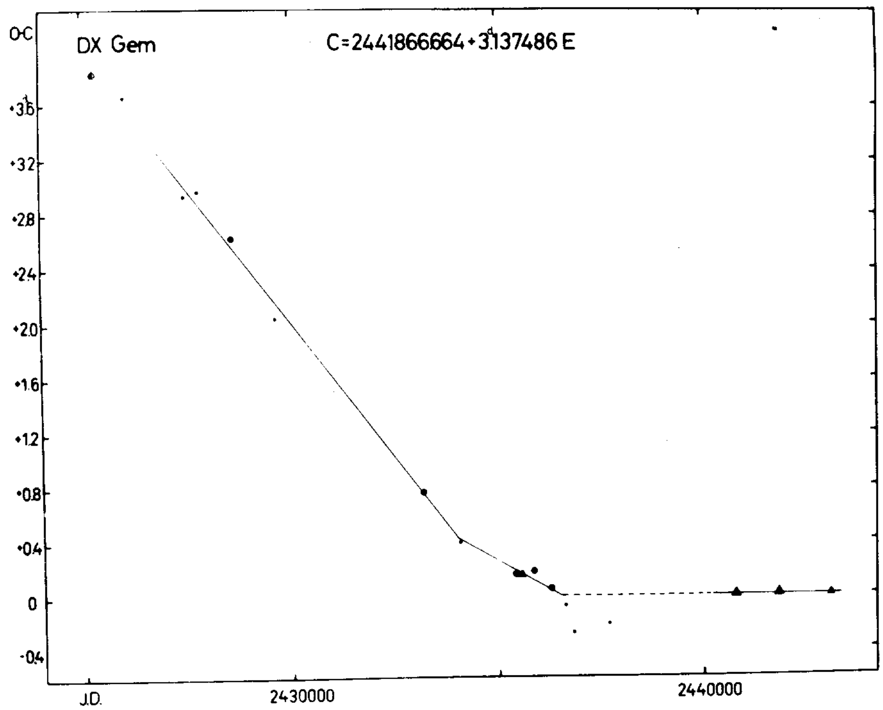

Figure 23 O-C diagram of DX Gem

Table 15 O-C residuals for DX Gem

Obs.Max.J.D.	E	O-C	Type	w	Source
2425295.158	-5283	+3.833 d	phg	1	Bartkus et al. (1961)
2426038.579	-5046	+3.669	phg	0.5	Bartkus et al. (1961)
2427449.718	-4596	+2.940	phg	0.5	Bartkus et al. (1961)
2427782.331	-4490	+2.979	phg	0.5	Bartkus et al. (1961)
2428594.596	-4231	+2.635	phg	1	Meshkova (1940)
2429638.790	-3898	+2.046	phg	0.5	Teplitskaya (1950)
2433182.876	-2768	+0.773	phg	1	Satyvaldiev (1970)
2434067.275	-2486	+0.401	phg	0.5	Satyvaldiev (1970)
2435413.021	-2057	+0.166	phg	1	Satyvaldiev (1970)
2435554.199	-2012	+0.157	phel	1	Walraven et al. (1958)
2435896.212	-1903	+0.184	phg	1	Bartkus et al. (1961)
2436275.716	-1782	+0.052	phg	1	Bartkus et al. (1961)
2436623.856	-1671	-0.069	phg	0.5	Satyvaldiev (1970)
2436815.042	-1610	-0.270	phg	0.5	Bartkus et al. (1961)
2437687.330	-1332	-0.203	phg	0.5	Satyvaldiev (1970)
2438744.322	-995	-0.543	phg	0	Satyvaldiev (1970)
2440793.641	-342	-0.003	phel	3	Pel (1976)
2441866.668	0	+0.004	phel	3	present paper
2443165.579	+414	-0.004	phel	2	present paper

The O-C diagram (Fig. 23) shows two changes in the period. The first period change was also suspected by Bartkus and Puchinskas

(1961). The following values of the period are valid for different time intervals:

before J.D. 2434000, $P = 3^{d}.136226$;
between J.D. 2434000 and J.D. 2436500, $P = 3^{d}.136955$;
after J.D. 2436500, $P = 3^{d}.137486$.

SZ Tauri

According to Kukarkin et al. (1974) SZ Tau is a possible member of the cluster NGC 1647. The phase relations of the colour curves (see Fig. 24) also support its belonging to Population I. However, several authors classified SZ Tau as a Population II variable (Walraven et al. 1958, Petit 1960, Mianes 1963, Kheilo 1969). According to Madore (1977), SZ Tau has a blue photometric companion.

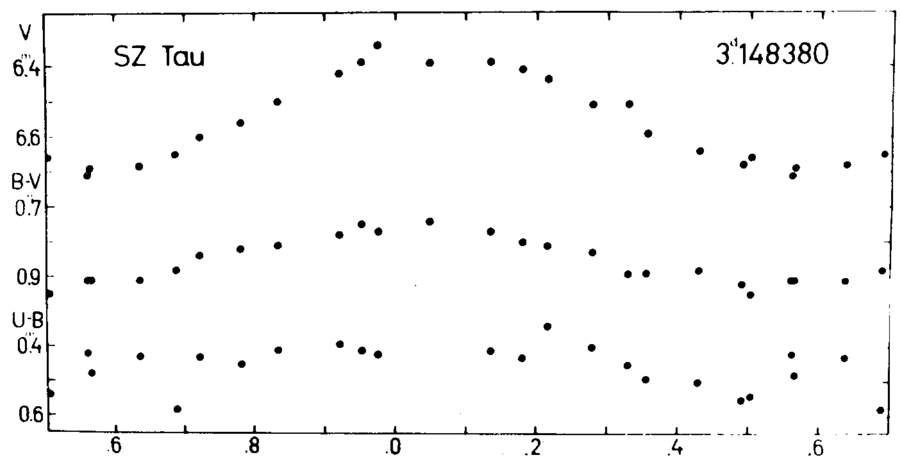

Figure 24 V, B-V and U-B curves of SZ Tau

The O-C residuals have been derived using the formula:

$$C = 2441659.194 + 3^{d}.14838E \ .$$

The O-C diagram (Fig. 25) shows three changes in the period of SZ Tauri:

before J.D. 2418500, $P = 3^{d}.14839$;
between J.D. 2418500 and J.D. 2425500, $P = 3^{d}.149235$;
between J.D. 2425500 and J.D. 2436300, $P = 3^{d}.149057$;
after J.D. 2436300, $P = 3^{d}.148380$.

This O-C diagram shows an interesting phenomenon: at present the period of pulsation of SZ Tau is nearly identical with the value of the period which was valid several decades ago. Such a return

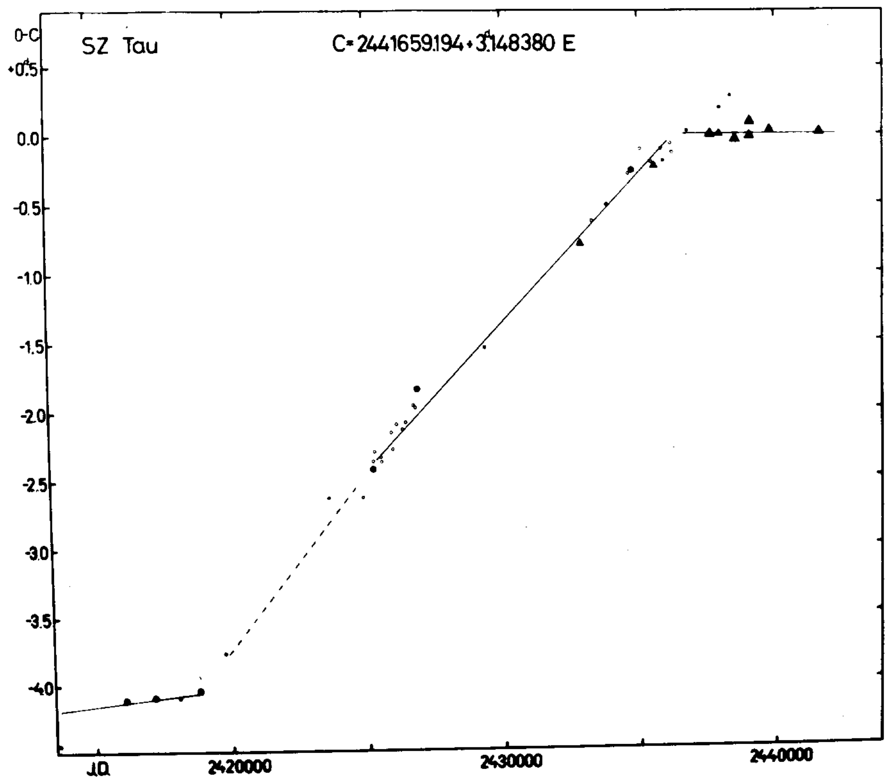

Figure 25 O-C diagram of SZ Tau

to an earlier period has been found for DT Cyg and other cepheids. A more detailed discussion of this phenomenon will be given in the next section.

Table 16 O-C residuals for SZ Tau

Obs.Max.J.D.	E	O-C	Type	w	Source
2413671.947	-8888	$-4^{d}.446$	phg	0.5	Pickering (1914)
2416118.575	-8111	-4.109	phg	1	Pickering (1914)
2417179.596	-7774	-4.092	phg	1	Pickering (1914)
2418086.326	-7486	-4.095	phg	0.5	Pickering (1914)
2418713.005	-7287	-3.944	vis	1	Schwarzschild (1911)
2418829.399	-7250	-4.040	phg	1	Pickering (1914)
2419267.519	-7111	-3.545	phg	0	Robinson (1930)
2419758.445	-6955	-3.766	phg	0.5	Pickering (1914)
2423619.49	-5729	-2.63	vis	0.5	Nielsen (1941)
2424878.851	-5329	-2.626	vis	0.5	Kukarkin (1940)
2425225.378	-5219	-2.421	phg	1	Hellerich (1935)
2425231.729	-5217	-2.367	vis	0.5	Kukarkin (1940)
2425301.067	-5195	-2.293	vis	0.5	Collmann (1930)
2425530.856	-5122	-2.336	vis	0.5	Kukarkin (1940)

Table 16 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2425587.492	-5104	$-2^{d}.370$	vis	0.5	Zverev (1936)
2425934.028	-4994	-2.156	vis	0.5	Zverev (1936)
2425959.093	-4986	-2.278	vis	0.5	Terkán (1935)
2426119.843	-4935	-2.096	vis	0.5	Kukarkin (1940)
2426324.450	-4870	-2.133	vis	0.5	Zverev (1936)
2426440.993	-4833	-2.080	vis	0.5	Terkán (1935)
2426705.583	-4749	-1.954	vis	0.5	Kukarkin (1940)
2426781.131	-4725	-1.967	vis	0.5	Zverev (1936)
2426894.594	-4689	-1.846	phg	1	Kox (1935)
2429363.229	-3905	-1.541	phg	0.5	Koshkina (1963)
2432852.379	-2797	-0.796	phel	2	Eggen (1951)
2432858.695	-2795	-0.777	phg	0.5	Satyvaldiev (1970)
2433283.87	-2660	-0.63	vis	0.5	Pohl[1] (1950)
2433819.217	-2490	-0.511	phg	0.5	Koshkina (1963)
2434628.57	-2233	-0.29	vis	0.5	Marks[2] (1959)
2434776.562	-2186	-0.267	phg	1	Satyvaldiev (1970)
2435082.12	-2089	-0.11	vis	0.5	Marks (1959)
2435478.719	-1963	-0.205	vis	0.5	Azarnova (1957)
2435541.659	-1943	-0.233	phel	1	Walraven et al. (1958)
2435840.877	-1848	-0.111	vis	0.5	Azarnova (1960)
2435878.569	-1836	-0.199	phg	0.5	Satyvaldiev (1970)
2436162.052	-1746	-0.071	vis	0.5	Latyshev (1969)
2436206.061	-1732	-0.139	vis	0.5	Azarnova (1960)
2436574.589	-1615	+0.029	vis	0.5	Azarnova (1960)
2436766.632	-1554	+0.021	phg	0.5	Satyvaldiev (1970)
2437619.809	-1283	-0.013	phel	3	Mitchell et al. (1964)
2437962.988	-1174	-0.008	phel	1	Williams (1966)
2437969.481	-1172	+0.188	phg	0.5	Satyvaldiev (1970)
2438378.857	-1042	+0.275	phg	0.5	Satyvaldiev (1970)
2438529.659	-994	-0.045	phel	3	Wisniewski et al.(1968)
2439055.461	-827	-0.023	phel	3	Milone (1970)
2439077.600	-820	+0.078	phel	3	Wamsteker (1972)
2439807.965	-588	+0.018	phel	3	present paper[3]
2441659.204	0	+0.010	phel	3	present paper

Remarks: [1] Observer: Mielke; [2] Obs.: Wroblewski; [3] Obs.:Abaffy.

DQ Andromedae

This cepheid has not previously been observed photoelectrically. The presence of a bump on the descending branch $0^{p}.3$ after the maximum can be suspected on the first photoelectric light curve (see Fig. 26). Classical cepheids with such a short period do not show bumps on their light curves. Moreover, the galactic latitude of DQ And is -18^{o}. These two facts give reason to classify this cepheid as a Population II variable.

The O-C residuals have been computed with the formula:

$$C = 2441994.943 + 3^{d}.200557E\ .$$

DQ And has a constant period during 8000 cycles (see Fig. 27).

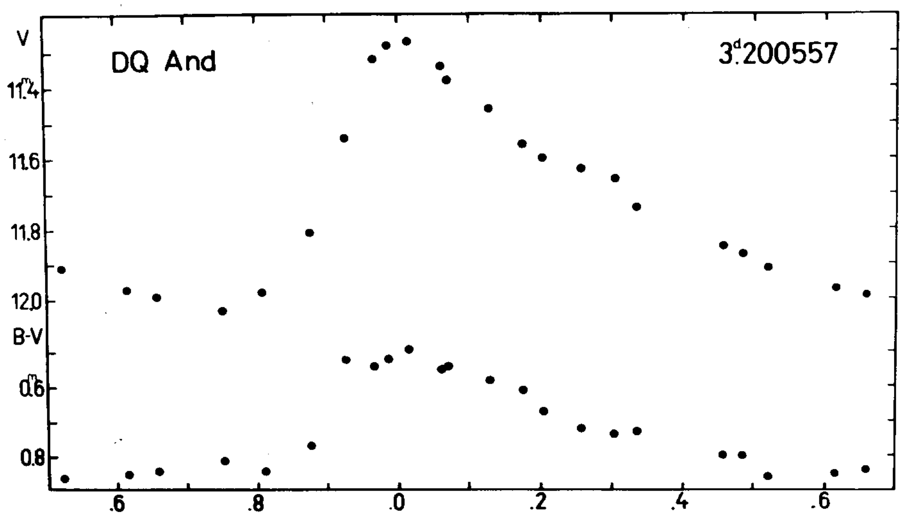

Figure 26 V and B-V curves of DQ And

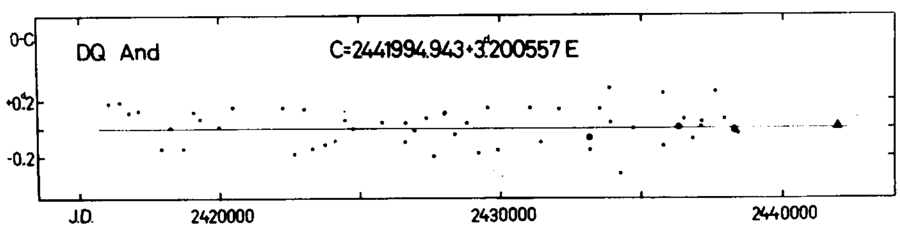

Figure 27 O-C diagram of DQ And

Table 17 O-C residuals for DQ And

Obs.Max.J.D.	E	O-C (d)	Type	w	Source
2416038.600	-8110	+0.174	phg	0.5	Strohmeier et al.(1968)
2416438.681	-7985	+0.186	phg	0.5	Strohmeier et al.(1968)
2416761.865	-7884	+0.113	phg	0.5	Strohmeier et al.(1968)
2417104.340	-7777	+0.129	phg	0.5	Strohmeier et al.(1968)
2417910.609	-7525	-0.143	phg	0.5	Strohmeier et al.(1968)
2418214.807	-7430	+0.003	phg	0.5	Strohmeier et al.(1968)
2418691.542	-7281	-0.145	phg	0.5	Strohmeier et al.(1968)
2419053.468	-7168	+0.118	phg	0.5	Strohmeier et al.(1968)
2419306.261	-7089	+0.067	phg	0.5	Strohmeier et al.(1968)
2419987.914	-6876	+0.001	phg	0.5	Strohmeier et al.(1968)
2420468.147	-6726	+0.150	phg	0.5	Strohmeier et al.(1968)
2422257.255	-6167	+0.147	phg	0.5	Strohmeier et al.(1968)
2422666.599	-6039	-0.180	phg	0.5	Strohmeier et al.(1968)
2423044.580	-5921	+0.135	phg	0.5	Strohmeier et al.(1968)
2423322.750	-5834	-0.143	phg	0.5	Strohmeier et al.(1968)

Table 17 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2423758.055	-5698	$-0\overset{d}{.}114$	phg	0.5	Strohmeier et al.(1968)
2424788.747	-5376	-0.002	phg	0.5	Strohmeier et al.(1968)
2425825.770	-5052	+0.041	phg	0.5	Strohmeier et al.(1968)
2426651.375	-4794	-0.098	phg	0.5	Strohmeier et al.(1963)
2426654.712	-4793	+0.039	phg	0.5	Strohmeier et al.(1968)
2426987.516	-4689	-0.015	phg	0.5	Strohmeier et al.(1963)
2427397.279	-4561	+0.076	phg	0.5	Strohmeier et al.(1963)
2427665.853	-4477	-0.196	phg	0.5	Strohmeier et al.(1968)
2428043.819	-4359	+0.104	phg	0.5	Strohmeier et al.(1968)
2428069.427	-4351	+0.108	phg	0.5	Strohmeier et al.(1963)
2428408.537	-4245	-0.042	phg	0.5	Strohmeier et al.(1963)
2428818.289	-4117	+0.039	phg	0.5	Strohmeier et al.(1968)
2429240.546	-3985	-0.177	phg	0.5	Strohmeier et al.(1968)
2429567.324	-3883	+0.144	phg	0.5	Strohmeier et al.(1968)
2429912.686	-3775	-0.154	phg	0.5	Strohmeier et al.(1968)
2430641.964	-3547	-0.603	vis	0	Tsessevitsch (1957)
2431055.586	-3418	+0.147	phg	0.5	Strohmeier et al.(1968)
2431439.406	-3298	-0.100	phg	0.5	Strohmeier et al.(1968)
2432092.556	-3094	+0.136	phg	0.5	Strohmeier et al.(1963)
2433177.339	-2755	-0.069	phg	2	Satyvaldiev (1970)
2433183.656	-2753	-0.154	phg	0.5	Strohmeier et al.(1968)
2433532.810	-2644	+0.140	phg	0.5	Strohmeier et al.(1968)
2433865.814	-2540	+0.286	phg	0.5	Strohmeier et al.(1968)
2433926.387	-2521	+0.038	phg	0.5	Strohmeier et al.(1963)
2434252.475	-2419	-0.321	phg	0.5	Strohmeier et al.(1963)
2434707.274	-2277	-0.001	phg	0.5	Strohmeier et al.(1963)
2435766.931	-1946	+0.272	phg	0.5	Wenzel, Ziegler (1965)
2435779.332	-1942	-0.129	phg	0.5	Strohmeier et al.(1963)
2436320.362	-1773	+0.007	phg	2	Satyvaldiev (1970)
2436509.252	-1714	+0.064	phg	0.5	Wenzel, Ziegler (1965)
2436825.965	-1615	-0.078	phg	0.5	Wenzel, Ziegler (1965)
2437232.522	-1488	+0.008	phg	0.5	Wenzel, Ziegler (1965)
2437245.363	-1484	+0.047	phg	0.5	Strohmeier et al.(1963)
2437610.445	-1370	+0.265	phg	0.5	Wenzel, Ziegler (1965)
2437933.503	-1269	+0.067	phg	0.5	Wenzel, Ziegler (1965)
2438295.081	-1156	-0.018	phg	2	Satyvaldiev (1970)
2438295.102	-1156	+0.003	phg	0.5	Wenzel, Ziegler (1965)
2438432.689	-1113	-0.034	phg	0.5	Wenzel, Ziegler (1965)
2441994.950	0	+0.007	phel	3	present paper

BY Cassiopeiae

BY Cas is a cepheid with small amplitude (see Fig. 28). Its period shows large variations. As can be seen from Fig. 29, the period of BY Cas has had the following values:

between J.D. 2417000 and J.D. 2426900 there was a change in the period, but both the time of the change and the value of the period in this interval are unknown;

between J.D. 2426900 and J.D. 2434300, $P = 3\overset{d}{.}221297$;

between J.D. 2434300 and J.D. 2439400, $P = 3\overset{d}{.}222588$;

after J.D. 2439400, $P = 3^{d}.223316$.

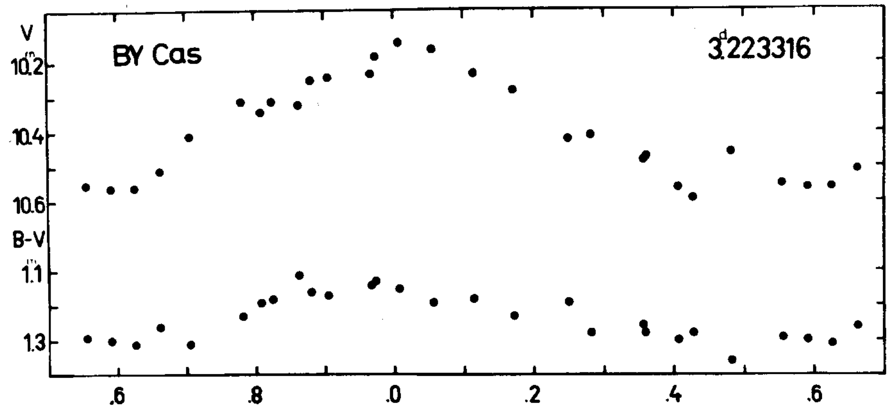

Figure 28 V and B-V curves of BY Cas

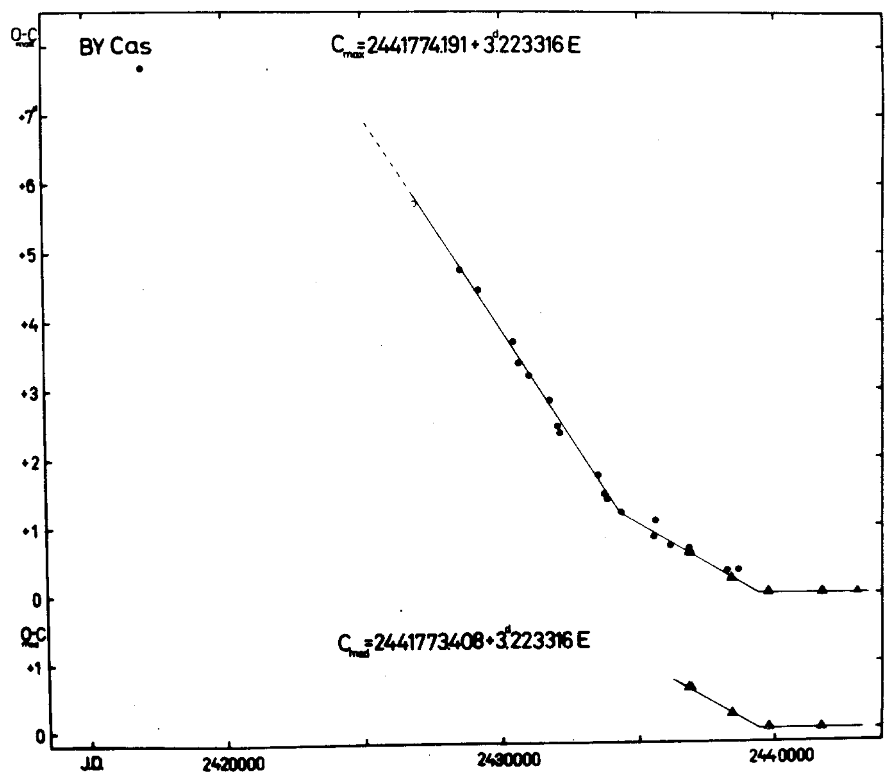

Figure 29 O-C diagram of BY Cas

The O-C residuals have been computed with the formulae:

$$C_{max} = 2441774.191 + 3^{d}.223316E \ ;$$
$$C_{med} = 2441773.408 + 3^{d}.223316E \ .$$

Table 18 O-C residuals for BY Cas

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2417068.714		-7667	$+7^{d}.687$		phg	1	Kukarkina (1954a)
2426933.30		-4606	+5.70		vis	1	Lange (1933)
2428563.344		-4100	+4.749		phg	1	Parenago (1939b)
2429223.824		-3895	+4.449		phg	1	Kukarkina (1954a)
2430480.163		-3505	+3.695		phg	1	Satyvaldiev (1970)
2430650.693		-3452	+3.389		phg	1	Dirks, Vaucouleurs (1949)
2431014.735		-3339	+3.196		phg	1	Satyvaldiev (1970)
2431781.53		-3101	+2.84		phg	1	Ashbrook (1954)
2432048.696		-3018	+2.473		phg	1	Dirks, Vaucouleurs (1949)
2432132.390		-2992	+2.360		phg	1	Satyvaldiev (1970)
2433524.24		-2560	+1.74		phg	1	Satyvaldiev (1970)
2433736.708		-2494	+1.467		phg	1	Kukarkina (1954a)
2433878.46		-2450	+1.39		phg	1	Ashbrook (1954)
2434361.768		-2300	+1.204		phg	1	Kheilo (1962)
2435557.258		-1929	+0.844		phg	1	Kheilo (1962)
2435615.515		-1911	+1.081		phg	1	Satyvaldiev (1970)
2436143.784		-1747	+0.716		phg	1	Kheilo (1962)
2436820.545	2436819.781	-1537	+0.591	$+0^{d}.610$	phel	3	Oosterhoff (1960)
2436827.004	2436826.233	-1535	+0.603	+0.615	phel	3	Weaver et al. (1960)
2436843.175		-1530	+0.657		phg	1	Kheilo (1962)
2436910.801	2436910.027	-1509	+0.594	+0.603	phel	3	Bahner et al. (1962)
2438248.220		-1094	+0.337		phg	1	Satyvaldiev (1970)
2438409.256	2438408.479	-1044	+0.207	+0.213	phel	3	Malik (1965)
2438660.818		-966	+0.350		phg	1	Satyvaldiev (1970)
2439785.406	2439784.636	-617	+0.001	+0.014	phel	3	present paper[1]
2441774.189	2441773.395	0	-0.002	-0.013	phel	3	present paper
2443079.635		+405	+0.001		phel	2	present paper

Remark: [1] Observer: Abaffy

V 532 Cygni

This small amplitude cepheid is suspected as having a blue photometric companion (Madore 1977). Its light and colour curves and O-C diagram are shown in Figs. 30 and 31, respectively. The

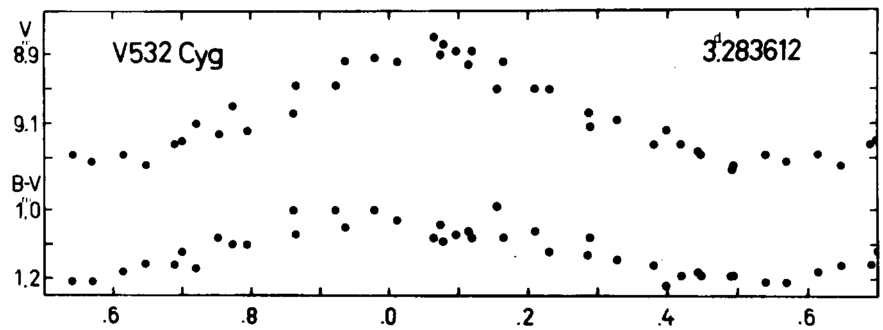

Figure 30 V and B-V curves of V 532 Cyg

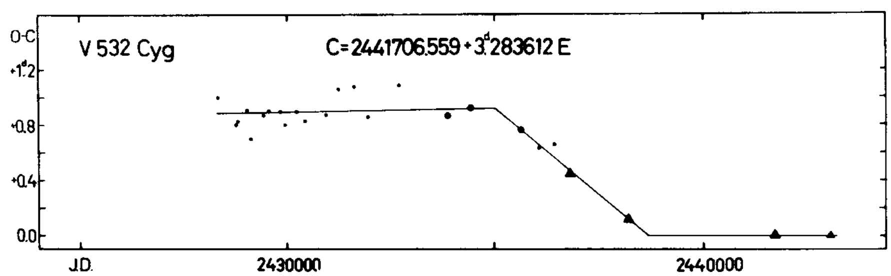

Figure 31 O-C diagram of V 532 Cyg

O-C residuals have been calculated with the elements:

$$C = 2441706.559 + 3^{d}.283612E .$$

The following values of the period are valid in the different time intervals:

between J.D. 2428000 and J.D. 2435000, $P = 3^{d}.283651$;
between J.D. 2435000 and J.D. 2438700, $P = 3^{d}.282792$;
after J.D. 2438700, $P = 3^{d}.283612$.

The structure of this O-C diagram resembles that of SZ Tauri, i.e. the period has returned to its earlier value.

Table 19 O-C residuals for V 532 Cyg

Obs.Max.J.D.	E	O-C	Type	w	Source
2428343.3	-4070	$+1^{d}.0$	phg	0.5	Ahnert (1949)
2428779.8	-3937	+0.8	phg	0.5	Ahnert (1949)
2428832.342	-3921	+0.826	phg	0.5	Ishchenko (1950)

Table 19 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2429058.993	-3852	$+0^{d}.907$	phg	0.5	Ishchenko (1950)
2429140.9	-3827	+0.7	phg	0.5	Ahnert (1949)
2429452.989	-3732	+0.870	phg	0.5	Ishchenko (1950)
2429571.2	-3696	+0.9	phg	0.5	Ahnert (1949)
2429860.182	-3608	+0.895	phg	0.5	Ishchenko (1950)
2429984.9	-3570	+0.8	phg	0.5	Ahnert (1949)
2430260.8	-3486	+0.9	phg	0.5	Ahnert (1949)
2430447.883	-3429	+0.830	phg	0.5	Filin (1951)
2430956.887	-3274	+0.874	phg	0.5	Filin (1951)
2431265.733	-3180	+1.060	phg	0.5	Filin (1951)
2431643.365	-3065	+1.077	phg	0.5	Filin (1951)
2431991.211	-2959	+0.860	phg	0.5	Filin (1951)
2432710.549	-2740	+1.087	phg	0.5	Filin (1951)
2433889.147	-2381	+0.868	phg	1	Shteiman (1958)
2434434.284	-2215	+0.926	phg	1	Shteiman (1958)
2435642.491	-1847	+0.763	phg	1	Shteiman (1958)
2436092.219	-1710	+0.637	phg	0.5	Korovkina (1958)
2436443.59	-1603	+0.66	phg	0.5	Korovkina (1959)
2436817.703	-1489	+0.442	phel	3	Oosterhoff (1960)
2438229.332	-1059	+0.118	phel	3	Kwee and Braun (1967)
2441706.559	0	0.000	phel	3	present paper
2443026.571	+402	0.000	phel	2	present paper

V 1334 Cygni

This cepheid is a component of a visual binary (Millis 1969). The nonvariable component of this binary system reduces the observable amplitude of the cepheid. Figure 32 shows that the light and colour amplitudes of V 1334 Cyg are extremely low for a cepheid variable. The O-C residuals have been computed with the formula:

$$C = 2441760.900 + 3^{d}.333020E \; .$$

These residuals are not plotted in a diagram.

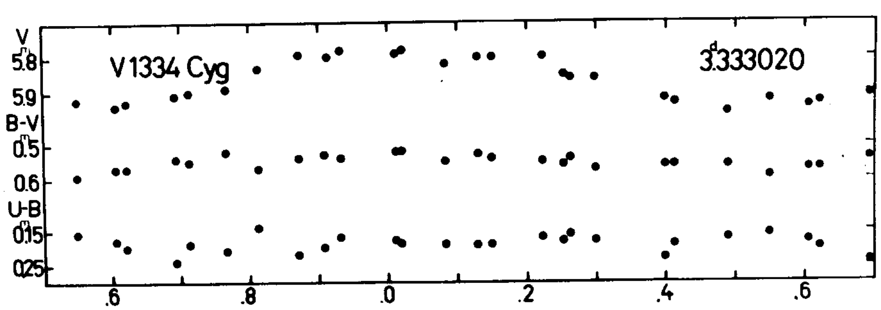

Figure 32 V, B-V and U-B curves of V 1334 Cyg

Table 20 O-C residuals for V 1334 Cyg

Obs.Max.J.D.	E	O-C	Type	w	Source
2440117.721	-493	$0^d.000$	phel	3	Millis (1969)
2441760.900	0	0.000	phel	3	present paper

BD Cassiopeiae

BD Cas is a cepheid with small amplitude. There is a bump on its light curve just after the minimum (see Fig. 33). Therefore it has been classified as a Population II variable.

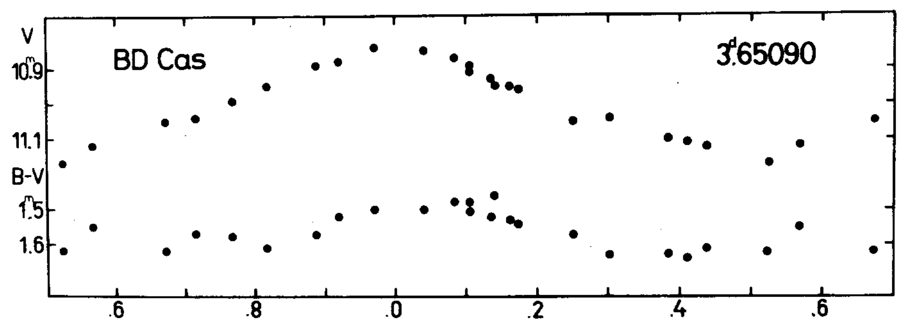

Figure 33 V and B-V curves of BD Cas

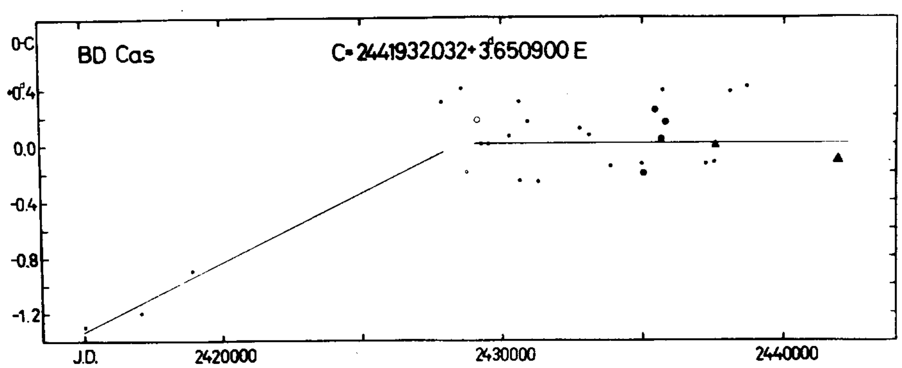

Figure 34 O-C diagram of BD Cas

The O-C residuals have been calculated with the formula:

$$C = 2441932.032 + 3^d.650900E \ .$$

The O-C curve (Fig. 34) consists of two straight lines. The values of the period are as follows:

before J.D. 2429000, $P = 3^d.65126$;

after J.D. 2429000, $P = 3^d.650900$.

Table 21 O-C residuals for BD Cas

Obs.Max.J.D.	E	O-C	Type	w	Source
2415038.2	-7366	$-1^{d}.3$	phg	0.5	Parenago (1947)
2417064.6	-6811	-1.2	phg	0.5	Parenago (1947)
2418926.8	-6301	-0.9	phg	0.5	Parenago (1947)
2427883.7	-3848	+0.3	phg	0.5	Parenago (1947)
2428573.8	-3659	+0.4	phg	0.5	Parenago (1947)
2428759.4	-3608	-0.2	vis	0.5	Zverev (1938)
2429124.84	-3508	+0.17	vis	1	Zverev (1938)
2429285.3	-3464	0.0	phg	0.5	Parenago (1947)
2429548.2	-3392	0.0	phg	0.5	Parenago (1947)
2430260.16	-3197	+0.06	phg	0.5	Vasil'yan. et al.(1970)
2430614.5	-3100	+0.3	phg	0.5	Parenago (1947)
2430643.19	-3092	-0.26	phg	0.5	Vasil'yan. et al.(1970)
2430939.33	-3011	+0.16	phg	0.5	Vasil'yan. et al.(1970)
2431300.34	-2912	-0.27	phg	0.5	Vasil'yan. et al.(1970)
2432768.38	-2510	+0.11	phg	0.5	Vasil'yan. et al.(1970)
2433118.82	-2414	+0.06	phg	0.5	Vasil'yan. et al.(1970)
2433863.38	-2210	-0.16	phg	0.5	Vasil'yan. et al.(1970)
2434962.32	-1909	-0.14	phg	0.5	Vasil'yan. et al.(1970)
2435042.57	-1887	-0.21	phg	1	Romano (1959)
2435430.02	-1781	+0.24	phg	1	Romano (1959)
2435670.77	-1715	+0.03	phg	1	Romano (1959)
2435700.33	-1707	+0.38	phg	0.5	Vasil'yan. et al.(1970)
2435835.18	-1670	+0.15	phg	1	Zonn, Semeniuk (1959)
2437211.28	-1293	-0.14	phg	0.5	Vasil'yan. et al.(1970)
2437525.27	-1207	-0.13	phg	0.5	Vasil'yan. et al.(1970)
2437572.843	-1194	-0.014	phel	1	Mitchell et al. (1964)
2438055.15	-1062	+0.37	phg	0.5	Vasil'yan. et al.(1970)
2438650.28	-899	+0.41	phg	0.5	Vasil'yan. et al.(1970)
2441931.916	0	-0.116	phel	3	present paper

RT Aurigae

Very many photoelectric observational series have been carried out on this star. The sets of photoelectric observations made in the UBV system do not verify the statement of the 3rd Supplement to the GCVS (Kukarkin et al. 1976), according to which the amplitude in V varies between $0^{m}.73$ and $0^{m}.85$. As Table 22 shows, A_V varies between $0^{m}.76$ and $0^{m}.83$, whereas A_B between $1^{m}.10$ and $1^{m}.19$. However, these amplitude variations are not real. The light curves with extreme values of the amplitude are rather uncertain around the maximum. For example, the maximum amplitude is based upon a single observation of the light curve observed by Winzer (1973). The well observed light curves (Wisniewski and Johnson 1968, and the present paper) have almost the same values for the amplitudes. Moreover, the variation in the amplitudes does not show any systematic trend.

Table 23 O-C residuals for RT Aur

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2414000.60		-7436	$-0^{d}.25$		vis	1	Müller, Kempf (1899)
2416938.466		-6648	-0.202		vis	0.5	Astbury (1905)
2416942.3		-6647	-0.1		vis	0.5	Williams (1905a)
2417643.048		-6459	-0.248		vis	0.5	Zeipel (1908)
2417788.484	2417788.100	-6420	-0.211	$-0^{d}.167$	vis	1	Wendell (1913)
2417889.20		-6393	-0.16		vis	1	Kukarkin[1] (1931a)
2418015.92		-6359	-0.19		vis	1	Kukarkin[1] (1931a)
2418344.03		-6271	-0.17		vis	1	Kukarkin[1] (1931a)
2418739.18		-6165	-0.20		vis	1	Kukarkin[1] (1931a)
2418921.974		-6116	-0.091		phg	0.5	Robinson (1930)
2419044.99		-6083	-0.105		vis	0.5	Kukarkin[1] (1931a)
2419421.48		-5982	-0.16		vis	1	Hornig (1915)
2419451.27		-5974	-0.20		vis	1	Kukarkin[1] (1931a)
2419689.908	2419689.502	-5910	-0.164	-0.142	vis	1	Lacchini (1921)
2419813.015	2419812.627	-5877	-0.087	-0.047	vis	0.5	Nijland (1923)
2419824.13		-5874	-0.16		vis	1	Kukarkin[1] (1931a)
2419902.26		-5853	-0.32		vis	0.5	Kaiser (1922)
2420129.921	2420129.425	-5792	-0.078	-0.146	vis	1	Nijland (1923)
2420133.623		-5791	-0.104		vis	0.5	Hoffmeister (1915)
2420375.871	2420375.528	-5726	-0.188	-0.103	phg	2	Kiess (1915)
2420495.43		-5694	+0.07		vis	0	Kukarkin[1] (1931a)
2420502.691	2420502.266	-5692	-0.127	-0.124	vis	1	Nijland (1923)
2420972.434	2420972.042	-5566	-0.135	-0.100	vis	1	Nijland (1923)
2420991.000	2420990.680	-5561	-0.210	-0.102	vis	1	Luyten (1922)
2421475.879	2421475.417	-5431	+0.004	-0.030	vis	0.5	Lacchini (1921)
2421565.231	2421564.925	-5407	-0.121	+0.001	vis	1	Luyten (1922)
2422728.38		-5095	-0.17		vis	0.5	Viaro (1921)
2422739.73		-5092	0.00		vis	0.5	Kukarkin[2] (1931a)
2423112.38		-4992	-0.17		vis	0.5	Kukarkin[1] (1931a)
2423239.209		-4958	-0.100		vis	0.5	Strömgren[3] (1928)
2423272.767	2423272.331	-4949	-0.096	-0.104	vis	1	Hellerich (1934)
2423351.18		-4928	+0.03		vis	1	Kukarkin[4] (1931a)
2423791.110		-4810	+0.029		vis	0.5	Hopmann (1926b)
2423999.770	2423999.360	-4754	-0.090	-0.072	vis	1	Hellerich (1934)

Table 23 (cont.)

Obs.Max.J.D.	Obs.Med.J.D.	E	$(O-C)_{max}$	$(O-C)_{med}$	Type	w	Source
2424361.434	2424360.957	-4657	$-0^d.060$	$-0^d.109$	phg	1	Kowalczewsky (1931)
2424741.657	2424741.243	-4555	-0.113	-0.099	vis	1	Kukarkin (1940)
2425155.509	2425155.114	-4444	-0.090	-0.057	phg	2	Hellerich (1935)
2425293.462	2425293.000	-4407	-0.080	-0.114	vis	1	Kukarkin (1940)
2425535.844	2425535.475	-4342	-0.030	+0.029	vis	1	Zverev (1936)
2425744.619	2425744.198	-4286	-0.034	-0.027	vis	1	Kukarkin (1940)
2425990.618		-4220	-0.095		vis	0.5	Kukarkin[5] (1934)
2426232.946	2426232.551	-4155	-0.100	-0.067	vis	1	Zverev (1936)
2426400.773		-4110	-0.041		vis	1	Mergentaler (1941)
2426467.859		-4092	-0.063		vis	1	Nielsen (1939)
2426475.364		-4090	-0.014		vis	1	Kowalczewsky[6] (1931)
2426520.023	2426519.542	-4078	-0.093	-0.146	vis	0.5	Kukarkin (1940)
2426587.221	2426586.818	-4060	-0.004	+0.022	vis	1	Dufay (1947b)
2426911.538	2426911.169	-3973	-0.038	+0.021	phg	2	Grouillier (1947)
2427325.424	2427325.017	-3862	+0.019	+0.040	vis	1	Dufay (1947b)
2427452.125	2427451.752	-3828	-0.039	+0.016	phg	2	Grouillier (1947)
2427687.013	2427686.633	-3765	-0.027	+0.021	vis	1	Krebs (1937b)
2428358.074	2428357.686	-3585	-0.040	0.000	vis	1	Krebs (1937b)
2429070.198	2429069.769	-3394	0.000	-0.001	phg	2	Opolski (1948)
	2429267.393	-3341		+0.029	phel	3	Bennett (1941)
2429603.272		-3251	-0.057		phel	3	Bennett (1941)
2433141.392	2433140.952	-2302	+0.010	-0.002	phel	3	Eggen et al. (1957)
2434539.42		-1927	-0.03		vis	0.5	Marks[7] (1959)
2435057.79		-1788	+0.12		vis	0.5	Marks (1959)
2435799.601	2435799.198	-1589	+0.020	+0.045	phel	3	Prokof'eva (1961)
2437339.350		-1176	+0.026		phel	3	Mitchell et al. (1964)
2437872.454		-1033	-0.001		vis	0.5	Tsai (1972)
2437995.423		-1000	-0.062		phel	2	Williams (1966)
2438920.047	2438919.618	-752	-0.029	-0.030	phel	3	Wisniewski, Johnson (1968)
2439359.960	2439359.505	-634	-0.043	-0.070	phel	3	Takase (1969)
2441429.115	2441428.757	-79	-0.033	+0.037	phel	3	Winzer (1973)
2441723.711	2441723.282	0	+0.036	+0.035	phel	3	present paper
2441761.14		+10	+0.18		vis	0.5	Small (1973)

Remarks: [1] Observer: Sharbe; [2] Obs.: Tsarevsky, Tsessevitsch, Selivanov; [3] Obs.: Johansen; [4] Obs.: Tsessevitsch; [5] Obs.: Zverev; [6] Obs.: Dziewulski, Iwanowska; [7] Obs.: Wroblewski.

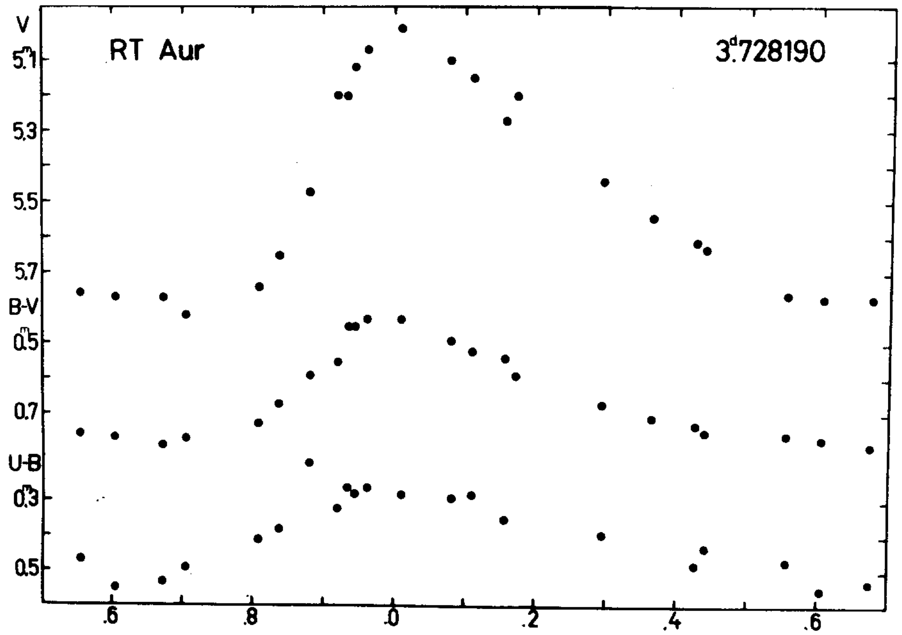

Figure 35 V, B-V and U-B curves of RT Aur

Table 22

Year	A_V	A_B	Source
1961	$0^m.77$:	$1^m.13$:	Mitchell et al. (1964)
1965	0.80	1.18	Wisniewski, Johnson (1968)
1966	0.76:	1.10:	Takase (1969)
1972	0.83:	1.19:	Winzer (1973)
1973	0.81	1.17	present paper

The light and colour curves based on the new observations are shown in Fig. 35. The small bump before the minimum light seems to be unreal. It appears in V light only, and the earlier photoelectric observations do not show such a bump at that phase. However, according to Winzer (1973), small fluctuations with amplitude of $0^m.02$ - $0^m.04$ may occur on the light curve.

The O-C residuals have been computed with the formulae:

$$C_{max} = 2441723.675 + 3^d.728190E \; ;$$
$$C_{med} = 2441723.247 + 3^d.728190E \; .$$

As the O-C diagram (Fig. 36) shows, the period has changed on one occasion:

before J.D. 2430000, $P = 3^d.728243$;

after J.D. 2430000, $P = 3^d.728190$.

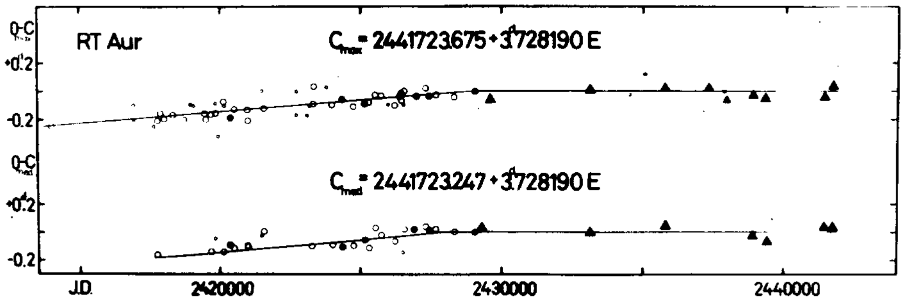

Figure 36 O-C diagram of RT Aur

V 572 Aquilae

According to the 2nd Supplement to the GCVS (Kukarkin et al. 1974) its period and form of the light curve vary. However, the present observations have shown (see Fig. 37) that the light curve is stable and very similar to earlier published ones if the observations are plotted with the correct period. Though the present observations were made in two colours, the U-B colour curve of V 572 Aql is available from the observations made by Oosterhoff (1960). The phase relation between the minimum values of U-B and B-V colour indices and the relatively large distance of this variable from the galactic plane ($b = -15^{\circ}.5$) give reason to classify V 572 Aql as a Population II cepheid.

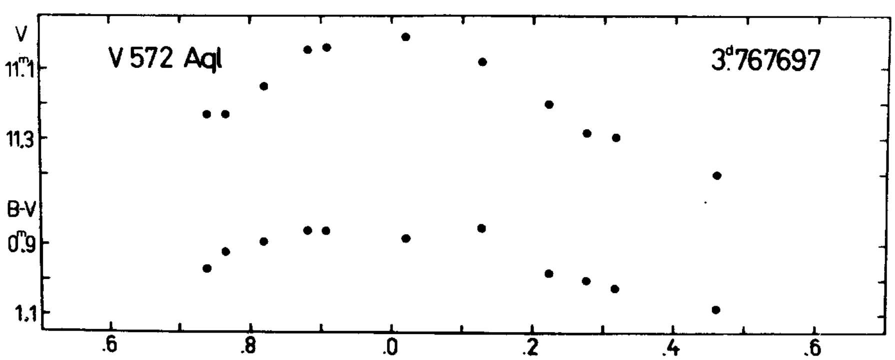

Figure 37 V and B-V curves of V 572 Aql

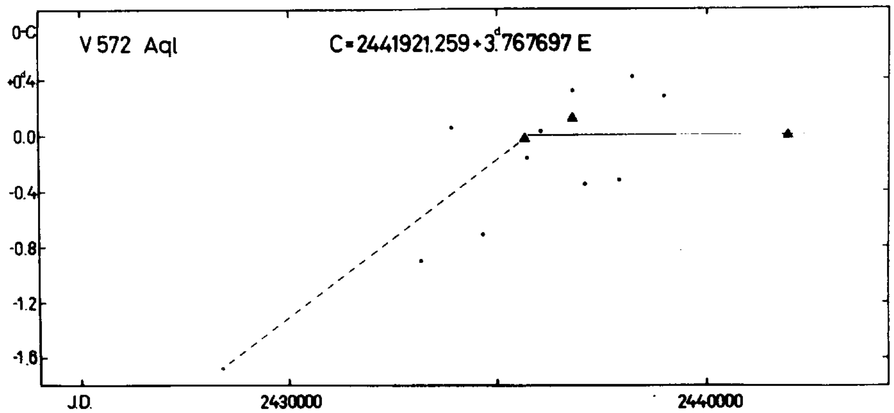

Figure 38 O-C diagram of V 572 Aql

The O-C residuals have been calculated with the formula:

$$C = 2441921.259 + 3\overset{d}{.}767697E \ .$$

For the time before J.D. 2435500 the value of the period is rather uncertain (about $3\overset{d}{.}7686$). After J.D. 2435500 the period is $3\overset{d}{.}767697$ (see Fig. 38).

Table 24 O-C residuals for V 572 Aql

Obs.Max.J.D.	E	O-C	Type	w	Source
2428397.31	-3589	$-1\overset{d}{.}68$	vis	0.5	Solov'yov (1944)
2433171.77	-2322	-0.90	phg	0.5	Vasil'yan. et al.[1] (1970)
2433911.20	-2126	+0.06	phg	0.5	Vasil'yan. et al.[1] (1970)
2434660.20	-1927	-0.71	phg	0.5	Vasil'yan. et al.[1] (1970)
2435666.856	-1660	-0.026	phel	3	Walraven et al. (1958)
2435723.24	-1645	-0.16	phg	0.5	Vasil'yan. et al.[1] (1970)
2436036.15	-1562	+0.03	phg	0.5	Vasil'yan. et al.[1] (1970)
2436398.33	-1466	+0.51	phg	0	Vasil'yan. et al.[1] (1970)
2436789.776	-1362	+0.120	phel	3	Oosterhoff (1960)
2436801.28	-1359	+0.32	phg	0.5	Vasil'yan. et al.[1] (1970)
2437079.42	-1285	-0.35	phg	0.5	Vasil'yan. et al.[1] (1970)
2437908.34	-1065	-0.32	phg	0.5	Vasil'yan. et al.[1] (1970)
2438229.34	-980	+0.42	phg	0.5	Vasil'yan. et al.[1] (1970)
2438971.43	-783	+0.28	phg	0.5	Vasil'yan. et al.[1] (1970)
2441921.259	0	0.000	phel	3	present paper

Remark: [1] Observer: Satyvaldiev

AD Geminorum

The light and colour curves of this variable are shown in Fig. 39. The O-C residuals have been calculated with the formula:

$$C = 2441694.911 + 3\overset{d}{.}787980E \ .$$

The period has remained constant since the discovery of the light variation of AD Gem (see Fig. 40).

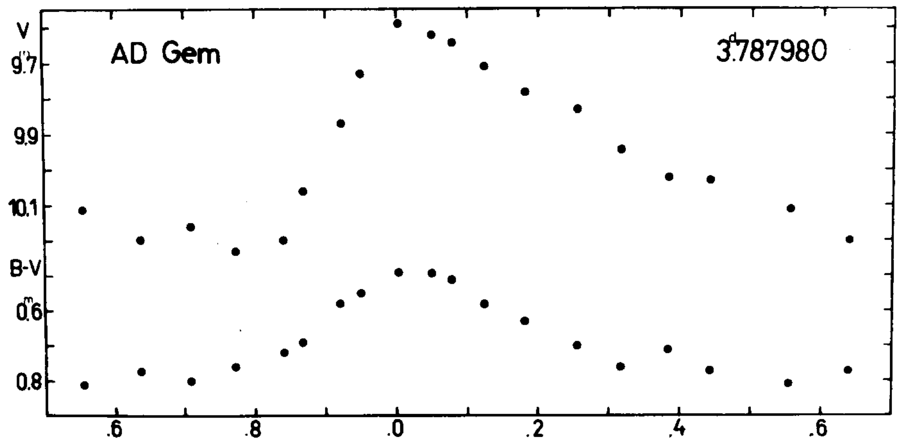

Figure 39 V and B-V curves of AD Gem

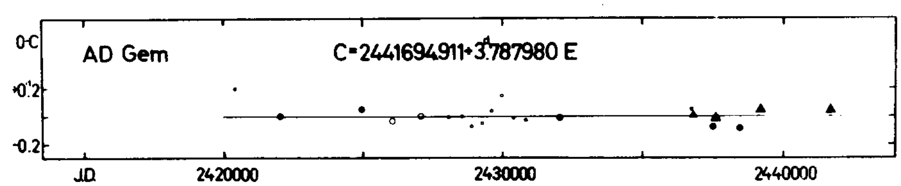

Figure 40 O-C diagram of AD Gem

Table 25 O-C residuals for AD Gem

Obs.Max.J.D.	E	O-C	Type	w	Source
2420410.450	-5619	+0.199	phg	0.5	Kukarkin (1930b)
2422031.507	-5191	0.000	phg	1	Kukarkina (1954b)
2424963.453	-4417	+0.050	phg	1	Prager (1929)
2426065.669	-4126	-0.037	vis	1	Beyer (1934a)
2427084.676	-3857	+0.004	vis	1	Beyer (1934a)
2428065.750	-3598	-0.009	vis	0.5	Martynov (1951)
2428558.196	-3468	0.000	vis	0.5	Martynov (1951)
2428899.045	-3378	-0.070	vis	0.5	Martynov (1951)
2429274.075	-3279	-0.050	vis	0.5	Martynov (1951)
2429611.295	-3190	+0.040	vis	0.5	Martynov (1951)
2429993.989	-3089	+0.148	vis	0.5	Martynov (1951)
2430395.357	-2983	-0.010	vis	0.5	Martynov (1951)
2430853.685	-2862	-0.027	vis	0.5	Martynov (1951)
2432081.011	-2538	-0.007	phg	1	Kukarkina (1954b)

Table 25 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2436778.167	-1298	$+0\overset{d}{.}054$	phg	0.5	Huth (1963a)
2436834.942	-1283	+0.009	phel	2	Weaver et al. (1960)
2437524.267	-1101	-0.078	phg	1	Fridel' (1971)
2437630.387	-1073	-0.021	phel	3	Mitchell et al. (1964)
2438475.042	-850	-0.086	phg	1	Fridel' (1971)
2439202.459	-658	+0.039	phel	3	Takase (1969)
2441694.948	0	+0.037	phel	3	present paper

<u>DF Cassiopeiae</u>

The light and colour curves of DF Cas are shown in Fig. 41. The O-C residuals have been computed with the formula:

$$C = 2441719.622 + 3\overset{d}{.}832472E \ .$$

The O-C diagram (Fig. 42) can be represented by a straight line, i.e. the period is constant.

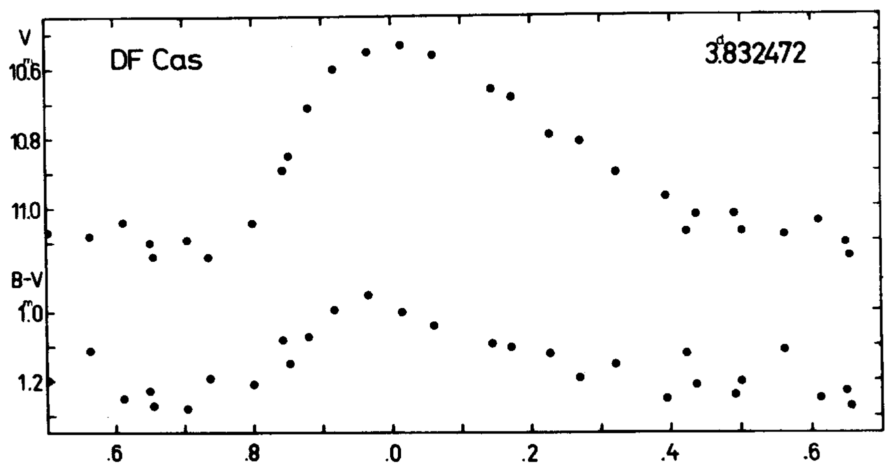

Figure 41 V and B-V curves of DF Cas

Table 26 O-C residuals for DF Cas

Obs.Max.J.D.	E	O-C	Type	w	Source
2417648.066	-6281	$+0\overset{d}{.}201$	phg	1	Perova (1954)
2428562.672	-3433	-0.074	phg	1	Meshkova (1940)
2428873.207	-3352	+0.031	phg	1	Perova (1954)
2432019.605	-2531	-0.030	phg	1	Perova (1954)
2433774.741	-2073	-0.167	phg	1	Perova (1954)
2434299.952	-1936	-0.004	phg	1	Perova (1954)
2436905.985	-1256	-0.052	phel	3	Bahner et al. (1962)
2437630.389	-1067	+0.015	phel	2	Mitchell et al. (1964)
2441719.659	0	+0.037	phel	3	present paper
2443149.118	+373	-0.016	phel	2	present paper

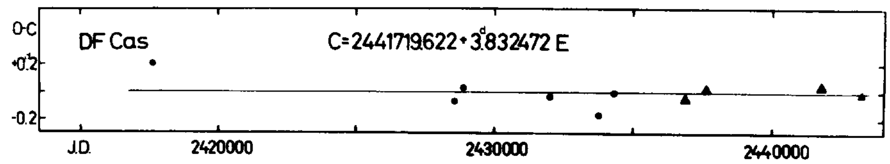

Figure 42 O-C diagram of DF Cas

SU Cygni

Its light and colour curves are typical of classical cepheids (see Fig. 43), nevertheless Kolesnik and Kheilo (1970) doubted this classification. According to Madore (1977), SU Cyg has a blue photometric companion.

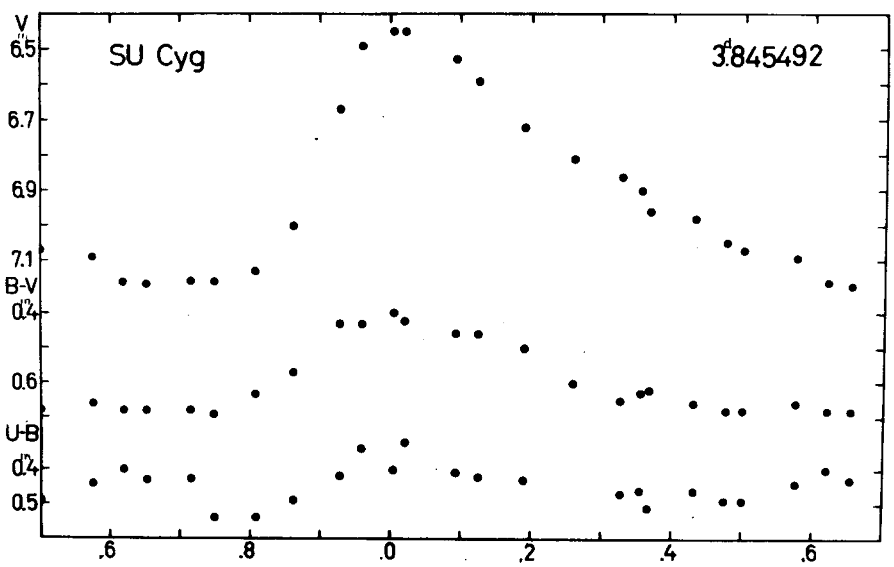

Figure 43 V, B-V and U-B curves of SU Cyg

The O-C residuals have been computed with the formulae:

$$C_{max} = 2441778.935 + 3\overset{d}{.}845492E \ ;$$

$$C_{med} = 2441778.589 + 3\overset{d}{.}845492E \ .$$

As Fig. 44 shows, a sudden period change took place at about J.D. 2430000 . After a short time the value of the period returned to its original. This phenomenon is similar to that mentioned for DT Cyg, SZ Tau and V 532 Cyg. This "rejumping" period is even more interesting because the O-C diagram for the median brightness could be also constructed. This latter O-C diagram

Table 27 O-C residuals for SU Cyg

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2414256.621		-7157	$-0^{d}.128$		vis	1	Müller, Kempf (1897)
2414441.3		-7109	0.0		vis	0.5	Müller, Hartwig[1] (1920)
2414491.161		-7096	-0.163		vis	1	Zinner[1] (1932)
2414564.221		-7077	-0.167		vis	1	Luizet (1899)
2414591.118	2414590.722	-7070	-0.189	$-0^{d}.239$	vis	1	Wendell (1913)
2414864.138		-6999	-0.198		vis	1	Prittwitz (1901)
2414906.20		-6988	-0.44		vis	0	Yendell (1900)
2414986.89		-6967	-0.50		vis	0	Yendell[2] (1902b)
2415079.481		-6943	-0.203		vis	1	Zinner[1] (1932)
2415236.85		-6902	-0.50		vis	0	Yendell (1902a)
2415606.573		-6806	+0.057		vis	0	Luizet (1907)
2415663.71		-6791	-0.39		vis	0	Yendell (1902a)
2415748.613		-6769	-0.187		vis	0.5	Zinner[1] (1932)
2415940.97		-6719	-0.10		vis	0.5	Yendell (1905)
2415956.4		-6715	-0.10		vis	0.5	Müller, Hartwig[1] (1920)
2415968.020		-6712	+0.027		vis	0.5	Luizet (1907)
2416337.155		-6616	-0.005		vis	0.5	Luizet (1907)
2416690.815		-6524	-0.130		vis	0.5	Luizet (1907)
2416848.454		-6483	-0.156		vis	1	Prittwitz (1907)
2417052.191	2417051.794	-6430	-0.230	-0.281	phg	2	Wilkens (1906)
2417079.313		-6423	-0.027		vis	0.5	Luizet (1907)
2417086.3		-6421	-0.7		vis	0	Maddrill (1906)
2417367.769		-6348	+0.017		vis	0.5	Luizet (1907)
2417829.048	2417828.641	-6228	-0.163	-0.224	vis	1	Zeipel (1908)
2417882.822		-6214	-0.226		vis	1	Van der Bilt (1925)
2418175.117		-6138	-0.188		vis	1	Van der Bilt (1925)
2418528.908		-6046	-0.182		vis	1	Van der Bilt (1925)
2419271.104		-5853	-0.166		vis	1	Van der Bilt (1925)
2421086.203		-5381	-0.140		vis	1	Luyten (1922)
2421278.435		-5331	-0.182		phg	0.5	Robinson (1931b)
2421443.751		-5288	-0.222		vis	1	Luyten (1922)
2421943.616		-5158	-0.271		vis	1	Luyten (1922)
2422582.072		-4992	-0.167		vis	0.5	Doberck (1925)
2423308.866		-4803	-0.171		vis	0.5	Doberck (1925)

Table 27 (cont.)

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2423320.515		-4800	$-0^{d}.058$		vis	1	Hellerich (1925)
2423658.842		-4712	-0.135		vis	0.5	Doberck (1925)
2423662.684		-4711	-0.138		vis	1	Hellerich (1925)
2424012.510		-4620	-0.252		vis	0.5	Parenago (1938)
2424028.020		-4616	-0.124		vis	1	Hellerich (1925)
	2424738.969	-4431		$-0^{d}.245$	vis	1	Moncibowitz[3] (1938)
2424816.453		-4411	-0.017		vis	0.5	Kukarkin (1940)
2425100.868	2425100.518	-4337	-0.168	-0.171	phg	2	Hellerich (1935)
	2425131.234	-4329		-0.220	vis	1	Moncibowitz[3] (1938)
2425147.039		-4325	-0.143		vis	0.5	Kukarkin (1940)
2425243.24		-4300	-0.08		vis	0.5	Lause (1938)
	2425323.499	-4279		-0.230	vis	1	Moncibowitz[3] (1938)
2425462.388		-4243	-0.124		vis	0.5	Kukarkin (1940)
2425696.940	2425696.552	-4182	-0.147	-0.189	vis	1	Zverev (1936)
2425804.661		-4154	-0.100		vis	0.5	Kukarkin (1940)
2425835.346		-4146	-0.179		vis	0.5	Parenago (1938)
2425904.749		-4128	+0.005		phg	0.5	Nassau, Townson (1932)
2426342.945		-4014	-0.185		vis	0.5	Kukarkin (1940)
2426423.739		-3993	-0.146		vis	1	Zverev (1936)
2426619.822		-3942	-0.184		vis	0.5	Kukarkin (1940)
2426908.262		-3867	-0.155		vis	0.5	Dziewulski et al. (1946)
2426923.669		-3863	-0.130		vis	1	Florya, Kukarkina (1953)
2427277.410	2427277.010	-3771	-0.175	-0.229	vis	1	Florya, Kukarkina (1953)
2427677.322	2427676.857	-3667	-0.194	-0.313	vis	1	Krebs (1935)
2427754.297		-3647	-0.129		vis	0.5	Dziewulski et al. (1946)
2427861.865		-3619	-0.234		vis	0.5	Miczaika (1937)
2428050.410		-3570	-0.119		vis	1	Krebs (1937a)
2428758.046		-3386	-0.053		phg	0.5	Dziewulski et al. (1946)
2429057.958		-3308	-0.089		phg	0.5	Kholopov (1947)
2429523.285		-3187	-0.067		vis	0.5	Remenchiz (1946)
2430238.647		-3001	+0.033		vis	0.5	Löchel[4] (1964)
2430588.687		-2910	+0.134		vis	0.5	Löchel[4] (1964)
2432861.300		-2319	+0.061		phg	0.5	Wachmann (1966)
2433126.659		-2250	+0.081		phel	3	Eggen (1951)
2433472.65		-2160	-0.02		vis	0.5	Domke, Pohl[5] (1952)

Table 27 (cont.)

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2433538.118		-2143	$+0^{d}.072$		phg	0.5	Wachmann (1966)
2433680.364		-2106	+0.035		phg	1	Tschuprina (1952)
2434328.02		-1938	+1.65		phg	0	Fu (1964)
2434368.640		-1927	-0.032		phg	1	Shteiman (1958)
2434591.666		-1869	-0.044		phel	2	present paper[6]
2434603.406		-1866	+0.159		phg	0.5	Wachmann (1966)
2434922.43		-1783	+0.01		vis	0.5	Marks (1959)
2435172.32		-1718	-0.06		vis	0.5	Marks[7] (1959)
2435303.355		-1684	+0.229		phg	0	Wachmann (1966)
2435338.146		-1675	+0.410		phg	0	Tschuprina (1957)
2435356.949		-1670	-0.014		phel	2	Walraven et al. (1958)
2435380.180		-1664	+0.144		vis	0.5	Azarnova (1957)
2435645.305		-1595	-0.070		phg	1	Shteiman (1958)
2435922.056		-1523	-0.194		vis	0.5	Azarnova (1958)
2436087.339		-1480	-0.268		vis	0	Vinnik[8] (1958)
2436099.119		-1477	+0.024		phel	2	Svolopoulos (1960)
2436214.589		-1447	+0.081		vis	0.5	Latyshev (1969)
2436448.952		-1386	-0.131		vis	0.5	Azarnova (1958)
2436903.132		-1268	+0.281		phg	0	Wachmann (1966)
2436926.058		-1262	+0.134		vis	0.5	Azarnova (1962)
2437198.867		-1191	-0.087		vis	0.5	Kiperman (1963)
2437287.383		-1168	-0.017		phel	3	Mitchell et al. (1964)
2437494.980		-1114	-0.077		vis	0.5	Kiperman (1963)
2437941.117		-998	-0.017		phel	2	Williams (1966)
2438179.565		-936	+0.011		vis	0.5	Ross, Hartmann (1972)
2438971.724		-730	0.000		vis	0.5	Borisov[9] (1972)
2438987.18		-726	+0.07		vis	0.5	Braune, Hübscher (1967)
2438994.833	2438994.418	-724	+0.034	$-0^{d}.033$	vis	1	Borisov (1972)
2439014.054		-719	+0.028		phel	3	Wisniewski, Johnson (1968)
2439344.655		-633	-0.083		vis	1	Borisov (1972)
2439740.868		-530	+0.044		vis	1	Borisov (1972)
2440482.991		-337	-0.013		vis	1	Borisov (1972)
2441778.985	2441778.619	0	+0.050	+0.030	phel	3	present paper

Remarks: [1] Observer: Hartwig ; [2] Obs.: Flanery; [3] Obs.: Rybka; [4] Obs.: Model; [5] Obs.: Mielke; [6] Obs.: Detre; [7] Obs.: Wroblewski; [8] Obs.: Sazanova; [9] Obs.: Pantschuk.

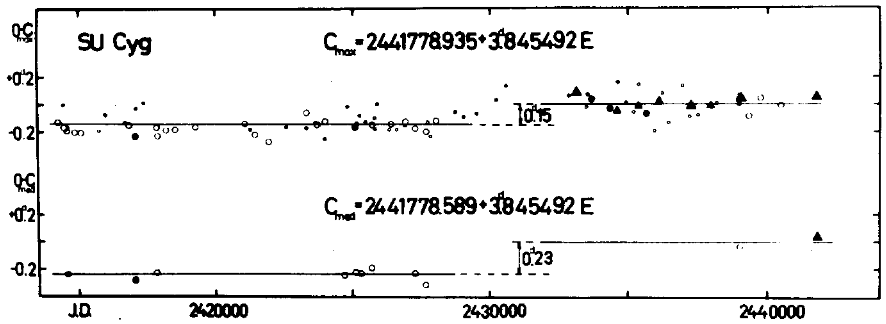

Figure 44 O-C diagram of SU Cyg

shows the jump of the period as well, but the variations in the O-C values are not equal. The difference in the O-C values is equal to $0^d.15$ in the case of the maximum, whereas it is equal to $0^d.23$ for the median brightness. This means that the light curve has become steeper after the rejump. The time difference between the moments of a maximum and the preceding moment of median brightness on the ascending branch is nearly $0^d.35$. Considering that the median point has moved nearer the maximum, the increase in the steepness is about 20%.

Y Aurigae

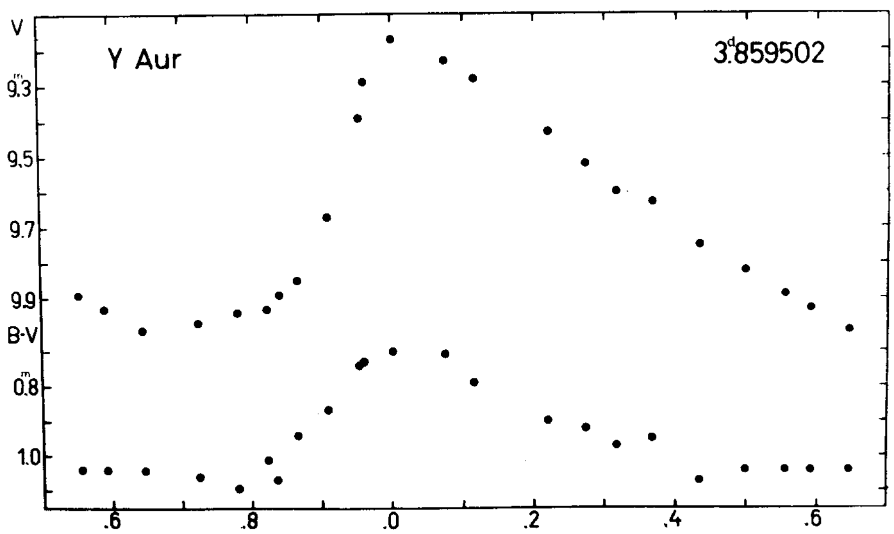

Figure 45 V and B-V curves of Y Aur

Table 28. O-C residuals for Y Aur

Obs.Max.J.D.	Obs.Med.J.D.	E	$(O-C)_{max}$	$(O-C)_{med}$	Type	w	Source
2415474.705		-6799	$+0\overset{d}{.}095$		vis	1	Williams (1905b)
2415737.096		-6731	+0.040		vis	1	Williams (1905b)
2416215.714		-6607	+0.080		phg	1	Kukarkin (1931c)
2416254.236		-6597	+0.007		vis	1	Williams (1905b)
2416466.565		-6542	+0.063		vis	0.5	Laü (1904)
2417277.43		-6332	+0.43		vis	0	Luizet (1917)
2417639.779	2417639.505	-6238	-0.012	$+0\overset{d}{.}068$	vis	1	Zeipel (1908)
2417663.23		-6232	+0.28		vis	0	Luizet (1917)
2417944.675	2417944.320	-6159	-0.016	-0.017	vis	1	Van der Bilt (1924)
2418446.412	2418446.045	-6029	-0.014	-0.027	vis	1	Van der Bilt (1924)
2418755.56		-5949	+0.37		vis	0	Luizet (1917)
2419133.69		-5851	+0.27		vis	0	Luizet (1917)
2419322.538	2419322.187	-5802	+0.005	+0.008	vis	1	Van der Bilt (1924)
2419488.74		-5759	+0.25		vis	0	Luizet (1917)
2419805.36		-5677	+0.39		vis	0	Luizet (1917)
2419866.903		-5661	+0.180		phg	0.5	Robinson (1929)
2420600.12		-5471	+0.09		vis	0.5	Luizet (1917)
2420982.11		-5372	-0.01		vis	0.5	Luizet (1917)
2421140.394		-5331	+0.035		vis	1	Doberck (1924c)
2421167.333	2421166.924	-5324	-0.042	-0.097	phg	2	Jordan (1929)

Table 28 (cont.)

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2422163.161	2422162.756	-5066	$+0^{d}.034$	$-0^{d}.017$	vis	1	Nijland (1923)
2422170.849	2422170.525	-5064	+0.003	+0.033	phg	2	Martin, Plummer (1921)
2422564.478		-4962	-0.037		vis	1	Doberck (1924c)
2422676.465	2422676.102	-4933	+0.024	+0.015	vis	1	Nijland (1923)
2422761.3		-4911	-0.05		vis	0.5	Hacar (1921)
2423043.097	2423042.773	-4838	+0.004	+0.034	vis	1	Nijland (1923)
2423355.680		-4757	-0.033		vis	1	Nijland (1923)
2423502.536		-4719	+0.162		phg	1	Kukarkin (1931c)
2423594.853		-4695	-0.149		vis	1	Doberck (1924c)
2425972.82		-4079	+0.36		vis	0	Kukarkin (1930a)
2426165.401	2426165.034	-4029	-0.029	-0.042	phg	1	Kukarkin (1931c)
2426234.922		-4011	+0.021		vis	1	Kukarkin (1940)
2428150.02		-3515	+0.81		vis	0	Fu (1964)
2430244.803		-2972	-0.121		vis	0.5	Lagrula (1941,1942)
2430785.41		-2832	+0.16		vis	0.5	Stein (1944)
2436833.102		-1265	+0.008		phel	3	Weaver et al. (1960)
2436844.654		-1262	-0.018		phel	2	Oosterhoff (1960)
2439361.069	2439360.687	-610	+0.001	-0.027	phel	3	Takase (1969)
2441715.370	2441715.027	0	+0.006	+0.017	phel	3	present paper

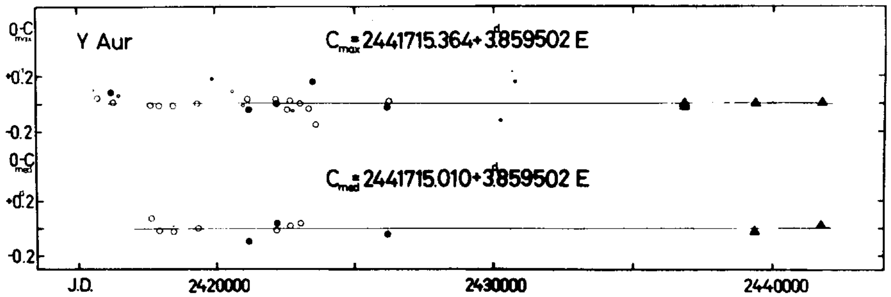

Figure 46 O-C diagram of Y Aur

The light and colour curves of this variable are shown in Fig. 45. The O-C residuals have been computed with the formulae:

$$C_{max} = 2441715.364 + 3\overset{d}{.}859502E \;;$$
$$C_{med} = 2441715.010 + 3\overset{d}{.}859502E \;.$$

Both O-C diagrams (Fig. 46) show constant period and give the same value for the period.

ST Tauri

According to Michalowska-Smak and Smak (1965) this star is a Population II variable. This statement can be refuted with the aid of the light and colour curves shown in Fig. 47. These

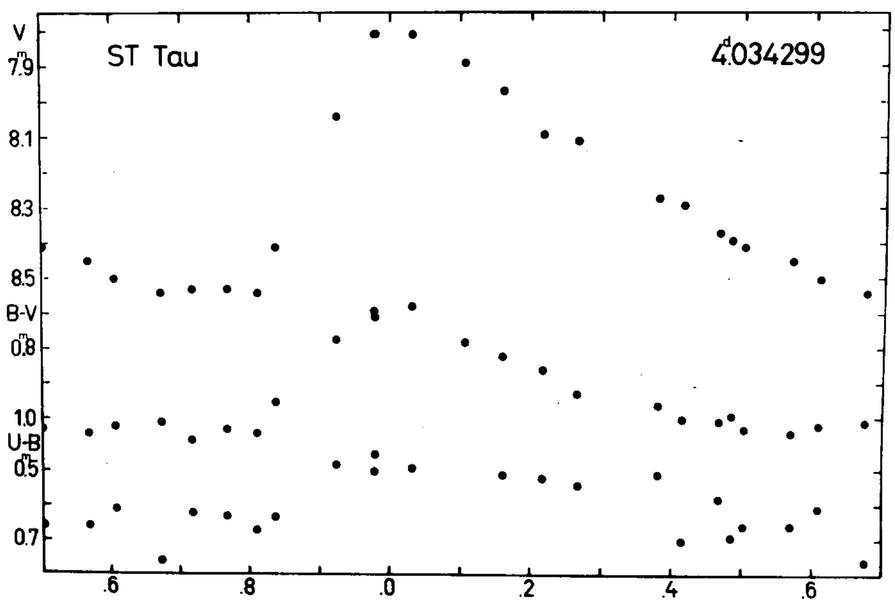

Figure 47 V, B-V and U-B curves of ST Tau

curves are typical of the classical cepheids.

The O-C residuals have been computed with the formula:

$$C = 2441761.963 + 4\overset{d}{.}034299E \ .$$

The 2nd Supplement to the GCVS (Kukarkin et al. 1974) reports on the period variation of ST Tau. The O-C diagram (Fig. 48) does not show any period variation.

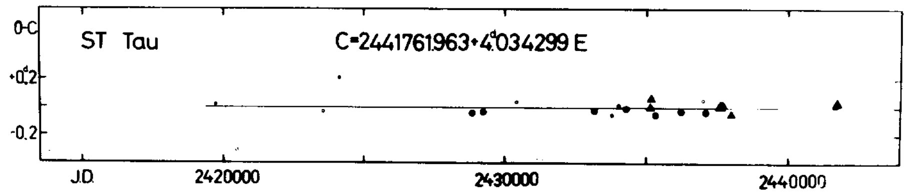

Figure 48 O-C diagram of ST Tau

Table 29 O-C residuals for ST Tau

Obs.Max.J.D.	E	O-C	Type	w	Source
2419718.565	-5464	+0.d012	phg	0.5	Robinson (1930)
2420480.73	-5275	-0.31	vis	0.5	Hoffmeister (1919)
2420864.45	-5180	+0.16	vis	0.5	Hoffmeister (1919)
2421199.35	-5097	+0.21	vis	0.5	Hoffmeister (1919)
2423559.172	-4512	-0.034	vis	0.5	Doberck (1924c)
2424132.283	-4370	+0.207	phg	0.5	Kukarkina (1954b)
2428856.195	-3199	-0.045	phg	1	Koshkina (1963)
2429251.566	-3101	-0.036	phg	1	Koshkina (1963)
2430421.585	-2811	+0.036	vis	0.5	Model, Löchel (1964)
2433185.016	-2126	-0.027	phg	1	Borzdyko (1962)
2433806.267	-1972	-0.058	phg	0.5	Koshkina (1963)
2434024.192	-1918	+0.014	phg	0.5	Borzdyko (1962)
2434298.499	-1850	-0.011	phg	1	Koshkina (1963)
2435177.981	-1632	-0.006	phel	2	Walraven et al. (1958)
2435182.080	-1631	+0.059	phel	2	Irwin (1961)
2435323.165	-1596	-0.057	phg	1	Borzdyko (1962)
2436243.010	-1368	-0.032	phg	1	Borzdyko (1962)
2436993.473	-1182	+0.051	vis	0.5	Huth (1963b)
2437106.343	-1154	-0.039	phg	1	Borzdyko (1962)
2437622.781	-1026	+0.009	phel	3	Mitchell et al. (1964)
2437699.435	-1007	+0.011	phel	2	Michalowska et al.(1965)
2437989.839	-935	-0.054	phel	1	Williams (1966)
2441761.984	0	+0.021	phel	3	present paper

V 395 Cassiopeiae

This star has not previously been observed photoelectrically. The light and colour curves of V 395 Cas are presented in Fig. 49. Since the O-C diagram consists of two points only, these have not been plotted in a figure. The O-C residuals have been calculated with the formula:

$$C = 2441949.427 + 4\overset{d}{.}037728E \ .$$

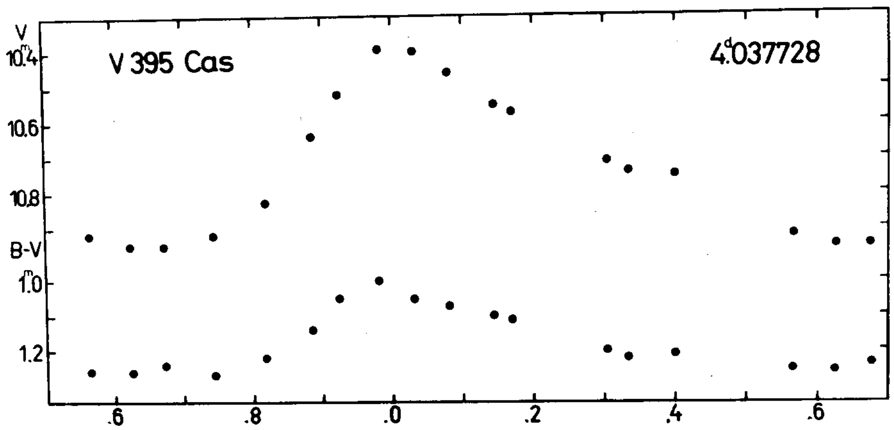

Figure 49 V and B-V curves of V 395 Cas

Table 30 O-C residuals for V 395 Cas

Obs.Max.J.D.	E	O-C	Type	w	Source
2435343.705	-1636	$+0\overset{d}{.}001$	phg	2	Kholopov et al. (1968)
2441949.427	0	0.000	phel	3	present paper

SY Cassiopeiae

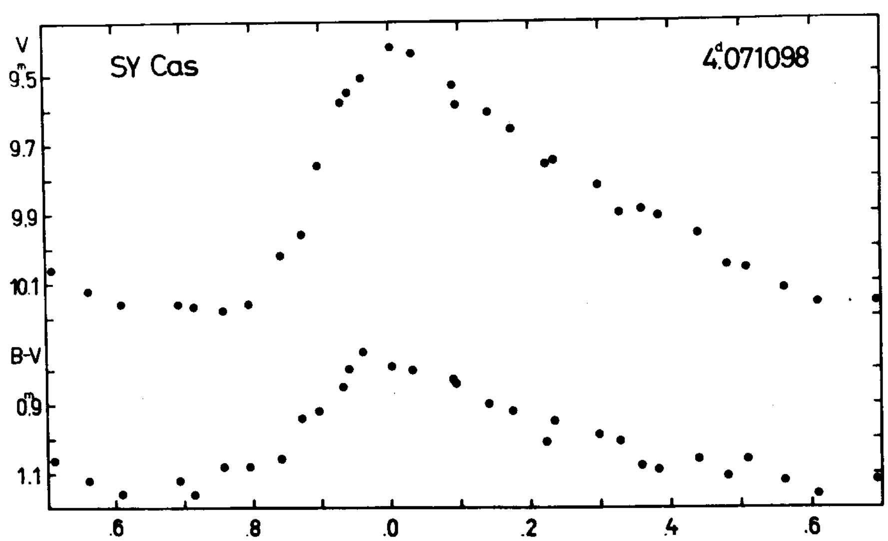

Figure 50 V and B-V curves of SY Cas

There is a faint companion SW at the variable within the diaphragm. The light and colour curves on SY Cas are presented in Fig. 50. The O-C residuals have been computed with the formula:

$$C = 2441682.230 + 4^{d}.071098E \ .$$

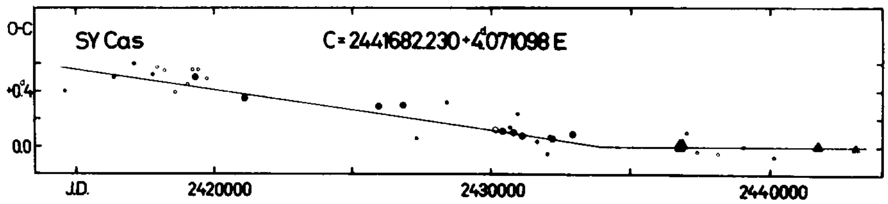

Figure 51 O-C diagram of SY Cas

The O-C diagram (Fig. 51) shows a sudden period change at J.D. 2434000. The corresponding periods are as follows:

before J.D. 2434000, $P = 4^{d}.070969$;

after J.D. 2434000, $P = 4^{d}.071098$.

Table 31 O-C residuals for SY Cas

Obs.Max.J.D.	E	O-C	Type	w	Source
2414605.8	-6651	$+0^{d}.4$	phg	0.5	Blazhko (1907b)
2416376.8	-6216	+0.5	phg	0.5	Blazhko (1907b)
2417121.9	-6033	+0.6	phg	0.5	Blazhko (1907b)
2417793.55	-5868	+0.52	phg	0.5	Blazhko (1907b)
2417911.2	-5839	+0.1	phg	0	Blazhko (1907b)
2417952.374	-5829	+0.574	vis	0.5	Luizet (1908)
2418229.18	-5761	+0.55	vis	0.5	Luizet (1913)
2418595.42	-5671	+0.39	vis	0.5	Luizet (1913)
2419047.38	-5560	+0.45	vis	0.5	Luizet (1913)
2419234.76	-5514	+0.56	vis	0.5	Luizet (1913)
2419336.475	-5489	+0.502	phg	1	Robinson (1931a)
2419466.81	-5457	+0.56	vis	0.5	Luizet (1913)
2419743.57	-5389	+0.49	vis	0.5	Luizet (1913)
2421131.676	-5048	+0.349	phg	2	Jordan (1929)
2425964.01	-3861	+0.29	phg	1	Oosterhoff (1935)
2426851.52	-3643	+0.30	phg	1	Oosterhoff (1935)
2427335.74	-3524	+0.06	phg	0.5	Oosterhoff (1935)
2428431.13	-3255	+0.32	phg	0.5	Fu (1964)
2430181.504	-2825	+0.126	vis	1	Conceicao-Silva (1950b)
2430433.905	-2763	+0.119	phg	1	Vasil'yanovskaya (1948)
2430629.53	-2715	+0.33	phg	0	Romano (1959)
2430678.192	-2703	+0.140	vis	0.5	Conceicao-Silva (1950b)
2430836.932	-2664	+0.107	phg	1	Solov'yov (1954)
2430979.55	-2629	+0.24	phg	0.5	Romano (1959)
2431146.305	-2588	+0.077	phg	2	Vasil'yanovskaya (1948)
2431687.72	-2455	+0.04	phg	0.5	Romano (1959)
2432041.82	-2368	-0.05	phg	0.5	Romano (1959)
2432127.439	-2347	+0.076	vis	0.5	Conceicao-Silva (1950b)
2432208.850	-2327	+0.065	phg	1	Vasil'yanovskaya (1948)
2432738.37	-2197	+0.34	phg	0	Romano (1959)
2432970.172	-2140	+0.092	phg	1	Solov'yov (1954)
2433121.25	-2103	+0.54	phg	0	Romano (1959)

Table 31 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2435083.29	-1621	$+0^{d}.31$	phg	0	Romano (1959)
2435413.05	-1540	+0.31	phg	0	Romano (1959)
2435721.87	-1464	-0.27	phg	0	Romano (1959)
2436809.135	-1197	-0.009	phel	3	Oosterhoff (1960)
2436833.544	-1191	+0.008	phel	3	Weaver et al. (1960)
2436906.850	-1173	+0.018	phel	3	Bahner et al. (1962)
2437045.355	-1139	+0.106	vis	0.5	Häussler (1973)
2437399.402	-1052	-0.033	vis	0.5	Häussler (1973)
2438144.399	-869	-0.047	vis	0.5	Häussler (1973)
2439056.378	-645	+0.006	vis	0.5	Häussler (1973)
2440151.424	-376	-0.073	vis	0.5	Häussler (1973)
2441682.236	0	+0.006	phel	3	present paper
2443041.968	+334	-0.009	phel	2	present paper

V 508 Monocerotis

This star has not previously been observed photoelectrically. The amplitude of its light variation is small (see Fig. 52) but non-sinusoidal (resembling IR Cep). As was discussed in the case of IR Cep, this phenomenon may be due to the presence of a companion star or to the non-homogeneity of the group of cepheids with small amplitude. As the ratio of amplitudes in yellow and blue lights for both IR Cep and V 508 Mon is close to the value of the ratio derived for single cepheids (i.e. the possible companion star would be of the same spectral type as the cepheid in both cases), the latter explanation is more probable.

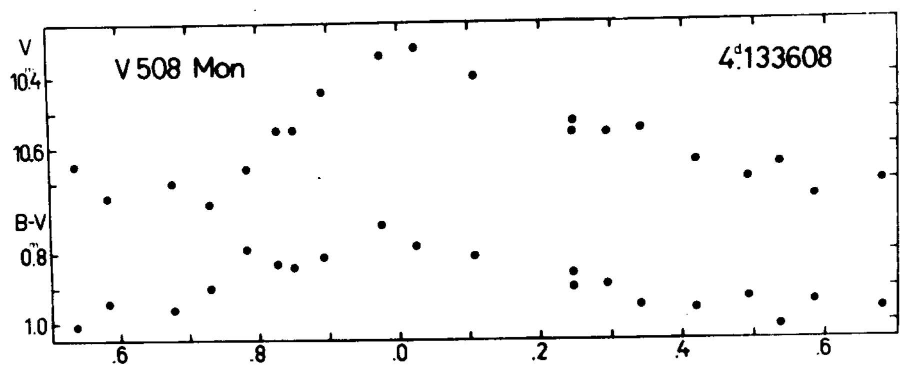

Figure 52 V and B-V curves of V 508 Mon

The O-C residuals have been computed with the formula:

$$C = 2441732.070 + 4^{d}.133608E \ .$$

As Fig. 53 shows, the period of V 508 Mon has remained constant since the discovery of its light variation.

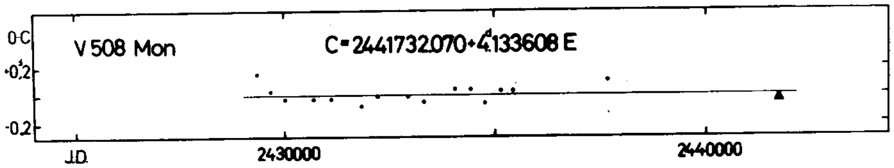

Figure 53 O-C diagram of V 508 Mon

Table 32 O-C residuals for V 508 Mon

Obs.Max.J.D.	E	O-C	Type	w	Source
2429343.80	-2997	$+0^{d}.15$	phg	0.5	Wachmann (1964)
2429670.23	-2918	+0.03	phg	0.5	Wachmann (1964)
2430021.53	-2833	-0.03	phg	0.5	Wachmann (1964)
2430699.44	-2669	-0.03	phg	0.5	Wachmann (1964)
2431116.93	-2568	-0.03	phg	0.5	Wachmann (1964)
2431852.67	-2390	-0.08	phg	0.5	Wachmann (1964)
2432233.03	-2298	-0.01	phg	0.5	Wachmann (1964)
2432948.14	-2125	-0.01	phg	0.5	Wachmann (1964)
2433332.53	-2032	-0.05	phg	0.5	Wachmann (1964)
2434068.40	-1854	+0.04	phg	0.5	Wachmann (1964)
2434444.56	-1763	+0.04	phg	0.5	Wachmann (1964)
2434775.15	-1683	-0.06	phg	0.5	Wachmann (1964)
2435163.80	-1589	+0.03	phg	0.5	Wachmann (1964)
2435453.15	-1519	+0.03	phg	0.5	Wachmann (1964)
2437693.63	-977	+0.10	phg	0.5	Wachmann (1964)
2441732.043	0	-0.027	phel	3	present paper

SX Persei

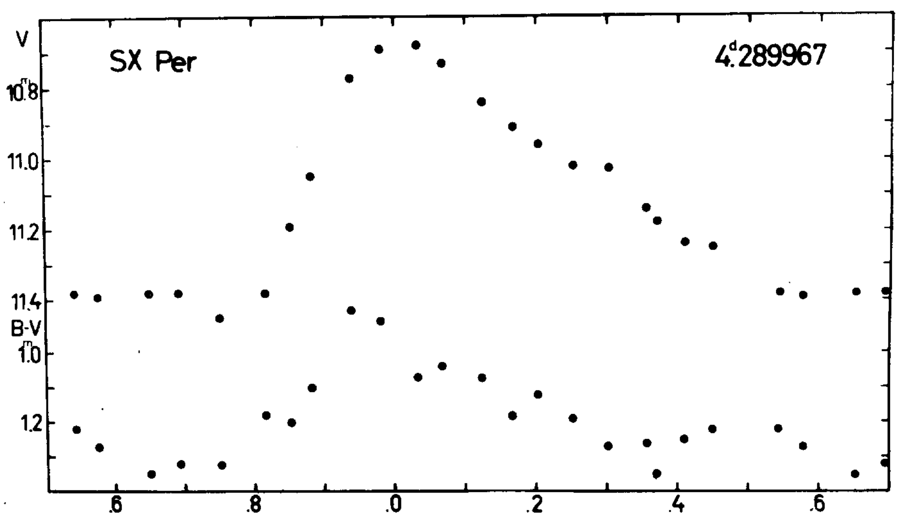

Figure 54 V and B-V curves of SX Per

The light and colour curves for this variable are shown in Fig. 54. The O-C residuals are computed with the formula:

$$C = 2441847.979 + 4\overset{d}{.}289967E \ .$$

As Fig. 55 shows, the period of SX Per has remained constant since the beginning of this century.

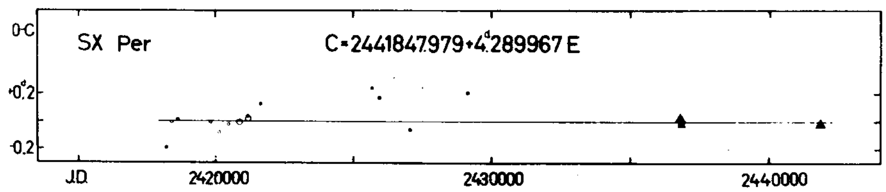

Figure 55 O-C diagram of SX Per

Table 33 O-C residuals for SX Per

Obs.Max.J.D.	E	O-C	Type	w	Source
2418210.070	-5510	$-0\overset{d}{.}191$	phg	0.5	Kukarkin (1931b)
2418390.436	-5468	-0.003	vis	0.5	Enebo (1911)
2418647.85	-5408	+0.01	phg	0.5	Oosterhoff (1935)
2419810.411	-5137	-0.008	vis	0.5	Nijland (1923)
2420127.795	-5063	-0.081	vis	0.5	Nijland (1923)
2420475.343	-4982	-0.020	vis	0.5	Nijland (1923)
2420857.163	-4893	-0.007	vis	1	Nijland (1923)
2421161.80	-4822	+0.04	phg	0.5	Oosterhoff (1935)
2421187.512	-4816	+0.014	vis	1	Nijland (1923)
2421638.07	-4711	+0.13	phg	0.5	Oosterhoff (1935)
2425692.20	-3766	+0.24	phg	0.5	Oosterhoff (1935)
2425966.69	-3702	+0.17	phg	0.5	Oosterhoff (1935)
2427064.69	-3446	-0.06	phg	0.5	Oosterhoff (1935)
2429145.60	-2961	+0.21	phg	0.5	Kurochkin (1950)
2436815.866	-1173	+0.018	phel	3	Weaver et al. (1960)
2436845.854	-1166	-0.023	phel	2	Oosterhoff (1960)
2441847.956	0	-0.023	phel	3	present paper

<u>Y Lacertae</u>

Table 34 O-C residuals for Y Lac

Obs.Max.J.D.	E	O-C	Type	w	Source
2417615.86	-5581	$+0\overset{d}{.}11$	phg	0.5	Blazhko (1907a)
2417715.193	-5558	-0.005	vis	0.5	Ichinohe (1909)
2417944.323	-5505	-0.035	vis	0.5	Zeipel (1908)
2418216.813	-5442	+0.057	vis	0.5	Ichinohe (1909)
2418424.295	-5394	-0.002	phg	0.5	Robinson (1930)
2421658.488	-4646	+0.006	phg	2	Jordan (1929)
2421818.386	-4609	-0.075	phg	2	Martin, Plummer (1919)
2424758.640	-3929	+0.011	vis	0.5	Schneller (1928)
2426228.749	-3589	+0.036	phg	0.5	Nekrasova (1938)
2429102.45	-2924	-1.57	phg	0	Shakhovskoj (1949)
2433125.147	-1994	+0.011	phel	3	Eggen (1951)
2433609.468	-1882	+0.069	phg	1	Solov'yov (1952b)

Table 34 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2436834.936	-1136	$+0\overset{d}{.}001$	phel	3	Bahner et al. (1962)
2437366.745	-1013	-0.015	phel	3	Mitchell et al. (1964)
2441746.720	0	-0.025	phel	3	present paper

The light and colour curves for this variable are shown in Fig. 56. According to Madore (1977), Y Lac has a blue photometric companion. The O-C residuals have been calculated with the formula:

$$C = 2441746.745 + 4\overset{d}{.}323776E \ .$$

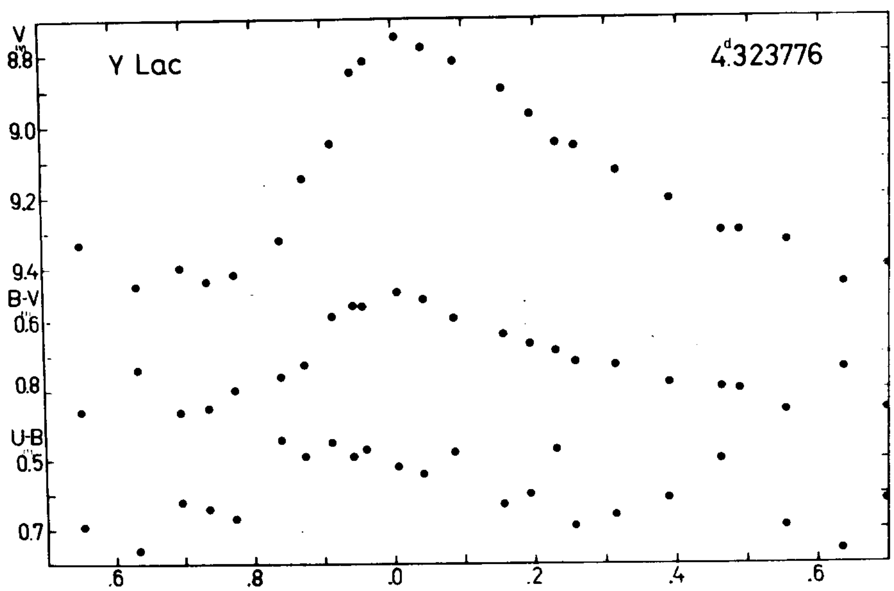

Figure 56 V, B-V and U-B curves of Y Lac

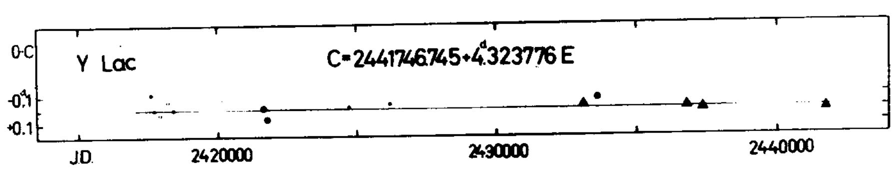

Figure 57 O-C diagram of Y Lac

The O-C diagram (Fig. 57) is a straight line, i.e. the period is constant.

V 402 Cygni

The light and colour curves of this variable are shown in Fig. 58. The O-C residuals have been computed with the formula:

$$C = 2441698.635 + 4\overset{d}{.}364836E\ .$$

These residuals which are plotted in Fig. 59 show constant period.

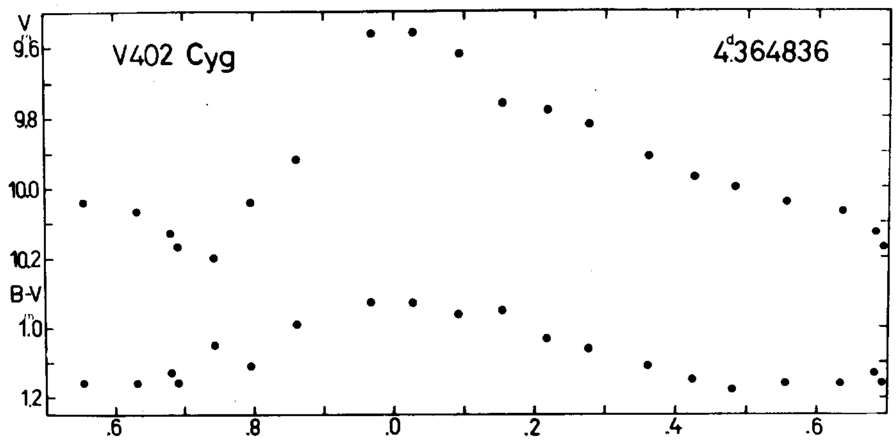

Figure 58 V and B-V curves of V 402 Cyg

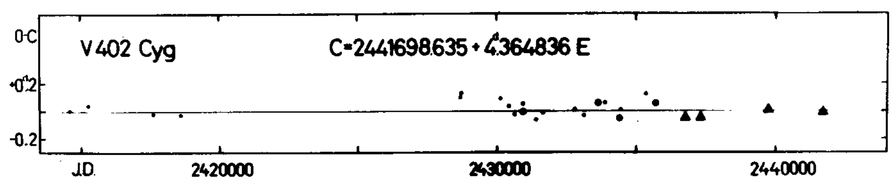

Figure 59 O-C diagram of V 402 Cyg

Table 35 O-C residuals for V 402 Cyg

Obs.Max.J.D.	E	O-C	Type	w	Source
2413841.80	-6382	$-0\overset{d}{.}45$	phg	0	Ikauniex (1946)
2414606.10	-6207	0.00	phg	0.5	Ikauniex (1946)
2415287.05	-6051	+0.04	phg	0.5	Ikauniex (1946)
2417613.45	-5518	-0.02	phg	0.5	Ikauniex (1946)
2418586.80	-5295	-0.03	phg	0.5	Ikauniex (1946)
2428717.71	-2974	+0.10	phg	0.5	Ikauniex (1946)
2428748.30	-2967	+0.13	phg	0.5	Suzuki, Huruhata(1938)
2430166.83	-2642	+0.09	phg	0.5	Ashbrook (1941)
2430446.124	-2578	+0.036	phg	0.5	Solov'yov (1946)
2430651.211	-2531	-0.024	phg	0.5	Filatov (1957)
2430956.765	-2461	-0.009	phg	1	Solov'yov (1946)
2430961.19	-2460	+0.05	phg	0.5	Ikauniex (1946)
2431410.654	-2357	-0.063	phg	0.5	Solov'yov (1946)
2431655.134	-2301	-0.013	phg	0.5	Filatov (1957)

Table 35 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2432794.380	-2040	$+0^{d}.010$	phg	0.5	Filatov (1957)
2433121.697	-1965	-0.035	phg	0.5	Filatov (1957)
2433649.937	-1844	+0.060	phg	1	Filatov (1957)
2433890.004	-1789	+0.061	phg	0.5	Shteiman (1958)
2434400.571	-1672	-0.058	phg	1	Filatov (1957)
2434448.650	-1661	+0.008	phg	0.5	Shteiman (1958)
2435334.826	-1458	+0.122	phg	0.5	Filatov (1957)
2435692.675	-1376	+0.054	phg	1	Shteiman (1958)
2436761.948	-1131	-0.057	phel	3	Oosterhoff (1960)
2437307.560	-1006	-0.050	phel	3	Mitchell et al. (1964)
2439743.193	-448	+0.005	phel	3	Takase (1969)
2441698.620	0	-0.015	phel	3	present paper

T Vulpeculae

The light and colour curves for this cepheid are shown in Fig. 60. The O-C residuals have been calculated with the formula:

$$C = 2441705.121 + 4^{d}.435462E .$$

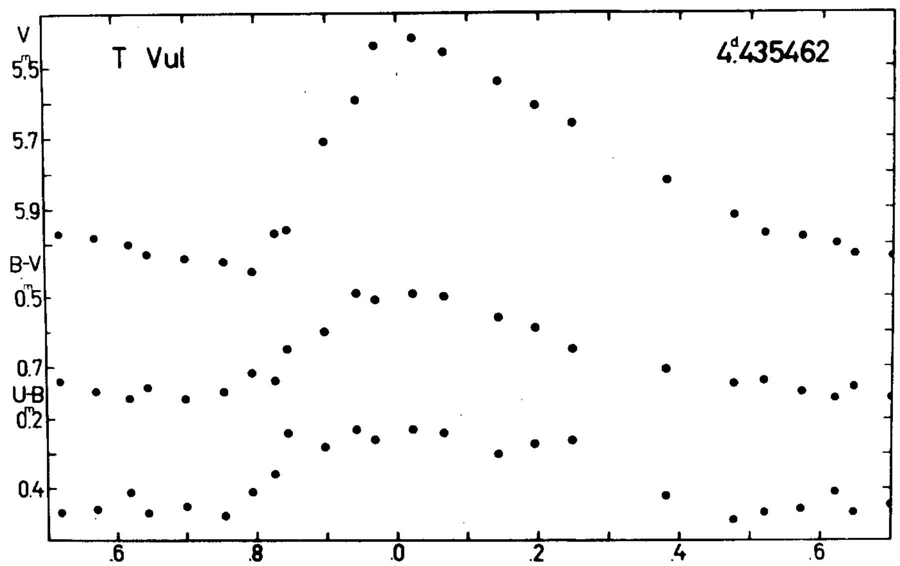

Figure 60 V, B-V and U-B curves of T Vul

The O-C diagram in Fig. 61 shows a small change in the period of T Vul at J.D. 2434000 . The value of the period before J.D. 2417000 is rather uncertain. The other values of the period are as follows:

between J.D. 2417000 and J.D. 2434000, $P = 4^{d}.435589$;

after J.D. 2434000, $P = 4^{d}.435462$.

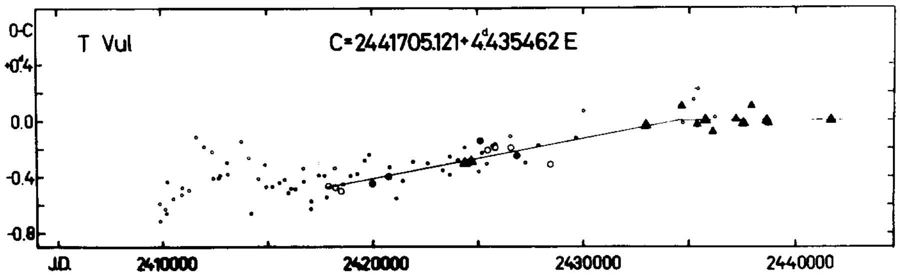

Figure 61 O-C diagram of T Vul

Table 36 O-C residuals for T Vul

Obs.Max.J.D.	E	O-C	Type	w	Source
2409884.531	-7174	-0.586 d	vis	0.5	Sawyer (1889)
2409897.709	-7171	-0.714	vis	0.5	Chandler (1886)
2410101.830	-7125	-0.624	vis	0.5	Chandler (1886)
2410199.373	-7103	-0.661	vis	0.5	Sawyer (1889)
2410212.91	-7100	-0.43	vis	0.5	Prager[1] (1936)
2410545.403	-7025	-0.557	vis	0.5	Sawyer (1896)
2410904.747	-6944	-0.526	vis	0.5	Sawyer (1896)
2410922.543	-6940	-0.472	vis	0.5	Yendell (1889)
2411272.927	-6861	-0.489	vis	0.5	Sawyer (1896)
2411313.392	-6852	+0.057	vis	0	Yendell (1890)
2411605.959	-6786	-0.117	vis	0.5	Yendell (1891)
2411991.774	-6699	-0.187	vis	0.5	Yendell (1893)
2412351.012	-6618	-0.221	vis	0.5	Yendell (1894)
2412404.048	-6606	-0.411	vis	0.5	Sawyer (1896)
2412670.178	-6546	-0.409	vis	0.5	Yendell (1895a)
2412736.725	-6531	-0.394	vis	0.5	Sawyer (1896)
2413056.175	-6459	-0.297	vis	0.5	Yendell (1895b)
2413096.011	-6450	-0.380	vis	0.5	Sawyer (1896)
2413761.565	-6300	-0.145	vis	0.5	Yendell (1897)
2414098.541	-6224	-0.265	vis	0.5	Yendell (1901)
2414213.467	-6198	-0.661	vis	0.5	Pickering (1907)
2414546.374	-6123	-0.413	vis	0.5	Luizet (1912)
2414870.265	-6050	-0.311	vis	0.5	Yendell (1901)
2414892.283	-6045	-0.470	vis	0.5	Luizet (1912)
2415211.636	-5973	-0.470	vis	0.5	Luizet (1912)
2415570.948	-5892	-0.431	vis	0.5	Luizet (1912)
2415801.604	-5840	-0.419	vis	0.5	Tass (1909)
2415925.05	-5812	-1.17	vis	0	Yendell (1905)
2415987.800	-5798	-0.512	vis	0.5	Luizet (1912)
2416120.895	-5768	-0.481	vis	0.5	Tass (1904)
2416324.921	-5722	-0.488	vis	0.5	Luizet (1912)
2416710.960	-5635	-0.333	vis	0.5	Terkán (1905)
2416715.297	-5634	-0.431	vis	0.5	Luizet (1912)
2417065.499	-5555	-0.631	vis	0.5	Luizet (1912)
2417069.989	-5554	-0.576	phg	0.5	Wilkens (1906)
2417433.887	-5472	-0.386	vis	0.5	Luizet (1912)
2417757.672	-5399	-0.390	vis	0.5	Zeipel (1908)
2417806.307	-5388	-0.545	vis	0.5	Luizet (1912)
2417872.917	-5373	-0.467	vis	1	Nijland (1923)
2418192.402	-5301	-0.335	vis	0.5	Luizet (1912)

Table 36 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2418196.696	-5300	$-0^{d}.476$	vis	1	Nijland (1923)
2418516.031	-5228	-0.495	vis	1	Nijland (1923)
2418551.555	-5220	-0.454	vis	0.5	Luizet (1912)
2418937.503	-5133	-0.392	vis	0.5	Luizet (1912)
2419283.487	-5055	-0.374	vis	0.5	Luizet (1912)
2419656.159	-4971	-0.280	phg	0.5	Robinson (1931a)
2419833.616	-4931	-0.242	vis	0.5	Dziewulski (1925)
2420001.954	-4893	-0.451	phg	1	Hertzsprung (1919)
2420747.163	-4725	-0.400	phg	1	Hertzsprung (1919)
2420813.763	-4710	-0.332	vis	0.5	Luyten (1922)
2421110.716	-4643	-0.555	vis	0.5	Luyten (1922)
2421439.068	-4569	-0.427	vis	0.5	Luyten (1922)
2421922.671	-4460	-0.289	vis	0.5	Luyten (1922)
2422641.203	-4298	-0.302	vis	0.5	Doberck (1924a)
2423333.034	-4149	-0.355	vis	0.5	Hellerich (1928b)
2423670.279	-4066	-0.254	vis	0.5	Hellerich (1928b)
2423674.582	-4065	-0.386	vis	0.5	Hopmann (1924)
2424029.526	-3985	-0.279	vis	0.5	Hellerich (1928b)
2424375.465	-3907	-0.306	phel	3	Huffer (1928a)
2424384.452	-3905	-0.190	vis	0.5	Hellerich (1928b)
2424721.445	-3829	-0.292	phel	3	Huffer (1928a)
2424770.258	-3818	-0.269	vis	0.5	Kukarkin (1940)
2425067.340	-3751	-0.363	vis	0.5	Kukarkin (1940)
2425116.349	-3740	-0.144	phg	2	Hellerich (1935)
2425218.28	-3717	-0.23	vis	0.5	Lause (1938)
2425426.662	-3670	-0.313	vis	0.5	Kukarkin (1940)
2425448.942	-3665	-0.211	vis	1	Zverev (1936)
2425701.800	-3608	-0.174	vis	0.5	Dziewulski et al.(1932)
2425781.623	-3590	-0.189	vis	1	Zverev (1936)
2425826.001	-3580	-0.166	vis	0.5	Kukarkin (1940)
2426531.289	-3421	-0.116	vis	0.5	Kukarkin (1940)
2426540.081	-3419	-0.195	vis	1	Zverev (1936)
2426859.380	-3347	-0.250	phg	2	Kox (1935)
2427289.6	-3250	-0.3	vis	0.5	Miczaika (1934)
2427875.176	-3118	-0.174	vis	0.5	Miczaika (1937)
2428451.646	-2988	-0.315	vis	1	Kepinski (1937)
2429631.665	-2722	-0.128	vis	0.5	Mandre (1950,1951)
2430004.44	-2638	+0.07	vis	0.5	Conceicao-Silva (1948)
2432967.224	-1970	-0.037	phel	3	Eggen (1951)
2434595.171	-1603	+0.096	phel	1	present paper[2]
2434701.51	-1579	-0.02	vis	0.5	Marks[3] (1959)
2435216.19	-1463	+0.15	vis	0.5	Marks (1959)
2435362.383	-1430	-0.027	phel	1	Walraven et al. (1958)
2435380.378	-1426	+0.226	vis	0.5	Azarnova (1957)
2435757.163	-1341	-0.003	phel	3	Prokof'eva (1961)
2436098.622	-1264	-0.075	phel	2	Svolopoulos (1960)
2436214.045	-1238	+0.026	vis	0.5	Latyshev (1969)
2437212.010	-1013	+0.012	phel	2	Mitchell et al. (1964)
2437562.372	-934	-0.027	phel	3	Johansen (1971)
2437939.516	-849	+0.102	phel	1	Williams (1966)
2438649.080	-689	-0.008	phel	3	Johansen (1971)
2438733.347	-670	-0.014	phel	2	Wisniewski et al.(1968)
2441705.118	0	-0.003	phel	3	present paper

Remarks: [1] Observer: Gore; [2] Obs.: Detre; [3] Obs.: Wroblewski.

FF Aquilae

This cepheid is a component of a spectroscopic binary system with an orbital period of 1435 days (Abt 1959). Its light and colour curves are presented in Fig. 62. The small bump before the minimum brightness seems to be real because it appears in all three colours and its presence can be suspected from some earlier photoelectric light curves, as well. The appearance of a bump at this phase is a unique phenomenon among the cepheids with such a short period.

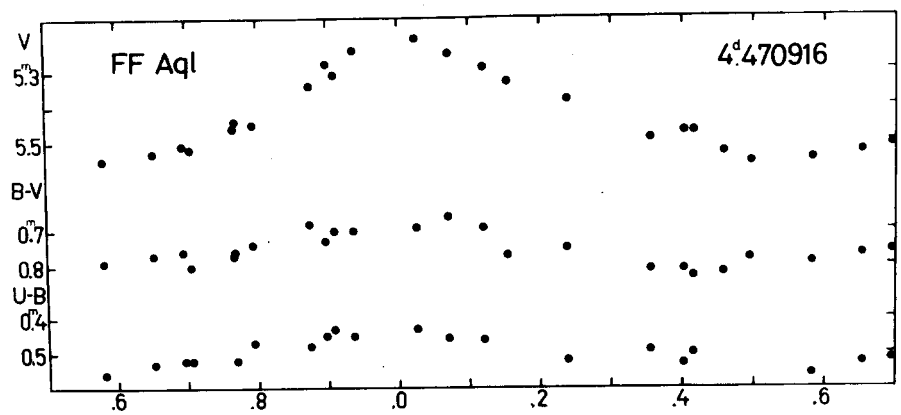

Figure 62 V, B-V and U-B curves of FF Aql

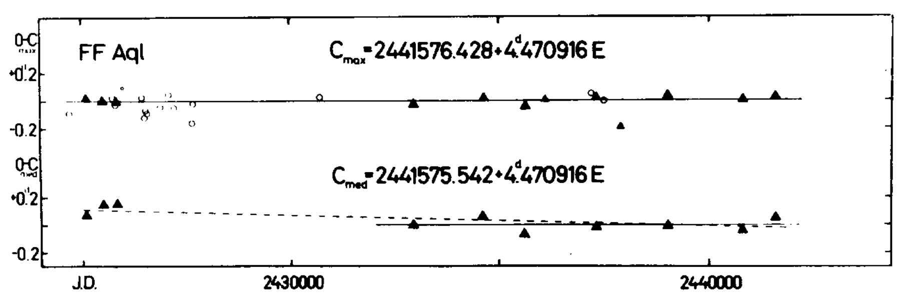

Figure 63 O-C diagram of FF Aql

The O-C residuals have been computed with the formulae:

$$C_{max} = 2441576.428 + 4^{d}.470916E ;$$

$$C_{med} = 2441575.542 + 4^{d}.470916E .$$

These residuals are shown in Fig. 63 . It can be seen from this figure that either the period determined from the O-C diagram of the median brightness ($P = 4^{d}.470886$) differs from the period val-

Table 37 O-C residuals for FF Aql

Obs.Max.J.D.	Obs.Med.J.D.	E	$O-C_{max}$	$O-C_{med}$	Type	w	Source
2424703.102		-3774	$-0^d.089$		vis	1	Kukarkin (1931b)
2425096.650	2425095.823	-3686	+0.018	$+0^d.077$	phel	3	Huffer (1931)
2425490.067	2425489.334	-3598	-0.005	+0.148	phel	3	Huffer (1931)
2425735.99		-3543	+0.02		vis	1	Kukarkin (1929)
2425803.008		-3528	-0.028		vis	1	Kukarkin (1940)
2425811.968	2425811.248	-3526	-0.010	+0.156	phel	3	Huffer (1931)
2425973.030		-3490	+0.099		vis	0.5	Zverev (1936)
2426433.462		-3387	+0.026		vis	1	Kukarkin (1940)
2426495.904		-3373	-0.124		vis	1	Selivanov (1935)
2426504.899		-3371	-0.071		vis	1	Loreta (1933)
2426540.654		-3363	-0.083		vis	1	Zverev (1936)
2426594.117		-3351	-0.271		vis	0	Dufay (1947b)
2426867.069		-3290	-0.045		vis	1	Loreta (1933)
2427068.35		-3245	+0.04		vis	1	Selivanov (1934)
2427202.382		-3215	-0.051		vis	1	Selivanov (1935)
2427627.007		-3120	-0.163		vis	1	Selivanov (1935)
2427658.447		-3113	-0.019		vis	1	Krebs (1935)
2430703.186		-2432	+0.026		vis	1	Dziewulski (1962)
2432960.946	2432960.088	-1927	-0.027	+0.001	phel	3	Eggen (1951)
2434611.17		-1558	+0.43		vis	0	Marks[1] (1959)
2434628.641	2434627.796	-1554	+0.016	+0.057	phel	3	present paper[2]
2435625.598	2435624.685	-1331	-0.041	-0.068	phel	3	Walraven et al. (1958)
2436099.567		-1225	+0.011		phel	2	Svolopoulos (1960)
2437199.443		-979	+0.042		vis	1	Makarenko[3] (1968)
2437320.127	2437319.215	-952	+0.011	-0.015	phel	3	Mitchell et al. (1964)
2437494.473		-913	-0.009		vis	1	Makarenko[3] (1968)
2437878.791		-827	-0.189		phel	1	Williams (1966)
2439019.100	2439018.170	-572	+0.036	-0.008	phel	3	Wisniewski, Johnson (1968)
2440811.901	2440810.980	-171	0.000	-0.035	phel	3	Pel (1976)
2441576.448	2441575.590	0	+0.020	+0.048	phel	3	present paper

Remarks:[1] Observer: Wroblewski; [2] Observer: Detre; [3] Observer: Kiperman id for the maximum brightness or a phase jump took place at the median brightness. This phenomenon has already been discussed in the case of SU Cygni.

A worthy subject for further investigations would be to determine whether there is some kind of connection between the mentioned peculiarities (variable steepness of the rising branch, bump on the light curve) and the presence of a magnetic field at this star (Babcock 1958). The points in the O-C diagrams in Fig. 63 derived from photoelectric observations show larger scatter than expected. This scatter is a result of the orbital motion of FF Aql around the centre of mass of the binary system. Let us examine the deviations of the O-C residuals (derived from photoelectric observations) from the expected value of O-C (solid line at the upper O-C diagram in Fig. 63). These deviations and the related orbital phases are listed in Table 38. The orbital phases are computed with the formula:

$$\text{Epoch} + \text{phase} = (\text{J.D.} - 2420000)\cdot 0.0006969 \; .$$

Table 38

Max. Obs.	Δ(O-C)	Phase	Max. Obs.	Δ(O-C)	Phase
2425096.650	$+0\overset{d}{.}018$	.55	2435625.598	$-0\overset{d}{.}041$	.89
2425490.081	−0.005	.83	2437320.127	+0.011	.07
2425811.968	−0.010	.05	2439019.100	+0.036	.25
2432960.946	−0.027	.03	2440811.901	0.000	.50
2434628.641	+0.016	.19	2441576.448	+0.020	.04

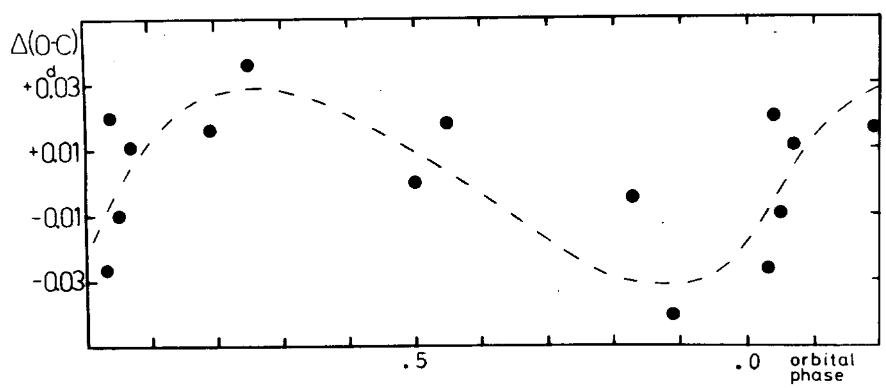

Figure 64 O-C variations due to the orbital motion

The data derived from the curve of O-C variations versus the orbital phase (Fig. 64) are in good agreement with those derived by Abt (1959). The value of a·*sini* can be determined from the amplitude of the O-C variation curve. The result is: $a \cdot \sin i = 78 \cdot 10^6$ km ($\pm 15 \cdot 10^6$ km). Abt obtained $68.3 \cdot 10^6$ km for this value from spectroscopic observations. Thus the spectroscopically and optically determined values of $a \cdot \sin i$ are very similar. Moreover, the moment of the point with largest positive deviation of O-C must coincide with the moment when the cepheid is the furthest from the observer during its orbital motion (i.e. at $0\overset{p}{.}23$ from periastron according to Abt).This coincidence is very good, but the time of the nearest point does not coincide so well with the largest negative deviation of O-C.

On the basis of the data given in Table 38 I suggest a slightly smaller value for the orbital period. The deviations of O-C plotted with a period of 1400^d results in a curve with smaller scatter. Moreover, the curve constructed from Abt's data on the mean velocity with the period of 1400 days shows less scatter than in the case of larger period (only two points with very low weight deviate considerably). Thus the suggested new value of the orbital period is $P_{orb} = 1400^d \pm 15^d$.

XY Cassiopeiae

The light and colour curves for this variable are shown in Fig. 65. The O-C residuals have been computed with the formula:

$$C = 2442006.786 + 4\overset{d}{.}501697E .$$

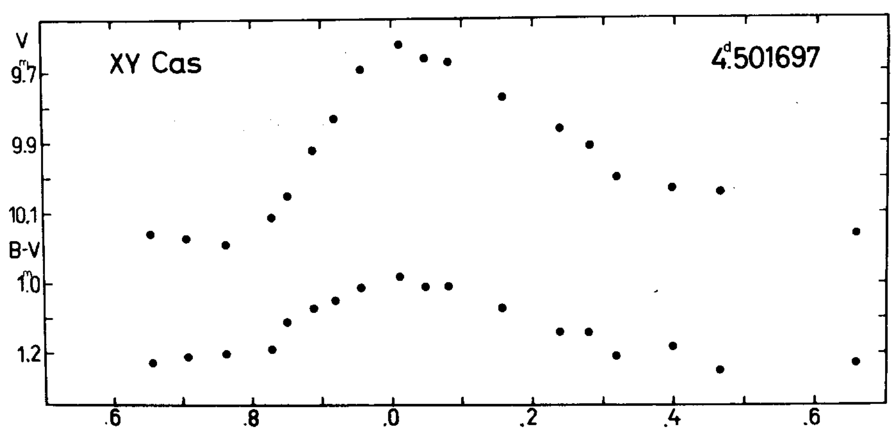

Figure 65 V and B-V curves of XY Cas

Figure 66 shows that the period has remained constant since the discovery of the light variation of XY Cas. The period change reported by Solov'yov (1954) cannot be confirmed.

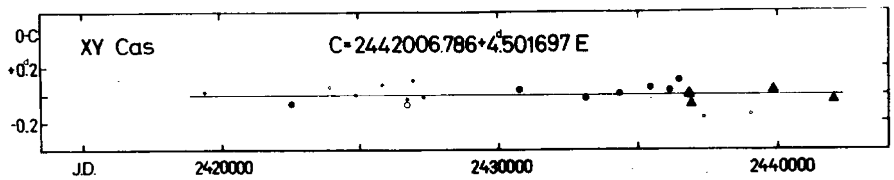

Figure 66 O-C diagram of XY Cas

Table 39 O-C residuals for XY Cas

Obs.Max.J.D.	E	O-C	Type	w	Source
2419403.784	-5021	$+0^{d}.019$	phg	0.5	Robinson (1929)
2422541.383	-4324	-0.065	phg	1	Lehmann-Balan. (1924)
2423919.026	-4018	+0.059	vis	0.5	Selivanov (1928)
2424859.820	-3809	-0.002	vis	0.5	Selivanov (1928)
2425845.76	-3590	+0.07	phg	0.5	Oosterhoff (1935)
2426287.00	-3492	-0.14	phg	0	Oosterhoff (1935)
2426705.737	-3399	+0.219	vis	0	Kukarkin (1940)
2426709.946	-3398	-0.074	vis	1	Dunst (1932)
2426714.49	-3397	-0.03	phg	0.5	Oosterhoff (1935)
2426948.71	-3345	+0.10	phg	0.5	Oosterhoff (1935)
2427335.74	-3259	-0.02	phg	0.5	Oosterhoff (1935)
2428466.03	-3008	+0.35	phg	0	Fu (1964)
2430761.585	-2498	+0.038	phg	1	Solov'yov (1954)
2433147.420	-1968	-0.026	phg	1	Solov'yov (1954)
2434340.403	-1703	+0.007	phg	1	Tsarevsky (1960)
2435456.868	-1455	+0.051	phg	1	Tsarevsky (1960)
2436136.605	-1304	+0.032	phg	1	Tsarevsky (1960)
2436474.306	-1229	+0.106	phg	1	Tsarevsky (1960)
2436820.826	-1152	-0.005	phel	3	Oosterhoff (1960)
2436829.852	-1150	+0.018	phel	3	Weaver et al. (1960)
2436901.796	-1134	-0.066	phel	3	Bahner et al. (1962)
2437365.373	-1031	-0.163	vis	0.5	Berthold (1973)
2439031.023	-661	-0.141	vis	0.5	Berthold (1973)
2439818.991	-486	+0.030	phel	3	present paper[1]
2442006.751	0	-0.035	phel	3	present paper
2442097.08	+20	+0.26	vis	0	Small (1974)

Remark: [1] Observer: Abaffy.

VZ Cygni

The light and colour curves of this variable are shown in Fig. 67. The O-C residuals have been computed with the formula:

$$C = 2441705.702 + 4^{d}.864453E \ .$$

The O-C diagram presented in Fig. 68 shows a period change:

before J.D. 2434000, $P = 4^{d}.864583$;

after J.D. 2434000, $P = 4^{d}.864453$.

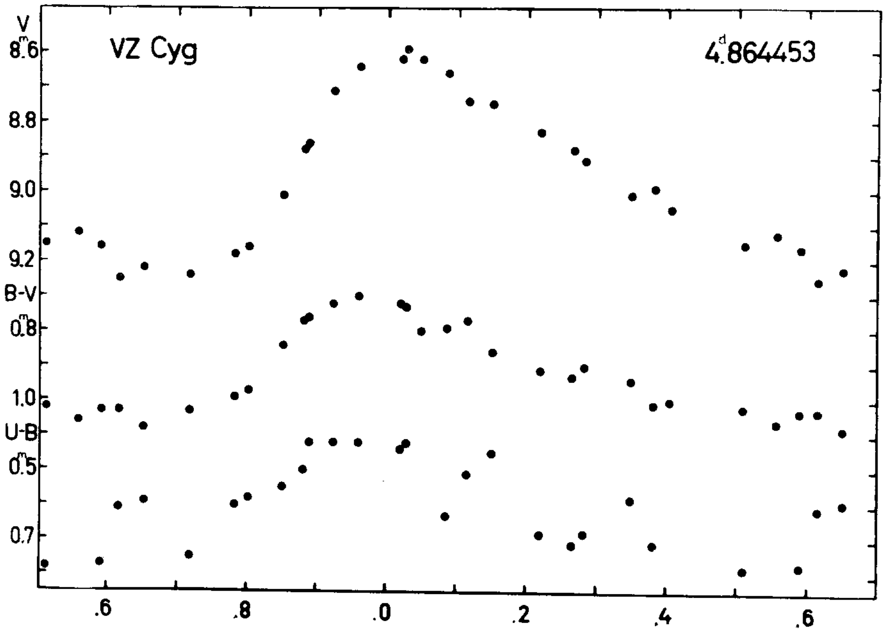

Figure 67 V, B-V and U-B curves of VZ Cyg

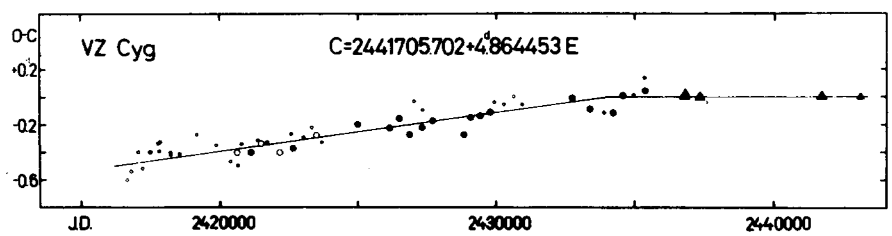

Figure 68 O-C diagram of VZ Cyg

Table 40 O-C residuals for VZ Cyg

Obs.Max.J.D.	E	O-C	Type	w	Source
2416658.035	-5149	$-0^{d}.599$	vis	0.5	Graff (1914)
2416799.165	-5120	-0.538	vis	0.5	Zinner[1] (1932)
2417062.0	-5066	-0.4	vis	0.5	Seares (1907a)
2417066.4	-5065	-0.8	vis	0	Blazhko (1906)
2417207.798	-5036	-0.519	vis	0.5	Zinner[1] (1932)
2417485.2	-4979	-0.4	vis	0.5	Seares (1907a)
2417499.783	-4976	-0.401	vis	0.5	Zinner[1] (1932)
2417762.528	-4922	-0.336	vis	0.5	Zeipel (1908)
2417815.980	-4911	-0.393	vis	0.5	Zinner[1] (1932)
2417820.912	-4910	-0.326	vis	0.5	Luizet (1909)
2418195.396	-4833	-0.405	vis	0.5	Zinner[1] (1932)
2418224.569	-4827	-0.418	vis	0.5	Luizet (1909)
2418560.219	-4758	-0.416	vis	0.5	Zinner[1] (1932)
2419158.686	-4635	-0.276	vis	0.5	Zinner[1] (1932)

Table 40 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2419859.095	-4491	$-0^d.349$	vis	0.5	Zinner[1] (1932)
2420379.476	-4384	-0.464	vis	0.5	Zinner[1] (1932)
2420627.598	-4333	-0.405	vis	1	Doberck (1920a)
2420642.129	-4330	-0.493	phg	0.5	Robinson (1930)
2420768.758	-4304	-0.338	vis	0.5	Zinner[1] (1932)
2421084.891	-4239	-0.395	vis	0.5	Zinner[1] (1932)
2421114.079	-4233	-0.393	phg	2	Jordan (1929)
2421386.567	-4177	-0.315	vis	0.5	Zinner[1] (1932)
2421498.432	-4154	-0.332	vis	1	Doberck (1920a)
2421722.207	-4108	-0.322	vis	0.5	Zinner[1] (1932)
2422165.164	-4017	-0.030	vis	0	Zinner[1] (1932)
2422179.388	-4014	-0.400	vis	1	Doberck (1920a)
2422588.133	-3930	-0.269	vis	0.5	Zinner[1] (1932)
2422656.134	-3916	-0.370	phg	1	Jordan (1929)
2423040.508	-3837	-0.288	vis	0.5	Zinner[1] (1932)
2423327.580	-3778	-0.219	vis	0.5	Doberck (1924b)
2423507.509	-3741	-0.274	vis	1	Nielsen (1954)
2423692.305	-3703	-0.328	vis	0.5	Doberck (1924b)
2424996.109	-3435	-0.197	phg	1	Wachmann (1935)
2426163.550	-3195	-0.225	phg	1	Wachmann (1935)
2426513.862	-3123	-0.153	phg	1	Wachmann (1935)
2426898.035	-3044	-0.272	phg	1	Wachmann (1935)
2427029.614	-3017	-0.033	vis	0.5	Dziewulski et al.(1938)
2427321.296	-2957	-0.218	phg	2	Gesundheit (1938)
2427360.339	-2949	-0.091	vis	0.5	Dziewulski et al.(1938)
2427739.687	-2871	-0.170	phg	2	Gesundheit (1938)
2428848.680	-2643	-0.273	phg	1	Abidov (1963)
2429096.894	-2592	-0.146	phg	1	Abidov (1963)
2429452.007	-2519	-0.138	phg	1	Abidov (1963)
2429812.004	-2445	-0.110	phg	1	Abidov (1963)
2429933.686	-2420	-0.040	vis	0.5	Conceicao-Silva (1950a)
2430269.317	-2351	-0.056	vis	0.5	Conceicao-Silva (1950a)
2430571.42	-2289	+0.45	vis	0	Stein (1944)
2430624.483	-2278	+0.005	vis	0.5	Conceicao-Silva (1950a)
2430921.153	-2217	-0.057	vis	0.5	Conceicao-Silva (1950a)
2432755.06	-1840	-0.05	phg	1	Novikov (1951)
2433387.402	-1710	-0.085	phg	1	Abidov (1963)
2433903.002	-1604	-0.117	phg	0.5	Abidov (1963)
2434219.193	-1539	-0.116	phg	1	Abidov (1963)
2434589.022	-1463	+0.015	phg	1	Abidov (1963)
2434953.849	-1388	+0.008	phg	0.5	Abidov (1963)
2435323.677	-1312	+0.137	phg	0.5	Abidov (1963)
2435362.501	-1304	+0.046	phg	1	Vyskupaitis (1961)
2436773.146	-1014	-0.001	phel	3	Weaver et al. (1960)
2436802.348	-1008	+0.015	phel	3	Oosterhoff (1960)
2437352.009	-895	-0.008	phel	3	Mitchell et al. (1964)
2437556.280	-853	-0.044	vis	0.5	Schreier (1962)
2441705.698	0	-0.004	phel	3	present paper
2443062.886	+279	+0.002	phel	2	present paper

Remark: [1] Observer: Hartwig

V 1154 Cygni

The cepheid V 1154 Cygni has a faint companion about 20" S. The light and colour curves for this variable are shown in Fig. 69. Unfortunately, the U-B colour curve is not complete.

The O-C residuals have been calculated with the formula:

$$C = 2441494.442 + 4^{d}.925460E \ .$$

According to Fig. 70 this star has a constant period.

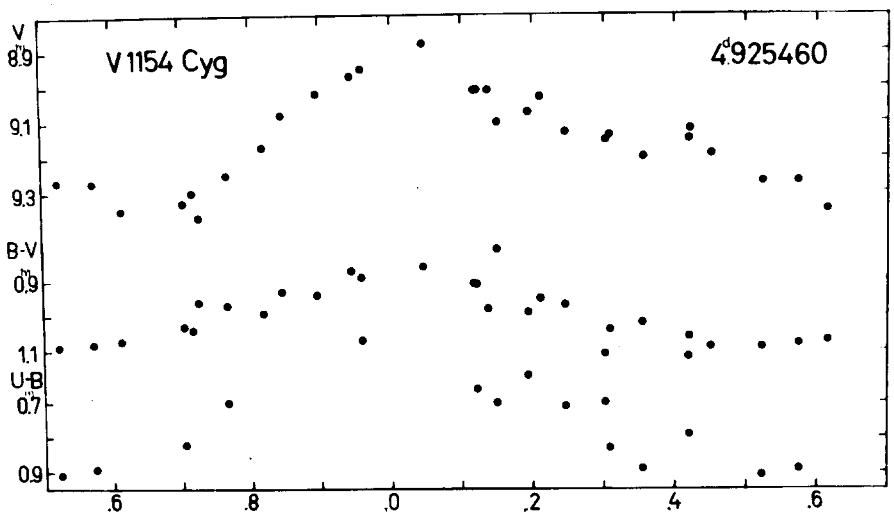

Figure 69 V, B-V and U-B curves of V 1154 Cyg

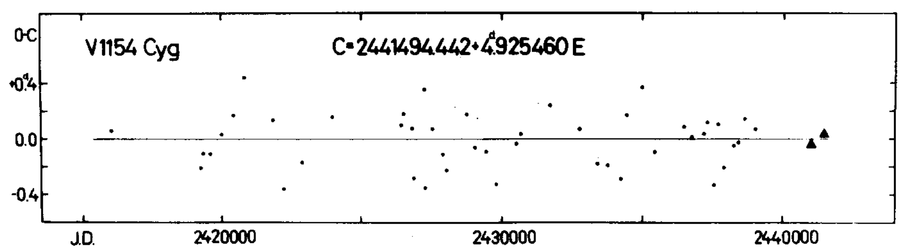

Figure 70 O-C diagram of V 1154 Cyg

Table 41 O-C residuals for V 1154 Cyg

Obs.Max.J.D.	E	O-C	Type	w	Source
2416044.647	-5167	$+0^{d}.057$	phg	0.5	Strohmeier et al.(1968)
2419265.632	-4513	-0.209	phg	0.5	Strohmeier et al.(1968)
2419349.471	-4496	-0.103	phg	0.5	Strohmeier et al.(1968)
2419595.739	-4446	-0.108	phg	0.5	Strohmeier et al.(1968)
2420009.616	-4362	+0.031	phg	0.5	Strohmeier et al.(1968)
2420423.492	-4278	+0.168	phg	0.5	Strohmeier et al.(1968)

Table 41 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2420852.283	-4191	$+0^d.440$	phg	0.5	Strohmeier et al.(1968)
2421846.916	-3989	+0.134	phg	0.5	Strohmeier et al.(1968)
2422230.609	-3911	-0.359	phg	0.5	Strohmeier et al.(1968)
2422895.733	-3776	-0.172	phg	0.5	Strohmeier et al.(1968)
2423984.587	-3555	+0.156	phg	0.5	Strohmeier et al.(1968)
2426427.558	-3059	+0.098	phg	0.5	Ott (1966)
2426531.072	-3038	+0.178	phg	0.5	Strohmeier et al.(1968)
2426846.198	-2974	+0.074	phg	0.5	Strohmeier et al.(1968)
2426880.322	-2967	-0.280	phg	0.5	Ott (1966)
2427260.218	-2890	+0.356	phg	0.5	Strohmeier et al.(1968)
2427303.838	-2881	-0.353	phg	0.5	Ott (1966)
2427530.835	-2835	+0.072	phg	0.5	Strohmeier et al.(1968)
2427919.762	-2756	-0.112	phg	0.5	Strohmeier et al.(1968)
2428067.411	-2726	-0.227	phg	0.5	Ott (1966)
2428777.082	-2582	+0.178	phg	0.5	Strohmeier et al.(1968)
2429077.290	-2521	-0.067	phg	0.5	Ott (1966)
2429456.525	-2444	-0.093	phg	0.5	Strohmeier et al.(1968)
2429825.703	-2369	-0.325	phg	0.5	Strohmeier et al.(1968)
2430535.260	-2225	-0.033	phg	0.5	Strohmeier et al.(1968)
2430673.244	-2197	+0.036	phg	0.5	Nikulina (1970)
2431717.643	-1985	+0.239	phg	0.5	Nikulina (1970)
2432776.449	-1770	+0.071	phg	0.5	Nikulina (1970)
2433406.659	-1642	-0.177	phg	0.5	Nikulina (1970)
2433790.836	-1564	-0.186	phg	0.5	Strohmeier et al.(1968)
2434248.806	-1471	-0.284	phg	0.5	Strohmeier et al.(1968)
2434480.757	-1424	+0.170	phg	0.5	Nikulina (1970)
2434983.354	-1322	+0.370	phg	0.5	Nikulina (1970)
2435445.884	-1228	-0.093	phg	0.5	Nikulina (1970)
2436495.184	-1015	+0.084	phg	0.5	Nikulina (1970)
2436780.793	-957	+0.013	phg	0.5	Ott[1] (1966)
2437199.479	-872	+0.038	phg	0.5	Ott[2] (1966)
2437332.550	-845	+0.122	phg	0.5	Nikulina (1970)
2437583.294	-794	-0.332	phg	0.5	Ott (1966)
2437706.869	-769	+0.106	phg	0.5	Busch, Häussler (1966)
2437918.353	-726	-0.205	phg	0.5	Ott (1966)
2438287.920	-651	-0.047	phg	0.5	Ott[2] (1966)
2438425.857	-623	-0.023	phg	0.5	Nikulina (1970)
2438662.447	-575	+0.145	phg	0.5	Ott[2] (1966)
2439031.788	-500	+0.076	phg	0.5	Ott[2] (1966)
2441006.788	-99	-0.033	phel	3	Wachmann (1976)
2441494.482	0	+0.040	phel	3	present paper

Remarks: [1] Observer: Weber; [2] Obs.: Häussler.

AS Persei

The light and colour curves of this star based on the observations made between 1972-1974 are shown in Fig.71. It is highly interesting that the amplitude of the light variation is decreasing. In 1959 the amplitudes were $1^m.361$ and $0^m.957$ in B and V, respectively (Schaltenbrand and Tammann 1971). In 1972-1974 the

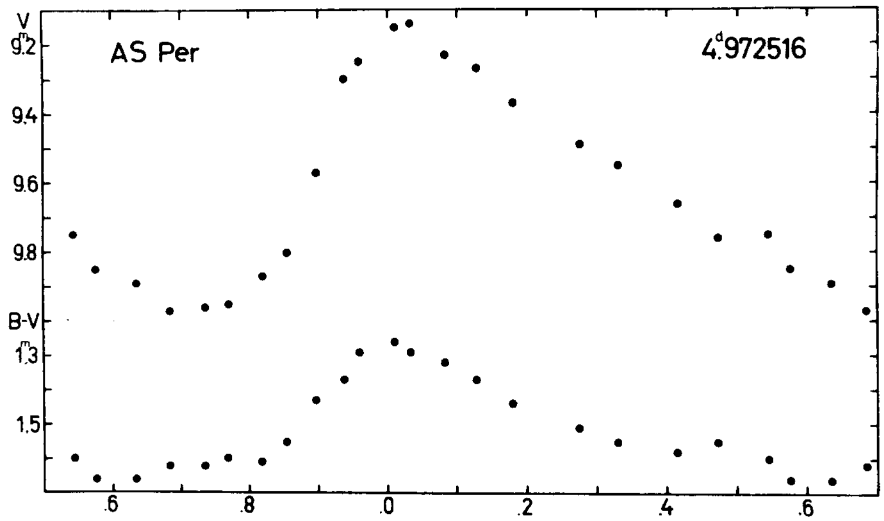

Figure 71 V and B-V curves of AS Per

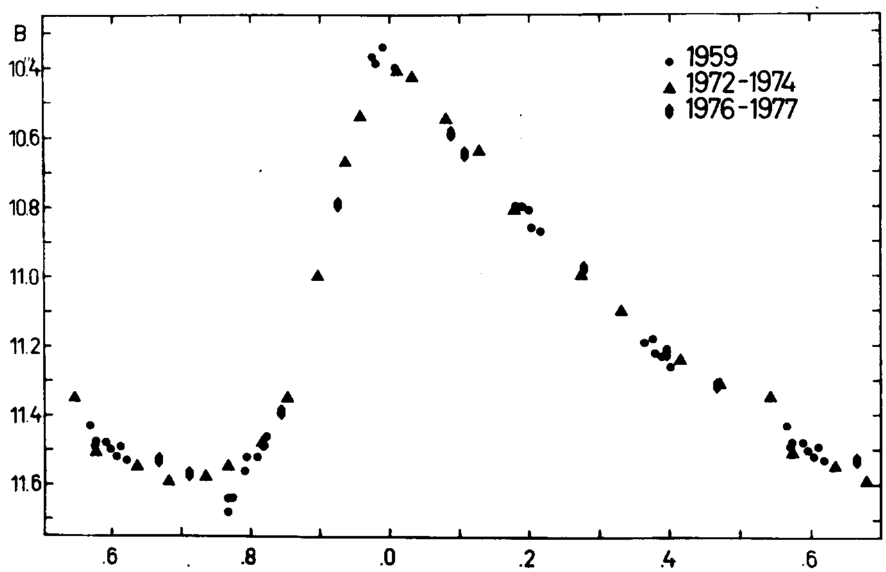

Figure 72 The composite B light curve of AS Per

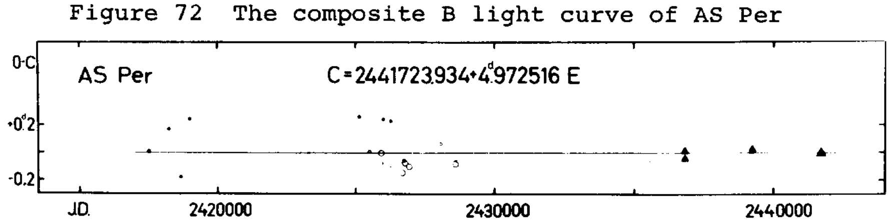

Figure 73 O-C diagram of AS Per

amplitudes were smaller: $1^m_.20$ in B and $0^m_.83$ in V. In order to check the reality of this unique behaviour AS Per was reobserved in 1976-1977. The amplitudes were even smaller in this season. The composite B light curve is shown in Fig. 72. The decrease of the amplitude is about $0^m_.01$/year in B light. Unfortunately, the unfavourable period prevents getting a complete light curve during one observational season. Further continuous photometry is needed to study this interesting phenomenon.

The O-C residuals have been computed with the formula:

$$C = 2441723.934 + 4^d_.972516E .$$

The O-C diagram (Fig. 73) shows the constancy of the period.

Table 42 O-C residuals for AS Per

Obs.Max.J.D.	E	O-C	Type	w	Source
2417522.706	-4867	$+0^d_.007$	phg	0.5	Kukarkin (1949)
2418258.80	-4719	+0.17	phg	0.5	Oosterhoff (1935)
2418676.14	-4635	-0.18	phg	0.5	Oosterhoff (1935)
2419009.72	-4568	+0.24	phg	0.5	Oosterhoff (1935)
2420546.56	-4259	+0.57	phg	0	Oosterhoff (1935)
2421585.66	-4050	+0.42	phg	0	Oosterhoff (1935)
2423399.77	-3685	-0.44	phg	0	Oosterhoff (1935)
2423783.63	-3608	+0.53	phg	0	Oosterhoff (1935)
2425155.87	-3332	+0.26	phg	0.5	Oosterhoff (1935)
2425528.46	-3257	+0.01	vis	0.5	Guthnick (1928)
2425936.190	-3175	-0.006	vis	1	Beyer (1934b)
2425985.840	-3165	-0.081	vis	0.5	Rügemer (1933)
2426001.08	-3162	+0.24	phg	0.5	Oosterhoff (1935)
2426239.433	-3114	-0.086	vis	1	Beyer (1934b)
2426284.50	-3105	+0.23	phg	0.5	Oosterhoff (1935)
2426565.02	-3049	+2.29	vis	0	Lange (1931)
2426691.869	-3023	-0.149	vis	1	Rügemer (1933)
2426761.57	-3009	-0.06	phg	0.5	Oosterhoff (1935)
2426786.424	-3004	-0.072	vis	1	Beyer (1934b)
2426995.241	-2962	-0.101	vis	1	Rügemer (1933)
2427034.78	-2954	-0.34	phg	0	Oosterhoff (1935)
2428094.332	-2741	+0.064	vis	0.5	Ahnert (1947)
2428611.322	-2637	-0.081	phg	1	Kukarkin (1949)
2428631.23	-2633	-0.07	vis	0.5	Kukarkin (1949)
2436816.019	-987	-0.042	phel	2	Weaver et al. (1960)
2436821.041	-986	+0.008	phel	2	Oosterhoff (1960)
2439252.614	-497	+0.020	phel	2	Takase (1969)
2441723.922	0	-0.012	phel	3	present paper

V Lacertae

According to Oosterhoff (1960) there is a photometric companion at V Lac. Miller and Preston (1964) contradicted this statement. The ratios of light amplitudes in different colours do not confirm the presence of a companion (see Fig. 74).

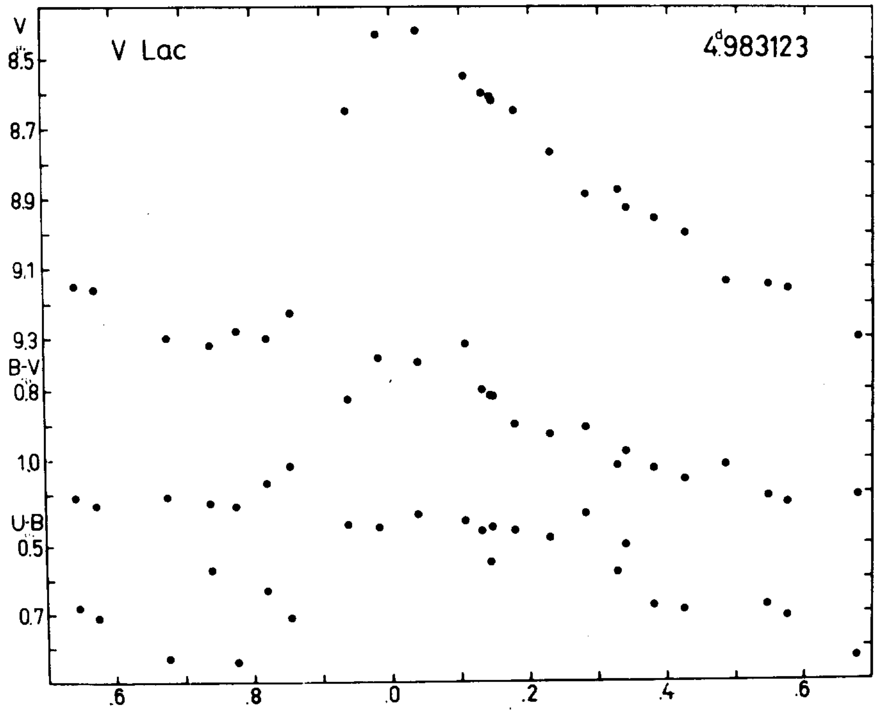

Figure 74 V, B-V and U-B curves of V Lac

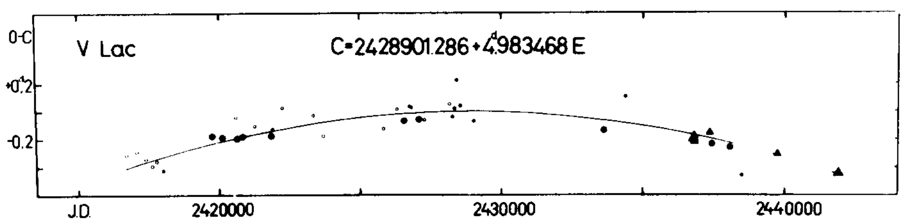

Figure 75 O-C diagram of V Lac

Table 43 O-C residuals for V Lac

Obs.Max.J.D.	E	O-C	Type	w	Source
2416716.392	-2445	$-0^{d}.314$	vis	0.5	Seares (1907b)
2417065.259	-2375	-0.289	vis	0.5	Seares (1907b)
2417353.6	-2317	-1.0	vis	0	Blazhko (1907a)
2417399.097	-2308	-0.344	vis	0.5	Seares (1907b)
2417613.341	-2265	-0.389	vis	0.5	Seares (1907b)
2417782.809	-2231	-0.359	vis	0.5	Zeipel (1908)
2417783.5	-2231	+0.3	vis	0	Müller, Hartwig[1] (1920)
2418031.919	-2181	-0.424	phg	0.5	Robinson (1931b)
2419716.574	-1843	-0.179	phg	1	Martin, Plummer (1916)
2420070.390	-1772	-0.189	phg	2	Martin, Plummer (1916)
2420578.848	-1670	-0.045	vis	0.5	Doberck (1920b)
2420633.512	-1659	-0.199	phg	2	Martin, Plummer (1916)

Table 43 (cont.)

Obs.Max.J.D.	E	O-C	Type	w	Source
2420817.920	-1622	$-0^d.181$	phg	2	Hertzsprung (1922)
2421266.507	-1532	-0.106	vis	0.5	Doberck (1920b)
2421844.515	-1416	-0.180	phg	2	Jordan (1929)
2421884.427	-1408	-0.136	vis	0.5	Doberck (1920b)
2422203.529	-1344	+0.024	vis	0.5	Doberck (1920b)
2423334.721	-1117	-0.031	vis	0.5	Doberck (1924b)
2423698.370	-1044	-0.175	vis	0.5	Doberck (1924b)
2425836.327	-615	-0.126	vis	0.5	Parenago (1938)
2426324.847	-517	+0.014	vis	0.5	Terkán (1935)
2426529.094	-476	-0.061	vis	0.5	Kukarkin (1940)
2426558.980	-470	-0.076	phg	1	Zonn (1933)
2426758.428	-430	+0.033	vis	0.5	Dziewulski[2] (1947)
2426818.224	-418	+0.028	vis	0.5	Dziewulski (1947)
2427092.226	-363	-0.061	phg	1	Zonn (1933)
2427281.593	-325	-0.066	vis	0.5	Florya, Kukarkina(1953)
2428173.748	-146	+0.048	vis	0.5	Gur'yev (1938)
2428283.296	-124	-0.040	phg	0.5	Dziewulski et al.(1946)
2428353.125	-110	+0.020	phg	0.5	Dziewulski et al.(1946)
2428423.09	-96	+0.22	phg	0.5	Fu (1964)
2428557.460	-69	+0.033	phg	0.5	Dziewulski et al.(1946)
2429045.74	+29	-0.07	phg	0.5	Kurochkin (1946)
2433635.445	+950	-0.136	phg	1	Solov'yov (1952b)
2434393.169	+1102	+0.101	phg	0.5	Nikulina (1970)
2436794.894	+1584	-0.205	phel	3	Weaver et al. (1960)
2436809.829	+1587	-0.221	phel	2	Oosterhoff (1960)
2436834.777	+1592	-0.191	phel	2	Bahner et al. (1962)
2437348.104	+1695	-0.160	phel	2	Mitchell et al. (1964)
2437422.781	+1710	-0.235	phg	1	Golovatyj (1964)
2437487.567	+1723	-0.234	phg	0.5	Nikulina (1970)
2438070.607	+1840	-0.260	phg	1	Golovatyj (1964)
2438474.068	+1921	-0.460	phg	0.5	Nikulina (1970)
2439754.969	+2178	-0.310	phel	2	present paper[3]
2441907.688	+2610	-0.449	phel	3	present paper

Remarks: [1] Observer: Hartwig; [2] Obs.: Iwanowska; [3] Obs.: Abaffy.

The O-C residuals have been computed with the formula:

$$C = 2428901.286 + 4^d.983468E \ .$$

The O-C diagram (Fig. 75) can be represented by a negative parabola:

$$C_{par} = 2428901.286 + 4^d.983468E - 6^d.7\cdot10^{-8}E^2 \ .$$

This representation of O-C residuals contradicts Parenago's (1956) statement that only sudden period changes can exist at the cepheids.

GENERAL REMARKS

Period changes

The investigation of period changes of cepheids is of a great importance because an observational test of the cepheid evolution theory becomes possible by means of such investigations. The larger the number of epochs during which the observations have been made the more probable the detection of some evolutionary features on the basis of the observed period changes.

Parenago (1956) investigated period changes of 42 cepheids selected arbitrarily. His sample contains only 7 cepheids with periods less than 5 days, and the O-C diagrams published by him are not correct in the case of BL Her, SW Tau, BY Cas, SU Cyg and XY Cas.

Since 1956 many cepheids have changed their period. As photoelectric photometry has become general in the last decades, it has been possible to determine the recent period changes more accurately. The present study on the period changes of cepheids based on uniformly constructed O-C diagrams has therefore uncovered a number of previously unnoticed phenomena. However, Parenago's statements concerning the statistics of period changes are correct (cf. page 110).

Parenago found that the period changes were always sudden, i.e. the O-C diagram for a cepheid variable consists of straight lines. Detre (1970) distinguished three kinds of O-C diagrams for cepheids:

1. Those showing an evolutionary characteristic (parabolic curve), assuming that a cepheid changes its period while crossing the instability strip. Among cepheids with a period of less than 5 days there is only one star with an obviously parabolic O-C graph, viz. V Lac (see Fig. 75);
2. Those showing constant period. The number of cepheids with constant period diminishes continuously because each cepheid will change its period within a certain time;
3. Those showing irregular fluctuations of the period. Detre did not state that only sudden period changes could exist. The O-C diagrams presented in the previous section have shown that the

period changes are sudden in the overwhelming majority of cases. As a matter of fact the straight lines may be distorted because of the period noise. Moreover, the velocity of the period change is unknown, i.e. we do not know the real shape of the O-C diagrams at the intersections of these straight lines. Therefore, we only approximate the O-C diagrams with straight lines. Besides the parabolic O-C curve of V Lac only AU Peg and possibly BL Her show an O-C graph which cannot be represented by straight lines. However, these latter two stars are Population II cepheids.

Several cepheids which changed their period more than once have very interesting gradual, "stepwise" O-C variations. The original value of the period changed at a certain moment and in a short or somewhat longer time the period returned to its original value.Such a rejump may take place so suddenly (e.g. SU Cyg in Fig. 44) that the value of the intermediate period cannot be determined.If the rejump of the period is slower (e.g. V 532 Cyg in Fig. 31) the two opposite period jumps are well observable. In the case of SZ Tau there are two intermediate periods before returning to the original value of the period. These stepwise period changes can best be seen in DT Cyg (see Fig. 16). DT Cyg has changed its period and returned to the original period at least four times.

This kind of period change may well have an important role in checking the recent theory on the evolution of cepheids. Arp (1960) showed the path of cepheid evolution between the blue giants and the red supergiants to be very close to a period-equals-constant line for cepheids in Small Magellanic Cloud. Later, Efremov (1968a) constructed the composite colour-magnitude diagram for the galactic groups of stars containing cepheids. His composite diagram shows that the slope of the evolutionary path is close to the slope of lines of constant period for the galactic cepheids, as well.

The stepwise O-C diagram can be interpreted as a result of the evolution of the cepheid along the line of a given (constant) period.The deviations from this constant period are marks of small period fluctuations. The existence of this kind of O-C diagram is observational evidence supporting the hypothesis on the evolution of cepheids along the lines of constant period.

It is noteworthy that among RR Lyrae variables such kinds of period changes are very rare. Among the 195 field RR Lyrae variables investigated by Tsessevitch (1966), only two stars (UY Boo, AT Ser) showed a return to the earlier period. Among 117 investigated RR Lyrae stars in the globular cluster M3, three variables (V54, V81, V110) showed rejump of the period (Szeidl 1965).

There is another phenomenon observable for SU Cyg (a cepheid with a rejumping period), which leads us to treat secular variations of the light curves.

Secular variations of the light curves

The difference between the O-C values before the period jump and after the rejump for maximum brightness ($\Delta(O-C)_{max}$) differs remarkably from $\Delta(O-C)_{med}$ for median brightness in the case of SU Cyg (see Fig. 44).

The time difference between the moments of a maximum and the preceding median brightness were equal to about $0\overset{d}{.}43$ until the period jump and after the rejump became $0\overset{d}{.}35$. This means that the ascending branch of the light curve became considerably steeper than before the period jump.

Secular variation in the shape of the light curve can be observed in the case of FF Aql as well. As is shown in Fig. 63, the moments of the median brightness either repeat themselves with a period somewhat less than the period determined from the maxima or they are repeated with the period valid for the maximum but with a period jump and rejump at an unknown time between J.D. 2426000 and J.D. 2433000. In the case of FF Aql the ascending branch of the light curve has become less steep either suddenly or continuously.

The third case of the observed secular light curve variations is the amplitude decrease of AS Per. This very slight decrease (about 0.01 mag/year in B) may not mean that AS Per evolves out of the instability strip because the calculated decay time of the pulsation is not more than several years (Christy 1966). Moreover, the period of the light variation of AS Per is constant. This means that the star is in a quiet stage of its evolution.

The physical causes of above-mentioned sudden period changes and secular light curve variations are not yet known.

Cepheids with small amplitude

The first problem connected with these cepheids is the separation of cepheids with apparently small amplitude (photometric effect because of a companion) from the group of cepheids with really small amplitude. Cepheids with a nearly symmetrical light curve are undoubtedly true members of the group containing cepheids with small amplitude, since cepheids with large amplitude and nearly symmetrical light curve do not exist (except some cepheids with a period of 9-10 days for which the symmetrical light curve is caused by the presence of a bump). In order to decide whether a cepheid with small amplitude and light curve consisting of a steep rising branch and a less steep descending branch belongs either to large amplitude variables with apparently decreased amplitude or to small amplitude variables, spectroscopic observations of good quality are necessary. Spectroscopic observations are recommended in the cases of IR Cep and V 508 Mon.

The second and more important problem concerning the small amplitude cepheids is their evolutionary status. According to Efremov (1968b) these stars have not yet reached the red supergiant stage, they are just crossing the instability strip for the first time. A great many arguments support this hypothesis. However, the theoretical calculations on the crossing time predict far fewer small amplitude cepheids compared with the other classical cepheids (Hofmeister 1967). If the first crossing were slower, the number of observable small amplitude cepheids would be greater.

According to the theory of cepheid evolution the period of a cepheid must increase during the first crossing of the instability strip. During a given time interval the calculated change in the period is about a hundred times larger at the first crossing by comparison with other crossings of larger serial numbers in the case of low and intermediate cepheid masses (Hofmeister 1965).The cepheids with periods of less than five days are not massive for cepheids.

The period changes determined from the O-C diagrams show much less difference between the ratios of period variation for small amplitude cepheids (first crossing) and large amplitude cepheids (second, third and other crossings). Let ΔP be the difference between the new and old values of the period at any period change. The relative change of the period is $|\Delta P|/P \approx 0.00011$ for small amplitude cepheids averaged from 14 individual values. Seven variables showed no period changes. The three small amplitude cepheids showing both period jump and rejump are considered as cepheids with constant period, as well. The value $|\Delta P|/P$ for large amplitude classical cepheids is equal to 0.000007 (averaged from 17 values). Thus the relative period variation for small amplitude cepheids is only 10-20 times larger compared with the relative period variation for large amplitude classical cepheids. This can be explained in two different ways. Either the small amplitude cepheids evolve more slowly than predicted by the theory or the period variation does not mean the evolution of the cepheids – if these variables evolve along a path close to the lines of constant period. The latter case is more probable on the basis of O-C diagrams showing a rejumping period. Of course, in this case the rapid evolution (i.e. the short crossing time) at the first crossing takes place without greater period changes. However, the individual changes in period of small amplitude cepheids are usually much larger than in the case of large amplitude ones.

The instability of the period

Parenago (1956) suggested a new quantity $\Delta E \cdot |\Delta P|/P$, which is characteristic of the instability of the period. Here ΔE is the number of epochs during which the period remained constant. Table 44 gives a short summary on the instability of the period for different groups of cepheids. The successive columns contain the following data:

1. Name of the group
2. Average value of $\Delta E \cdot |\Delta P|/P$
3. Average value of ΔE
4. Average value of period of cepheids on which basis the preceding parameters are derived

5. Number of investigated cepheids in this group
6. Abbreviation of the name of the group in Table 45 .

Table 44

Group	$\overline{\Delta E \cdot \lvert\Delta P\rvert / P}$	$\overline{\Delta E}$	$\overline{P}$	n	Abbrev.
Classical cepheids with large amplitude	0.03	4000	$4^{d}.1$	17	I
Classical cepheids with small amplitude	0.26	2400	3.1	14	Is
W Vir type variables	0.15*	5500	2.6	6*	II

The asterisks in Table 44 denote that AU Peg is omitted from among W Vir stars because its extremely large period changes would distort the statistics.

Parenago derived 3-4 times larger values for $\overline{\Delta E \cdot \lvert\Delta P\rvert / P}$. He obtained 0.10 and 0.54 for the I and II groups, respectively. This systematic difference between his results and mine can be understood easily. The average period of cepheids investigated by Parenago is longer than 10 days (for both I and II groups), and it is well known that the longer the period, the greater its instability.

Summary of the observations

The fundamental parameters of the light variation of the observed cepheids are summarized in Table 45. The successive columns contain the following data:

1. Name of the cepheid
2. Period of light variation

3-4. The moments of the normal maximum and normal median brightnesses derived from the observations listed in Table 3

5-7. The maximum and minimum magnitudes and the amplitude in V

8-10. The corresponding quantities for B as under 5-7

11-13. The corresponding quantities for U as under 5-7

14. Type of cepheid

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Table 45 Summary of the observations

Name	Period	Norm.Max. Hel.J.D.2440000+	Norm.Med.	V_{max}	V_{min}	A_V	B_{max}	B_{min}	A_B	U_{max}	U_{min}	A_U	Type
DQ And	$3^{d}.200557$	1994.943	1994.620	$11^{m}.27$	$12^{m}.03$	$0^{m}.76$	$11^{m}.76$	$12^{m}.84$	$1^{m}.08$				II
FF Aql	4.470916	1576.428	1575.542	5.21	5.57	0.36	5.89	6.36	0.47	$6^{m}.33$	$6^{m}.91$	$0^{m}.58$	Is
V 572 Aql	3.767697	1921.259	1920.415	11.01	11.42	0.41	11.87	12.50	0.63				II
Y Aur	3.859502	1715.364	1715.010	9.17	9.99	0.82	9.87	11.04	1.17				I
RT Aur	3.728190	1723.675	1723.247	5.01	5.82	0.81	5.43	6.60	1.17	5.72	7.08	1.36	I
SU Cas	1.949322	1645.910	1645.532	5.76	6.13	0.37	6.32	6.88	0.56	6.79	7.42	0.63	Is
SY Cas	4.071098	1682.236	1681.792	9.42	10.18	0.76	10.20	11.31	1.11				I
XY Cas	4.501697	2006.786	2006.239	9.61	10.19	0.58	10.58	11.40	0.82				I
BD Cas	3.650900	1932.032	1931.225	10.84	11.16	0.32	12.34	12.79	0.45				II
BY Cas	3.223316	1774.189	1773.395	10.18	10.58	0.40	11.32	11.86	0.54				Is
DF Cas	3.832472	1719.659	1719.230	10.53	11.12	0.59	11.49	12.36	0.87				I
V 395 Cas	4.037728	1949.427	1949.027	10.39	10.95	0.56	11.39	12.20	0.81				I
IR Cep	2.114124	1696.580	1696.248	7.58	7.98	0.40	8.28	8.86	0.58	8.70	9.39	0.69	Is*
BD+56°2806	2.80591	2676.397	2675.735	9.26	9.56	0.30	10.07	10.53	0.46				Is
SU Cyg	3.845492	1778.935	1778.589	6.45	7.17	0.72	6.83	7.86	1.03	7.17	8.34	1.17	I
VZ Cyg	4.864453	1705.698	1705.089	8.60	9.24	0.64	9.32	10.29	0.97	9.74	11.00	1.26	I
DT Cyg	2.499082	1737.798	1737.238	5.62	5.93	0.31	6.04	6.49	0.45	6.27	6.76	0.49	Is
V 402 Cyg	4.364836	1698.635	1698.050	9.54	10.18	0.62	10.47	11.27	0.80				I
V 532 Cyg	3.283612	1706.559	1705.882	8.97	9.31	0.33	9.90	10.41	0.49				Is
V 1154 Cyg	4.925460	1494.442	1493.555	8.95	9.36	0.41	9.72	10.34	0.62	10.35:	11.26	0.91:	Is

Table 45 (cont.)

Name	Period	Norm.Max. Hel.J.D.2440000+	Norm.Med. Hel.J.D.2440000+	V_{max}	V_{min}	A_V	B_{max}	B_{min}	A_B	U_{max}	U_{min}	A_U	Type
V 1334 Cyg	$3^d.333020$	1760.900	1760.240	$5^m.78$	$5^m.95$	$0^m.17$	$6^m.31$	$6^m.52$	$0^m.21$	$6^m.48$	$6^m.69$	$0^m.21$	Is
AD Gem	3.787980	1694.911	1694.555	9.59	10.23	0.64	10.08	10.99	0.91				I
BB Gem	2.308207	1839.700	1839.520	10.75	11.74	0.99	11.28	12.55	1.27				II
DX Gem	3.137486	1866.668	1866.047	10.53	10.89	0.36	11.39	11.86	0.47				Is
BL Her	1.3074502	1841.293	1841.180	9.78	10.60	0.82	10.02	11.13	1.11				II
V Lac	4.983123	1907.688	1907.204	8.41	9.32	0.91	9.09	10.45	1.36	9.53	11.23	1.70	I
Y Lac	4.323776	1746.745	1746.278	8.74	9.44	0.70	9.27	10.28	1.01	9.78	10.94	1.16	I
BE Mon	2.705510	1880.240	1879.932	10.25	10.84	0.59	11.17	11.98	0.81				I
V 465 Mon	2.713176	1698.687	1698.131	10.20	10.56	0.36	10.80	11.36	0.56				Is
V 508 Mon	4.133608	1732.070	1731.528	10.32	10.74	0.42	11.05	11.68	0.63				Is*
AU Peg	2.40142	1739.439	1738.920	9.11	9.46	0.35	9.78	10.29	0.51	10.11	10.80	0.69	II
SX Per	4.289967	1847.979	1847.601	10.68	11.43	0.75	11.60	12.77	1.17				I
AS Per	4.972516	1723.934	1723.397	9.14	9.97	0.83	10.39	11.59	1.20				I
ST Tau	4.034299	1761.963	1761.507	7.79	8.55	0.76	8.47	9.58	1.11	8.95	10.23	1.28	I
SW Tau	1.583584	1687.773	1687.418	9.37	10.16	0.79	9.82	10.88	1.06	10.05	11.26	1.21	II
SZ Tau	3.148380	1659.194	1658.491	6.35	6.71	0.36	7.10	7.62	0.52	7.52	8.13	0.61	Is
EU Tau	2.10248	1704.785	1704.360	7.94	8.28	0.34	8.57	9.03	0.46	9.02	9.60	0.58	Is
T Vul	4.435462	1705.121	1704.584	5.40	6.06	0.66	5.90	6.83	0.93	6.14	7.30	1.16	I

* Small amplitude, but non-sinusoidal light curve

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DER
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DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

Nr. 71.

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PERIOD CHANGES OF RR LYRAE STARS I. AT AND, SU DRA, RR LEO, TT LYN AND AR PER

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PERIOD CHANGES OF RR LYRAE STARS I.
AT AND, SU DRA, RR LEO, TT LYN AND AR PER

ABSTRACT

Photographic and photoelectric observations obtained at Konkoly Observatory during the past 45 years are presented.Using all available observations the O-C diagrams of AT And, SU Dra, RR Leo, TT Lyn and AR Per are constructed. Period jumps are characteristic of AT And and TT Lyn. In the period of AT And two jumps occurred: $+710\times10^{-8}$ days in 1956 and -545×10^{-5} days in 1962 (Figure 2). The period of TT Lyn is constant, but a jump of 8×10^{-5} days might have taken place in 1958 (Figure 10). The O-C diagram of SU Dra consists of waves of small amplitude, the photoelectric maxima from 1955 were able to be fitted by a straight line (Figure 5). The period of AR Per shows a constant increase with time at a rate of 1.01×10^{-8} days/year (Figure 13). The period of RR Leo also shows an increase at a rate of 15.849×10^{-8} days/year during the past 70 years. A more rigorous period analysis showed that cyclic variations with an amplitude of 0.006-0.007 days and with cycle length of 25000 epoch numbers were superimposed on the positive parabolic O-C diagram (Figures 7 and 8).

INTRODUCTION

Forty-five years ago *L. Detre* commenced to observe RR Lyrae stars at the Konkoly Observatory with the aim of investigating their possible multiple periodicity and secular period changes. In the thirties it was firmly believed that the evolutionary changes in the stars' constitution were reflected in the period changes. We now know that the question of period changes is more complex. The well-observed field RR Lyrae stars provide a good opportunity for us to investigate not only the rough structure but also the delicate features of their O-C diagrams as well as the minute changes in their periods. In this way it is hoped, that we will be able to elucidate the confused problem of period changes of RR Lyrae stars. Under the stimulation and inspiration of the late director of the Konkoly Observatory, *L. Detre*, we have buckled down to the task of processing the photographic and photoelectric data obtained at our observatory during the past 45 years and to collecting all the available moments of maximum of the RR Lyrae stars in order to construct precise and detailed O-C diagrams. In this paper we present the results on the RR Lyr type stars AT And, SU Dra, RR Leo, TT Lyn and AR Per. In subsequent papers we plan to publish our results on further RR Lyrae variables.

OBSERVATIONS

Since 1933 through the years some thousands of photographic and about 150000 photoelectric observations have been collected for field RR Lyrae variables at the Konkoly Observatory. The photographic observations were made with a 16 cm astrograph mostly using Kodak Eastman 40 and Guilleminot Superfulgur plates. The typical exposure times were 2-5 minutes. Photographic observations ceased in 1957.

The photoelectric observations were first carried out using the 60 cm Newton telescope at Budapest in 1952. Initially the observations were made without filters but since 1954, conventional filters of the UBV system have been used. The mirror of the telescope was first aluminized in 1963. The following multipliers were used: an RCA 931 A with Schott filters BG 12 in B and GG 11 in V; from 1954 an RCA 1P21 with Schott filters UG 1 in U, BG 12+ GG 13 in B and GG 11 in V; and after the aluminization of the mirror in 1963 an EMI 9052 B with the same filters as in the previous years. Since 1972 photoelectric observations were also made close to the international UBV system with the new 50 cm telescope at Konkoly Observatory's mountain station. At this location we used an integrating photometer equipped with an unrefrigerated EMI 9058 QB photomultiplier and the following Schott filters: UG 2 in U, BG 12 + GG 13 in B and GG 11 in V.

The photoelectric observations have been transformed into the UBV system in the traditional way (see e.g. *Hardie,* 1962).

The journal of the observations of AT And, SU Dra, RR Leo, TT Lyn and AR Per is given below.

Table 1

star	year	kind of obs.		number of obs.	star	year	kind of obs.		number of obs.
AT And	1974	pe	ΔV	385	RR Leo	1965	pe	ΔV	25
		pe	ΔB	385			pe	ΔB	28
	1975	pe	ΔV	281		1966	pe	ΔV	25
		pe	ΔB	288			pe	ΔB	86
	1977	pe	ΔV	44			pe	ΔU	59
		pe	ΔB	46		1967	pe	ΔV	76
							pe	ΔB	81
SU Dra	1937	pg		19		1968	pe	ΔV	28
	1939	pg		190			pe	ΔB	28
	1946	pg		100		1969	pe	ΔV	28
	1952	pg		149			pe	ΔB	27

Table 1 (cont.)

star	year	kind of obs.		number of obs.
SU Dra	1954	pg		94
	1955	pe	Δm	26
	1957	pe	ΔV	120
		pe	ΔB	107
	1959	pe	ΔV	230
		pe	ΔB	232
	1974	pe	ΔV	43
		pe	ΔB	42
	1975	pe	ΔV	234
		pe	ΔB	234
		pe	ΔU	174
	1976	pe	ΔV	18
		pe	ΔB	19
	1977	pe	ΔV	23
		pe	ΔB	22
RR Leo	1952	pg		16
	1953	pg		34
	1954	pg		63
		pe	Δm	117
	1955	pe	Δm	57
	1956	pg		25
		pe	Δm	144
	1957	pg		98
	1958	pe	ΔV	113
		pe	ΔB	110
	1959	pe	ΔV	131
		pe	ΔB	131
	1961	pe	ΔV	56
		pe	ΔB	56
	1963	pe	ΔV	47
		pe	ΔB	60
	1964	pe	ΔV	37
		pe	ΔB	36
		pe	ΔU	19
RR Leo	1970	pe	ΔV	23
		pe	ΔB	28
	1971	pe	ΔV	95
		pe	ΔB	98
	1972	pe	ΔV	39
		pe	ΔB	34
		pe	ΔU	27
	1973	pe	ΔV	33
		pe	ΔB	34
	1975	pe	ΔV	53
		pe	ΔB	56
	1976	pe	ΔV	55
		pe	ΔB	57
	1977	pe	ΔV	14
		pe	ΔB	16
TT Lyn	1959	pe	ΔV	233
		pe	ΔB	228
	1978	pe	ΔV	78
		pe	ΔB	88
AR Per	1937	pg		82
	1954	pe	Δm	28
		pe	ΔV	12
		pe	ΔB	15
	1958	pe	ΔV	181
		pe	ΔB	183
	1969	pe	ΔV	26
		pe	ΔB	25
		pe	ΔU	24
	1976	pe	ΔV	31
		pe	ΔB	31

In Tables 8-15 the photographic and photoelectric observations of the stars mentioned are given. Asterisks indicate that the observations were carried out without filters and are not, of course, converted into the UBV system.

AT ANDROMEDAE

AT And = 178.1935 And was discovered by *Morgenroth* (1935). *Lange* (1935) classified the star as an RR Lyrae variable and gave the preliminary ephemeris:

$$\text{J.D. max. hel.} = 2428022.37 + 0^{d}.628 \times E$$

During the past 40 years a number of visual and photographic observations were carried out on this star. *Parenago* (1940) in-

Table 2

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	Reference
1906	2417469.447	pg n	+0.029	-40320	+0.029	-40320	Tsessevich,(1966)
1935	27999.542	vis n	-0.006	-23251	+0.001	-23233	Kanishcheva, Lange,(1971)
	28022.37:	vis n	+0.009:	-23214			Lange,(1935)
1937	28745.378	pg n	-0.008	-22042	-0.008	-22042	Tsessevich,(1966)
1938	29162.423	pg n	+0.003	-21366	+0.003	-21366	-"-
1945	31700.402	vis n	-0.005	-17252	-0.005	-17252	-"-
1954	34961.450	pg n	+0.031	-11966	+0.031	-11966	Alania,(1956)
1956	35755.378	pg	-0.010	-10679	-0.022	-10597	Romano, Perissinotto (1969)
	35802.250	pg	-0.023	-10603			-"-
1957	35860.229	pg	-0.034	-10509			-"-
	36135.375	pg	-0.032	-10063	-0.016	-10062	-"-
	36137.257	pg	-0.001	-10060			-"-
1958	36378.470	pg	-0.002	- 9669	-0.011	- 9515	-"-
	36427.179	vis n	-0.029	- 9590			Lange,(1959)
	36491.354	pg	-0.013	- 9486			Romano, Perissinotto (1969)
1959	36596.244	pg	+0.001	- 9316			-"-
	36805.357	pg	-0.020	- 8977	-0.016	- 8894	-"-
	36821.386	pg	-0.031	- 8951			-"-
	36900.380	pg	-0.002	- 8823			-"-
	36908.392	pg	-0.010	- 8810			-"-

Table 2 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	Reference
1963	2438298.313:	pg n	+0.003:	- 6557	+0.002:	- 6530	Daube,(1969)
	38334.709	pe	+0.001	- 6498			Sturch,(1966)
1965	39026.887	pe	0.000	- 5376	0.000	- 5376	Fitch et al.,(1966)
1968	40220.617:	pe	0.000:	- 3441	0.000:	- 3441	Epstein,(1969)
1974	42277.4110	pe	+0.0004	- 107	-0.0002	+ 22	present paper
	42304.5565	pe	+0.0016	- 63			-"-
	42307.6405	pe	+0.0011	- 58			-"-
	42309.4887	pe	-0.0015	- 55			-"-
	42319.3592	pe	-0.0016	- 39			-"-
	42343.4205	pe	0.0000	0			-"-
	42361.3110	pe	0.0000	+ 29			-"-
	42367.4810	pe	+0.0008	+ 39			-"-
	42369.3290	pe	-0.0019	+ 42			-"-
	42403.2644	pe	+0.0032	+ 97			-"-
1975	42422.3849	pe	-0.0007	+ 128			-"-
	42424.2338	pe	-0.0025	+ 131			-"-
	42432.2550	pe	-0.0012	+ 144			-"-
	42712.3350	pe	-0.0005	+ 598	-0.0005	+ 598	-"-
1977	43422.4067	pe	+0.0023	+ 1749	+0.0023	+ 1749	-"-

vestigated AT And on 431 photographic plates of the Moscow Sternberg Institute and determined the following new elements:

$$\text{J.D. max. hel.} = 2429146.347 + 0^{d}.6169129 \times E$$

The amplitude of the light variation turned out to be fairly small, only $0^{m}.53$ pg.

Other visual and photographic maxima were derived from the observations of *Kippenhahn* (1953), *Alania* (1956), *Lange* (1959, 1968), *Tchumak* (1965), *Daube* (1969), *Romano* and *Perissinotto* (1969) and *Kanishcheva* and *Lange* (1971). *Tsessevich* (1966) examined the old Harvard plates and gave a very important time of maximum for the year 1906.

Tchumak (1965), using both *Parenago*'s and *Tsessevich*'s observations, stated that this star had a strong Blazhko effect. According to him the period of the secondary variation of the light curve was $P_B = 82^{d}.75$ and during this cycle the O-C oscillation of the maxima was 1.5 hours = $0^{d}.06 = 0^{P}.10$.

Lange (1968) and *Olah* (1975) questioned *Tchumak*'s results. Here we publish all the photoelectric observations obtained at the Konkoly Observatory in 1974, 1975 and 1977 (Table 8). These observations (see Figure 1) clearly and unambiguously show that AT And has a stable light curve and does not possess Blazhko effect. Other photoelectric observations (*Fitch* et al. 1966, *Sturch* 1966, *Epstein* 1969) also confirm the stable character of its light curve.

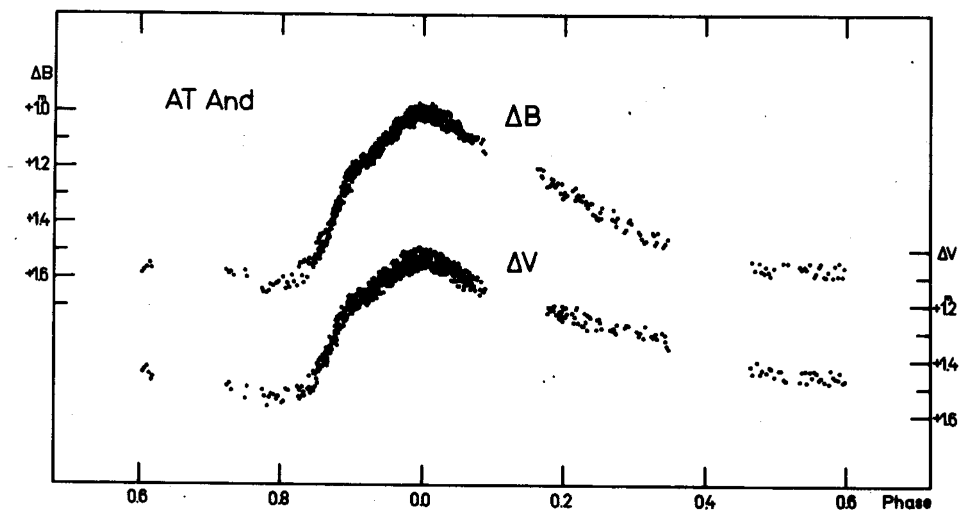

Figure 1: B and V light curves of AT And

The comparison star used for the photoelectric observations at Konkoly Observatory was BD $+42^{\circ}4739$. Its magnitude and colour were adopted from *Sturch* (1966): V = 9.465 and B-V = 0.372.

All the published maxima are given in Table 2. For each year we determined a mean value of O-C's. The O-C diagram (Figure 2) was constructed by using these mean values with the elements:

$$\text{J.D. max. hel.} = 2442343.4205 + 0\overset{d}{.}61691475 \times E$$

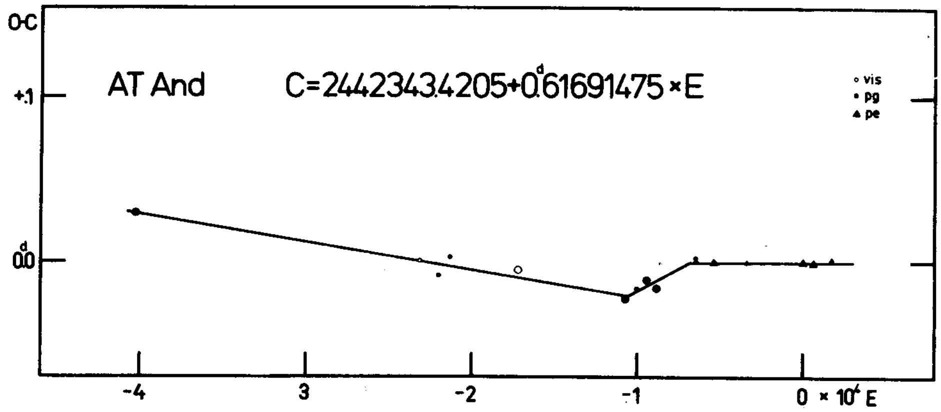

Figure 2: O-C diagram of AT And

Because of the abnormally wide scatter of *Tchumak*'s observations, they were omitted. We also did not take into account *Alania*'s maximum in constructing the O-C diagram.

The O-C diagram can be approximated by broken lines. The periods are:

interval	period
- 2436000	0.61691310
2436000 - 2438000	0.61692020
2438000 -	0.61691475

The period jumps were $+710 \times 10^{-8}$ days and -545×10^{-8} days.

SU DRACONIS

This bright RR Lyrae type variable was discovered by Miss *Leavitt* from plates of the Harvard Map of the Sky; its variability was announced by *Pickering* (1907a). The first investigators of SU Dra = BD $+68^{\circ}652$ (9.5) = HD 100971 (A2) = 43.1907 = HV 2900 = AG Chri 1788 (9.4) were *Enebo* (1907, 1911), *Seares* (1908), *Sperra*

(1909) and *Ginori* (1912). Their visual observations yielded a fairly good period of the star. *Martin* and *Plummer* (1913) found strange fluctuations superimposed on the light curve. Since *Martin* and *Plummer*'s observations a great number of accurate photographic and photoelectric observations have been collected but this unusual phenomenon has never again been seen. Certainly these fluctuations resulted from the fairly large observational errors of *Martin* and *Plummer*.

The period change of SU Dra can easily be followed. The star has been observed almost continuously over the years. *Floria* (1931, 1933), *Lange* (1938, 1960), *Soloviev* (1934a,b, 1936a,b), *Ahnert* (1960b), *Sacharov* (1964) and *Braune* et al. (1970,1972,1973) carried out visual observations, *Robinson* (1933), *Jordan* (1929), *Kepinski* and *Kowalczewski* (1934), *Dziewulski* (1938,1951), *Opalski* (1938), *Alania* (1956), *Koshuba* (1961) and *Harding* and *Penston* (1966) photographic observations. *Payne-Gaposchkin* (1954), using the old Harvard plates, gave the first known time of maximum.

Tsessevich (1966) rediscussed a few observations and gave new maxima. We have not included *Jost*'s data (*Jost*, 1933) in our discussion because of the large observational errors. The most accurate moments of maximum were obviously obtained from photoelectric measurements (see *Geyer* (1961), *Spinrad* (1961) and *Fitch* et al. (1966)).

In the years 1939, 1946, 1952 and 1954 the star was photographically observed at Konkoly Observatory. The measurements are given in Table 10. We used the following comparison stars (see Figure 3):

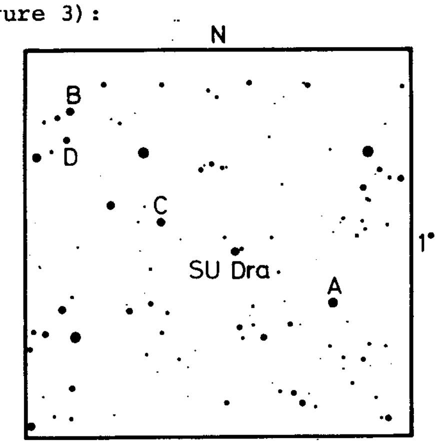

Figure 3

star	m_{pg}
A	9.11
B	9.96
C	10.24
D	11.10

The first photoelectric observations were made at our observatory without filter in 1955. These observations of course cannot be transformed into the international UBV system. Later on, our photoelectric observations were obtained in a system close to the international one. Our data are given in Table 9 and in Figure 4. As a comparison star we used BD +68^{o}655. A tie-in observation yielded for this star: V = 9.26, B-V = 1.05, U-B = 0.98. The photoelectric observations clearly show that SU Dra has a stable, repetitive light curve.

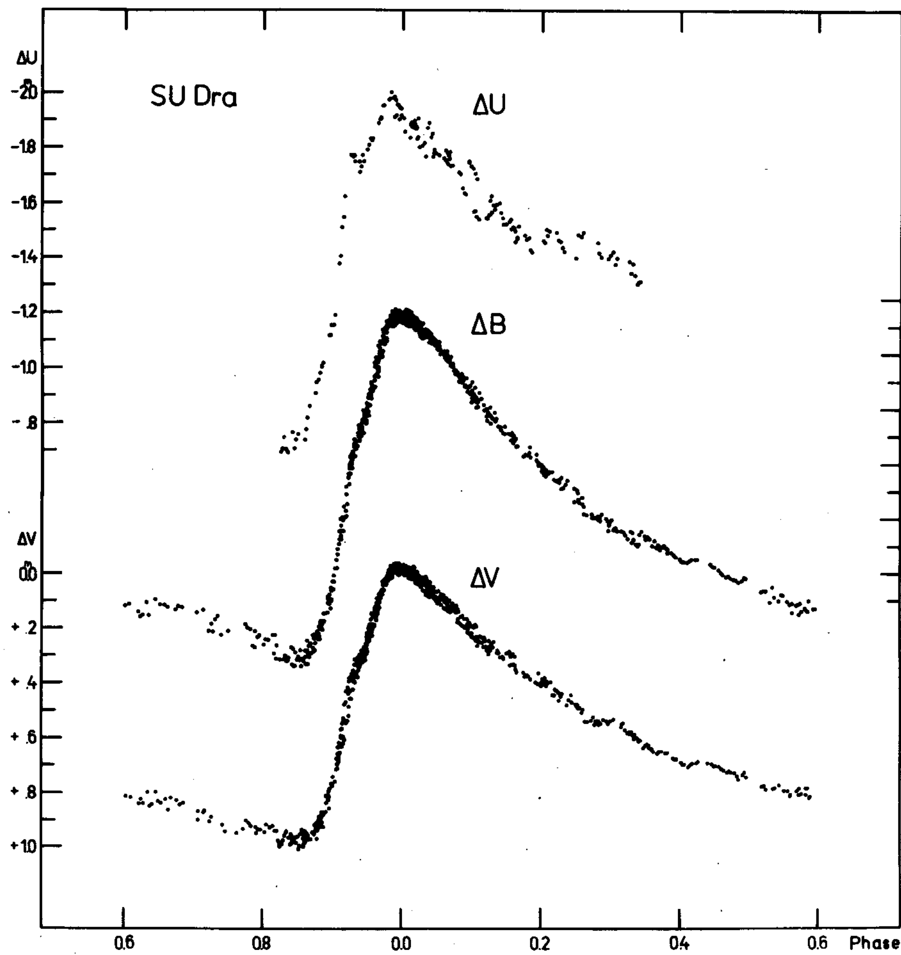

Figure 4: U, B and V light curves of SU Dra

Table 3

Year	J.D.max.hel.	Type	O–C	E	$\overline{O-C}$	$\overline{E}$	Reference
1904	2416556.38	pg n	+0.004	- 6131	+0.004	- 6131	Payne-Gaposchkin,(1954)
1907	17845.27	vis n	+0.099	- 4180			[1]Enebo,(1907)
	17981.25	vis n	-0.007	- 3974	-0.0075	- 3776	Enebo,(1911)
1908	18073.70	vis	-0.016	- 3834			Seares,(1908)
	18104.76	vis	+0.004	- 3787			-"-
	18118.63	vis	+0.006	- 3766			-"-
	18122.57	vis	-0.017	- 3760			-"-
	18131.82	vis	-0.013	- 3746			-"-
	18138.80	vis	-0.297	- 3735			[1] -"-
	18251.3591	vis n	-0.0095	- 3565			Enebo,(1911)
1909	18394.6736	vis n	-0.0059	- 3348	-0.0059	- 3348	[2]Sperra,(1909)
1912	19451.3499	vis n	+0.0001	- 1748	-0.0021	- 1541	[3]Ginori,(1912)
	19724.7589	pg n	-0.0043	- 1334			[2]Martin, Plummer,(1913)
1915	20568.1440	pg n	+0.0259	- 57	+0.0101	+ 34	Robinson,(1933)
	20688.3088	pg n	-0.0056	+ 125			Jordan,(1929)
1930	26258.9548	pg n	+0.0070	+ 8560	+0.0063	+ 8608	Floria,(1933)
	26322.3536	vis n	+0.0056	+ 8656			[2]Floria,(1931)
1931	26540.2710	vis n	-0.0152	+ 8986	-0.0054	+ 9012	Floria,(1933)
	26583.8783	vis n	+0.0044	+ 9052			-"-
1932	26929.9310	vis n	-0.0024	+ 9576	-0.0024	+ 9576	-"-
1933	27151.1668	pg n	-0.0070	+ 9911	-0.0050	+10033	Kepinski, Kowalczewski,(1934)
	27312.313	vis n	-0.003	+10155			Lange,(1938)
1934	27486.664	vis n	-0.003	+10419	+0.0020	+10484	Soloviev,(1934a, b)
	27572.528	vis n	+0.007	+10549			Tsessevich,(1966)
1935	27882.2645	vis n	+0.0071	+11018	-0.0008	+11142	Dziewulski,(1938)
	27974.703	vis n	-0.013	+11158			Soloviev,(1936a, b)
	28036.1386	pg n	+0.0036	+11251			Dziewulski,(1938)
1939	29372.6803	vis n	-0.1426	+13275			[1] -"-
	29375.466	pg	+0.001	+13279	+0.001	+13279	present paper
1946	32061.392	pg	+0.004	+17346	+0.004	+17346	-"-
1952	34099.434	pg	-0.008	+20432	-0.0002	+20491	-"-
	34126.526	pg	+0.008	+20473			-"-
	34130.485	pg	+0.004	+20479			-"-

Table 3 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	Reference
1952	2434196.518	pg	-0.005	+20579			present paper
1954	34807.415	pg	+0.005	+21504	-0.0020	+21521	Alania,(1956)
	34830.516	pg	-0.009	+21539			present paper
1955	35186.484	pe	-0.006	+22078	-0.006	+22078	-"-
1957	35892.4618	pe	-0.0165	+23147	-0.0075	+23465	Geyer,(1961)
	36152.6811	pe	-0.0022	+23541			present paper
	36164.5657	pe	-0.0052	+23559			-"-
	36199.5671	pe	-0.0060	+23612			-"-
1959	36610.357	vis n	+0.003	+24234	+0.003	+24234	Ahnert,(1960b)
	36619.5941	pe	-0.0054	+24248	-0.0060	+24267	present paper
	36645.3492	pe	-0.0066	+24287			-"-
	36902.263	pg n	+0.004	+24676	+0.004	+24676	[3]Koshuba,(1961)
1960	37044.9066	pe	-0.0027	+24892	-0.0027	+24892	Spinrad,(1961)
	37137.360	vis n	-0.008	+25032	-0.008	+25032	Lange,(1960)
1962	37881.6643	vis n	+0.0043	+26159	+0.0043	+26159	Sacharov,(1964)
1963	38150.447	pg n	-0.003	+26566	-0.003	+26566	Harding, Penston(1966)
1964	38464.810	pe	0.000	+27042	0.000	+27067	Fitch et al.,(1966)
	38497.831	pe	0.000	+27092			-"-
1966	39245.419	vis n	-0.006	+28224	-0.0147	+28290	Braune et al.,(1970)
	39255.306	vis n	-0.025	+28239			Batyrev,(1973)
	39261.252	vis n	-0.023	+28248			-"-
	39389.391	vis n	-0.005	+28442			Braune et al.,(1970)
	39710.341	vis n	-0.019	+28928	-0.0155	+28978	Batyrev,(1973)
1967	39776.390	vis n	-0.012	+29028			-"-
1971	41075.436	vis n	-0.010	+30995	-0.010	+30995	Braune et al.,(1972)
1972	41394.431	vis n	+0.003	+31478	+0.003	+31478	Braune et al.,(1973)
1975	42403.5545	pe	+0.0063	+33006	+0.0074	+33038	present paper
	42415.4444	pe	+0.0087	+33024			-"-
	42454.4077	pe	+0.0072	+33083			-"-
1976	42948.3975	pe	+0.0037	+33831	+0.0037	+33831	-"-
1977	43204.6427	pe	+0.0064	+34219	+0.0064	+34219	-"-

Remarks: [1] omitted, [2] rediscussed by Floria (1933), [3] rediscussed by Tsessevich (1966)

The times of maximum are collected in Table 3. The residuals were calculated by the elements:

$$\text{J.D. max. hel.} = 2420605.7620 + 0\overset{d}{.}66041890 \times E$$

From the O-C values yearly means were formed. These are plotted against epoch numbers in Figure 5. The waves in the O-C diagram seem to be real. Since 1955 the O-C values using only the photoelectric observations can be approximated by a straight line, i.e. with the period $0\overset{d}{.}66042001$.

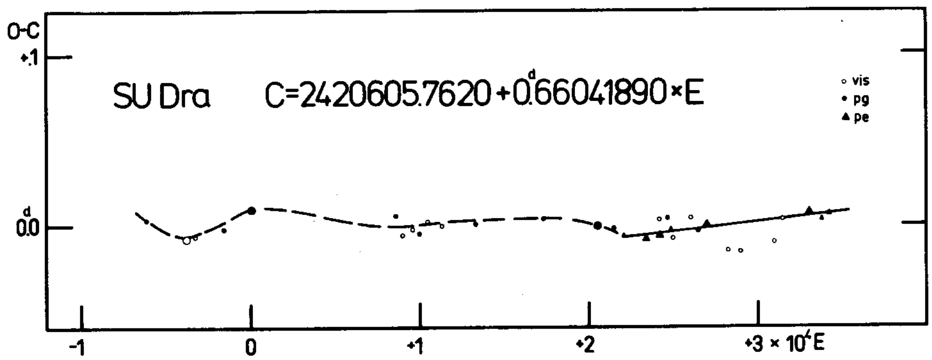

Figure 5: O-C diagram of SU Dra

RR LEONIS

The variability of this star RR Leo = BD +24°2183 (9.4)= 170.1907 = HV 3015 was discovered by *Leavitt* (*Pickering*, 1907) on Harvard photographs. *Luizet* later determined the period. At first he found it to be 4.74867 days (*Luizet*, 1909) but later determined it as only 0.452368 days (*Luizet*, 1911a). *Luizet* (1911b) gave a long list of maxima from his visual observations. We were of the view that *Luizet*'s observations should be rediscussed and that normal maxima be determined using his data.

Martin and *Plummer* (1921) derived the light curve of this star and found secondary oscillations which have never been present in any of the light curves ever observed. The time of maximum was redetermined using *Martin* and *Plummer*'s data but it still remained very uncertain because they used exposition times of 34-60 minutes.

Jordan (1922) was the first to question the existence of these curious secondary oscillations on the descending branch of the variable. From his excellent photographic observations

(*Jordan*, 1929), we were able to derive three different moments of maximum and the moments are given in Table 4.

As RR Leo is relatively bright and the rising branch is very steep the star is easy to observe and has naturally attracted many observers. As early as 1929, *Nielsen* (1929) drew attention to the slow increase in the period of this star. He gave the elements:

$$\text{J.D. max. hel.} = 2418120.3412 + 0\overset{d}{.}4523702 \times E + 0\overset{d}{.}275 \times 10^{-9} \times E^2$$

Oosterhoff (1930) obtained new sets of very accurate photographic observations. Having analysed the available data he arrived at the quadratic term $+0\overset{d}{.}183 \times 10^{-9} \times E^2$. Since *Oosterhoff*'s investigation several attempts were made to give a more accurate value for the quadratic term (*Tsessevich*, 1934, *Kooreman*, 1935, *Gaposchkin*, 1934, *Balazs*, 1936). Following *Oosterhoff*'s procedure *Balazs* and *Detre* (1949) performed very detailed and precise period analysis. They gave the formula for the period as follows:

$$P = 0\overset{d}{.}45238142 + 0\overset{d}{.}360 \times 10^{-9} \times E - 0\overset{d}{.}7 \times 10^{-6} \times \cos 0\overset{\circ}{.}0134 \times (E+6500)$$

This period satisfied all the observations obtained up to 1949.

A long term periodic change in the period of an RR Lyrae type star is very interesting because it probably reflects the binary nature of the variable. The light-time effect can easily be made responsible for this kind of cyclic variation in the period.

This question seemed very interesting and a great number of photographic and photoelectric observations have been collected at Konkoly Observatory during the past 30 years. Since 1952 the star has been observed photoelectrically almost every year. The photographic plates were measured by a Cuffey microphotometer and the same comparison stars were used as by *Balazs* (1936). Their magnitudes were also adopted from her measurements. As comparison star we used BD $+24^{\circ}2181$ (V = 10.400, B-V = 0.090 and U-B = 0.105 adopted from *Kim* and *Sturch*, 1967, and *Sturch*, 1966) to our photoelectric observations (Table 11, 12, Figure 6).

The number of maxima and the time interval now seem to be sufficiently large for us to make a reasonable period analysis in order to answer the challenging question raised by the periodic term in the elements. In the course of the more rigorous period analysis some maxima observed by *Gaposchkin* (1934), *Sacharov* (1953), *Soloviev* and *Shakhovskoj* (1958), *Guriev* (1937), *Ashbrook* (1949), *Alania* (1954), *Huth* (1964), *Ahnert* (1959b, c, 1961), *Karetnikov* (1961, 1962) and *Demjanovskij* (1975) should have been ignored. All of these apart from *Gaposchkin*'s, *Alania*'s, *Huth*'s and *Demjanovskij*'s observations were made visually. *Gaposchkin* elaborated the old Harvard plates which had been obtained with very long exposure times and sparsely distributed in time. There-

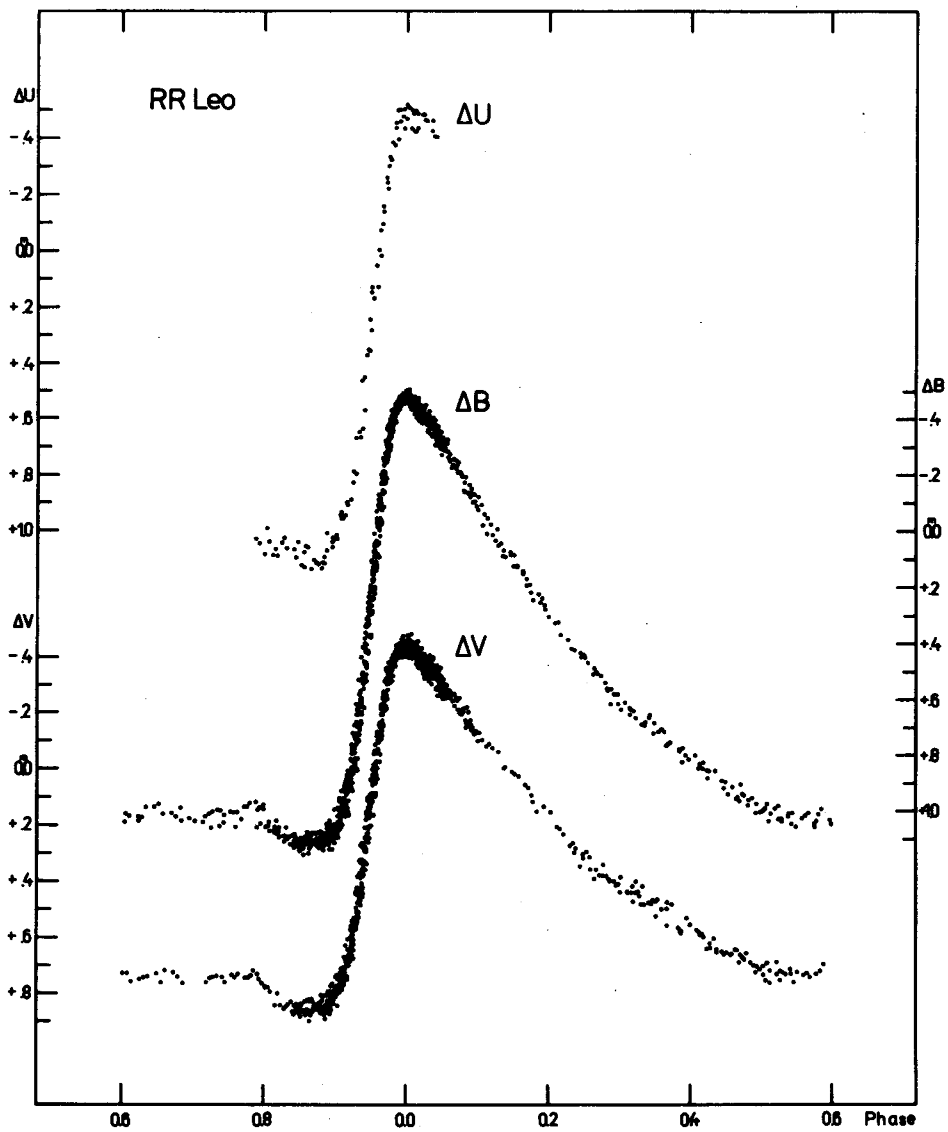

Figure 6: U,B and V light curves of RR Leo

fore the maxima given by him have very low accuracy. *Huth* worked on the Sonneberg sky patrol plates which had also been made with fairly long exposure times. *Alania*'s and *Demjanovskij*'s photographic observations also have very low weight in comparison with the photoelectric observations obtained at our observatory at about the same time.

The moments of maxima are collected in Table 4. The O-C residuals are calculated by the linear elements:

$$\text{J.D. max. hel.} = 2430440.3625 + 0^{d}.45238172 \times E$$

and plotted against epoch numbers (Figure 7).

A parabolic curve fit yielded the quadratic term:

$$+1^{d}.963 \times 10^{-10} \times E^2$$

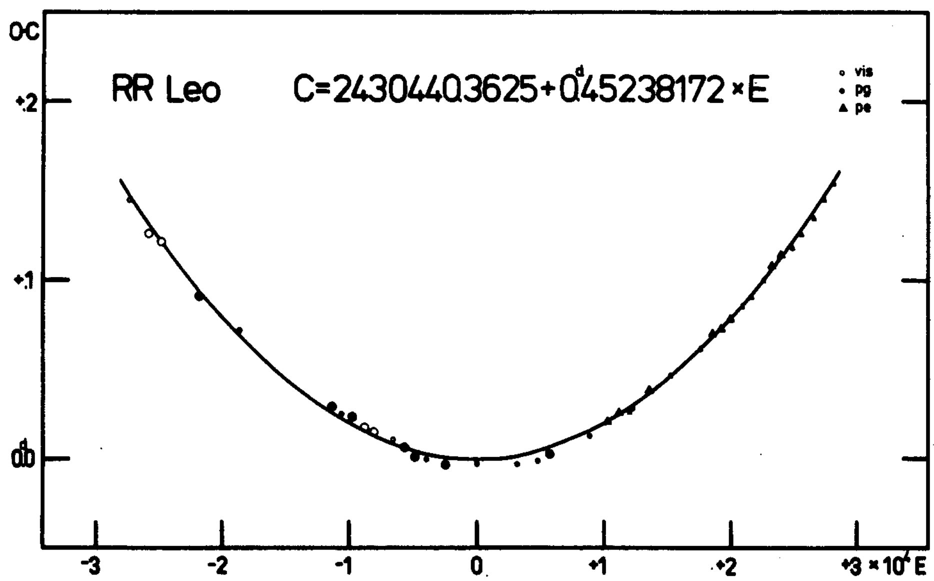

Figure 7: O-C diagram of RR Leo

The O-C residuals calculated by the quadratic formula clearly show a cyclic variation which is superimposed on the parabola. Since the time of maximum can be determined with lower accuracy than that of a well-defined point of the ascending branch of the light curve we decided to follow *Oosterhoff*'s and *Balazs* and *Detre*'s procedure (*Oosterhoff*, 1930; *Balazs* and *Detre*, 1949). After careful consideration we chose the points on the ascending branch at the following magnitudes:

Table 4

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\bar{E}$	Reference
1898	2414639.81	pg n	+0.24	-34927			[1]Gaposchkin,(1934)
1906	17257.68	pg n	+0.17	-29141			[1] -"-
1908	18062.439	vis n	+0.145	-27362	+0.145	-27362	[2]Luizet,(1911b)
1910	18756.373	vis n	+0.126	-25828	+0.126	-25828	[2] -"-
1911	19202.417	vis n	+0.121	-24842	+0.121	-24842	[2] -"-
1915	20547.774	pg	+0.090	-21868	+0.091	-21831	[2]Jordan,(1929)
	20567.676	pg	+0.092	-21824			[2] -"-
	20577.626	pg	+0.090	-21802			[2] -"-
1919	22023.420	pg n	+0.072	-18606	+0.072	-18606	[2]Martin, Plummer,(1921)
	22313.86	pg n	+0.083	-17964			[1]Gaposchkin,(1934)
1927	24922.90	pg n	+0.24	-12196			[1] -"-
1928	25299.527	pg	+0.030	-11364	+0.029	-11338	[3]Oosterhoff,(1930)
	25304.502	pg	+0.029	-11353			[3] -"-
	25318.525	pg	+0.028	-11322			[3] -"-
	25323.502	pg	+0.029	-11311			[3] -"-
	25335.716	vis	+0.029	-11284	+0.029	-11284	Nielsen,(1928)
1929	25645.594	pg	+0.025	-10599	+0.025	-10599	[3]Oosterhoff,(1930)
	25920.188	pg	+0.024	- 9992	+0.023	- 9789	[2]Allen, Marsh,(1932)
1930	26016.544	pg	+0.022	- 9779			[3]Oosterhoff,(1930)
	26030.570	pg	+0.025	- 9748			[3] -"-
	26031.473	pg	+0.023	- 9746			[3] -"-
	26060.424	pg	+0.021	- 9682			[3] -"-
	26143.200	vis	+0.012	- 9499			[1]Sacharov,(1953)
	26146.280	vis	-0.075	- 9492			[1] -"-
	26148.227	vis	+0.062	- 9488			[1] -"-
1931	26382.5197	vis	+0.0212	- 8970	+0.0167	- 8869	Lause,(1931)
	26387.4973	vis	+0.0226	- 8959			-"-
	26397.4484	vis	+0.0213	- 8937			-"-
	26406.4862	vis	+0.0115	- 8917			-"-

Table 4 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	Reference
1931	2426415.5357	vis	+0.0134	- 8897			Lause,(1931)
	26416.4417	vis	+0.0146	- 8895			-"-
	26417.3513	vis	+0.0194	- 8893			-"-
	26420.5077	vis	+0.0092	- 8886			-"-
	26421.4239	vis	+0.0206	- 8884			-"-
	26430.4662	vis	+0.0153	- 8864			-"-
	26440.4186	vis	+0.0153	- 8842			-"-
	26474.3538	vis	+0.0218	- 8767			-"-
	26487.4637	vis	+0.0127	- 8738			-"-
	26497.4180	vis	+0.0146	- 8715			-"-
1932	26764.320	vis n	+0.014	- 8126	+0.014	- 8126	Detre,(1936)
1934	27458.271	vis	+0.009	- 6592	+0.011	- 6548	Tsessevich,(1934)
	27472.75	pg n	+0.02	- 6560			[1]Gaposchkin,(1934)
	27498.536	vis n	+0.012	- 6503			Kanishcheva, Lange,(1971)
1935	27834.651	vis n	+0.007	- 5760	+0.007	- 5760	Soloviev,(1935b, c, 1936b)
	27840.531	pg	+0.006	- 5747	+0.006	- 5673	Kooreman,(1935)
	27864.507	pg	+0.006	- 5694			-"-
	27869.483	pg	+0.006	- 5683			-"-
	27874.459	pg	+0.006	- 5672			-"-
	27875.364	pg	+0.006	- 5670			-"-
	27889.388	pg	+0.006	- 5639			-"-
	27903.412	pg	+0.006	- 5608			-"-
1936	28178.460	vis n	+0.006	- 5000			[1]Soloviev, Shakhovskoj,(1958)
	28190.208	vis n	-0.008	- 4974			[1]Guriev,(1937)
	28245.4067	pg	+0.0003	- 4852	+0.0007	- 4845	Balázs, Detre,(1949)
	28249.4800	pg	+0.0022	- 4843			-"-
	28250.3822	pg	-0.0004	- 4841			-"-
1937	28668.3830	pg	-0.0003	- 3917	-0.0003	- 3917	-"-
1938	29136.605	vis n	+0.007	- 2882			[1]Soloviev, Shakhovskoj,(1958)

Table 4 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\bar{E}$	Reference
1939	2429312.5725	pg	-0.0024	- 2493	-0.0032	- 2428	Balázs, Detre,(1949)
	29371.3806	pg	-0.0039	- 2363			-"-
1942	30440.3598	pg	-0.0027	0	-0.0027	0	-"-
1946	31888.4332	pg	-0.0032	+ 3201	-0.0032	+ 3201	-"-
1948	32615.4126	pg	-0.0012	+ 4808	-0.0012	+ 4808	-"-
1949	33010.3456	pg	+0.0025	+ 5681	+0.0028	+ 5697	-"-
	33011.7061	vis n	+0.0059	+ 5684			[1]Ashbrook,(1949)
	33024.3700	pg	+0.0031	+ 5712			Balázs, Detre,(1949)
1952	34097.371	pg	-0.045	+ 8084			[1]Alania,(1954)
1953	34443.501	pg	+0.013	+ 8849	+0.013	+ 8849	present paper
1954	35069.6055	pe	+0.0209	+10233	+0.0212	+10276	-"-
	35069.606	pg	+0.021	+10233			-"-
1955	35127.5109	pe	+0.0214	+10361			-"-
1956	35479.4664	pe	+0.0239	+11139	+0.0256	+11225	-"-
	35489.4204	pe	+0.0255	+11161			-"-
	35542.3512	pe	+0.0277	+11278			-"-
	35561.3490	pe	+0.0254	+11320			-"-
1957	35874.3982	pe	+0.0265	+12012	+0.0265	+12012	Geyer,(1961)
	35925.519	pg	+0.028	+12125	+0.028	+12125	present paper
1958	36229.549	pg	+0.058	+12797			[1]Huth,(1964)
	36287.433	pg	+0.037	+12925			[1] -"-
	36513.6249	pe	+0.0378	+13425	+0.0385	+13612	present paper
1959	36586.4585	pe	+0.0380	+13586			-"-
	36599.587	pg	+0.047	+13615			[1]Huth,(1964)
	36604.5533	pe	+0.0375	+13626			present paper
	36610.441	vis n	+0.044	+13639			[1]Ahnert,(1959b, c)
	36614.5064	pe	+0.0382	+13648			present paper
	36667.464	pg	+0.067	+13765			[1]Huth,(1964)
	36672.4142	pe	+0.0411	+13776			Geyer,(1961)

Table 4 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	References
1961	2437316.6118	pe	+0.0472	+15200	+0.0472	+15200	present paper
	37375.427	pg	+0.053	+15330			[1]Ahnert,(1961)
	37375.438	pg	+0.064	+15330			[1]Huth,(1964)
	37376.329	vis n	+0.050	+15332			[1]Ahnert,(1961)
	37399.401	pg	+0.051	+15383			[1]Huth,(1964)
	37454.5845	vis n	+0.0434	+15505			[1]Karetnikov,(1961, 1962)
1962	37768.102	pg n	+0.060	+16198			[1]Demjanovskij,(1975)
1964	38414.5572	pe	+0.0621	+17627	+0.0621	+17627	present paper
1965	38824.876	pe	+0.071	+18534	+0.0698	+18576	Fitch et al.,(1966)
	38825.778	pe	+0.068	+18536			-"-
	38881.4237	pe	+0.0707	+18659			present paper
1966	39146.5225	pe	+0.0738	+19245	+0.0730	+19250	-"-
	39150.5922	pe	+0.0721	+19254			-"-
1967	39503.4564	pe	+0.0785	+20034	+0.0786	+20039	-"-
	39507.5280	pe	+0.0787	+20043			-"-
1968	39906.5364	pe	+0.0864	+20925	+0.0864	+20925	-"-
1969	40232.7079	pe	+0.0907	+21646	+0.0907	+21646	-"-
1970	40654.3372	pe	+0.1002	+22578	+0.1002	+22578	-"-
1971	40980.5097	pe	+0.1055	+23299	+0.1077	+23325	-"-
	41003.5855	pe	+0.1098	+23350			-"-
	41311.6607	pe	+0.1131	+24031	+0.1142	+24032	-"-
	41312.5677	pe	+0.1153	+24033			-"-
1972	41682.6190	pe	+0.1184	+24851	+0.1184	+24851	-"-
1973	42019.6515	pe	+0.1265	+25596	+0.1265	+25596	-"-
1975	42443.5415	pe	+0.1348	+26533	+0.1348	+26533	-"-
1976	42829.4335	pe	+0.1452	+27386	+0.1452	+27386	-"-
1977	43213.5140	pe	+0.1536	+28235	+0.1536	+28235	-"-

Remarks: [1] omitted, [2] redetermined by us, [3] determined by us

m_{pg} = 10.63 in the case of photographic observations

Δm = +0.33 in the case of photoelectric observations without filters

ΔV = +0.194 and ΔB = +0.326 in the case of photoelectric observations made in the UBV system

These points correspond to the point defined by *Oosterhoff* (1930) and used by *Balazs* and *Detre* (1949). The epochs of these points are designated by "t". In Table 5 the epochs determined by *Balazs* and *Detre* (1949, Table 4) are supplemented with the epochs based on our observations. The error of these epochs certainly does not exceed $0^{d}.0010$. The t-C′ residuals in Table 5 have been calculated by the formula taking into account the quadratic term as well:

$$C' = 2430440.3385 + 0^{d}.45238172 \times E + 1^{d}.963 \times 10^{-10} \times E^2$$

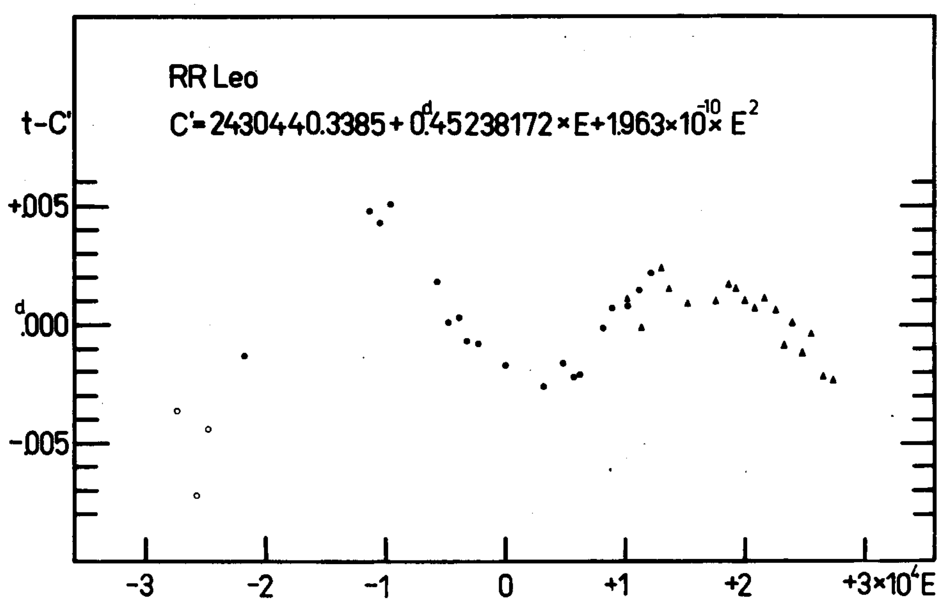

Figure 8: t-C′ diagram of RR Leo

The t-C′ values plotted against epoch numbers are presented in Figure 8. Although the cyclic variation is evident we do not have the courage to fit in a sine curve. The question of the existence of the sine term in the elements is open to further discussion and only by new observations which span at least the next two decades can the final answer be given.

Table 5

J.D.t.hel.	Type	t-C′	E	Reference
2400000+				
18062.4133	vis	-0.0036	-27362	Luizet
18756.3471	vis	-0.0072	-25828	-"-
19202.3885	vis	-0.0044	-24842	-"-
20547.7476	pg	-0.0013	-21868	Jordan
25318.5027	pg	+0.0048	-11322	Oosterhoff
25675.4279	pg	+0.0043	-10533	-"-
26060.4022	pg	+0.0051	- 9682	-"-
27874.4375	pg	+0.0018	- 5672	Kooreman
28249.4585	pg	+0.0001	- 4843	Balázs
28668.3626	pg	+0.0003	- 3917	-"-
28963.3136	pg	-0.0007	- 3265	Detre
29371.3608	pg	-0.0008	- 2363	-"-
30440.3368	pg	-0.0017	0	-"-
31903.3405	pg	-0.0026	+ 3234	Balázs
32615.3927	pg	-0.0016	+ 4808	-"-
33024.3471	pg	-0.0022	+ 5712	-"-
33264.5632	pg	-0.0021	+ 6243	Detre
34126.3577	pg	-0.0001	+ 8148	present paper
34443.4804	pg	+0.0007	+ 8849	-"-
35069.5820	pg	+0.0008	+10233	-"-
35069.5823	pe	+0.0011	+10233	-"-
35507.4922	pg	+0.0015	+11201	-"-
35542.3244	pe	-0.0001	+11278	-"-
35896.5452	pg	+0.0022	+12061	-"-
36288.3122	pe	+0.0024	+12927	-"-
36604.5297	pe	+0.0015	+13626	-"-
37316.5869	pe	+0.0009	+15200	-"-
38414.5331	pe	+0.0010	+17627	-"-
38881.3990	pe	+0.0017	+18659	-"-
39146.4989	pe	+0.0015	+19245	-"-
39503.4337	pe	+0.0010	+20034	-"-
39906.5127	pe	+0.0007	+20925	-"-
40232.6863	pe	+0.0011	+21646	-"-
40654.3137	pe	+0.0006	+22578	-"-
40980.4859	pe	-0.0009	+23299	-"-
41311.6371	pe	+0.0001	+24031	-"-
41682.5966	pe	-0.0012	+24851	-"-
42019.6292	pe	-0.0004	+25596	-"-
42433.5661	pe	-0.0022	+26511	-"-
42829.4092	pe	-0.0023	+27386	-"-

TT LYNCIS

This relatively bright RR Lyrae type variable (TT Lyn = BD +45°1669 (9.3) = S 4752 = CSV 1938) was discovered by *Hoffmeister* (1949) on Sonneberg plates. Subsequently it was studied visually by *Tsessevich* (1956) and both visually and photographically by *Ahnert* (1959d, 1960a). *Tremko* (1974) thoroughly investigated TT Lyn and constructed its light curves in U,B,V and colour-colour diagram. He made use of nearly 400 photographic and about 4600 photoelectric observations obtained at Skalnate Pleso Observatory (*Tremko*, 1976). In his discussion he also used the photoelectric observations obtained at Konkoly Observatory in 1959. The observations were tested for Blazhko-effect and it was unambiguously shown that TT Lyn has a stable, strictly repetitive light curve.

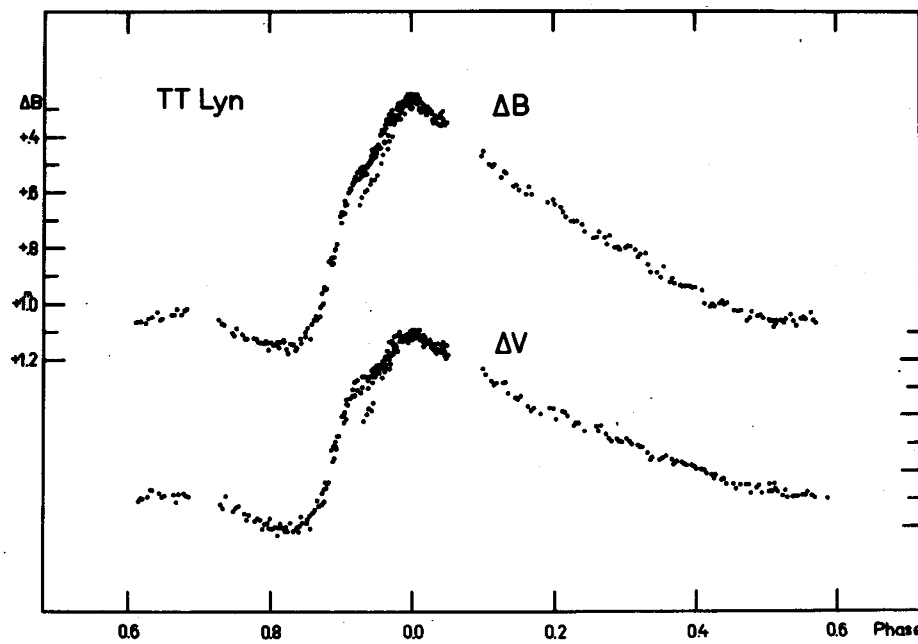

Figure 9: B and V light curves of TT Lyn

The star was reobserved at our observatory in 1978. As a comparison star BD +45°1666 was used. Its magnitude and colours V = 9.16, B-V = 0.28 were adopted from a tie-in observation. The observations made at Konkoly Observatory are given in Table 13.

On J.D. 2443583 the ascending branch was, oddly enough, much steeper than it used to be (see Figure 9). We have found no explanation for this strange, unexpected phenomenon. The maximum in phase and height is not shifted, therefore any Blazhko-effect is out of the question.

Tremko, in his paper mentioned above (1974), gave the list of maxima of various observers. In the following table we supplement this list with the maxima obtained from *Jones'* (1966) and our observations. *Sturch's* (1966) observations were insufficient for deriving the time of maximum (Table 6).

Table 6

J.D.max.hel.	O-C	E	Reference
2438463.3775	+0.0034	+ 3033	Jones (1966)
43580.3935	-0.0033	+11598	present paper
43583.3855	+0.0015	+11603	-"-
43595.3350	+0.0023	+11623	-"-

The O-C diagram has been constructed using the new elements:

$$J.D.max.\ hel. = 2436651.3566 + 0\overset{d}{.}59743406 \times E$$

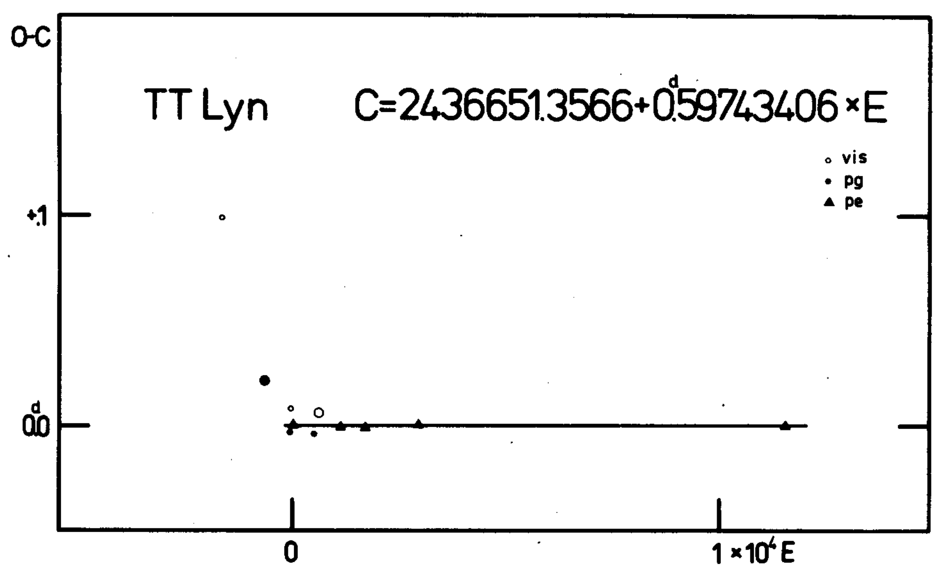

Figure 10: O-C diagram of TT Lyn

Yearly means were formed separately from the visual, photographic and photoelectric observations and plotted against epoch numbers (Figure 10). The photoelectric maxima can easily be approximated by a straight line and the new elements were obtained in this way.

AR PERSEI

The discovery of the variability of BD +47°965 (9.5)=421.1928 was announced by *Guthnick* (1928) and named AR Per by *Guthnick* and *Prager* (1930). Immediately after the discovery *Kukarkin* (1930) and *Lange* (1931) investigated this variable, but *Floria* (1932a,b) and *Beyer* (1932,1943) were the first to determine its correct period using their own visual observations: $0^d.4255463$ and $0^d.425551$, respectively.

Long series of visual observations were obtained by *Soloviev* (1934a, 1935a, 1937, 1939), *Kukarkin* (1937, 1941, 1949), *Lange* (1938), *Guriev* (1938), *Miczaika* (1946), *Batyrev* (1957), *Soloviev* and *Shakhovskoj* (1958), *Steinman* (1958), *Ahnert* (1959a, c) and *Tsessevich* (1966). *Alania* (1954) and *Payne-Gaposchkin* (1954) gave photographic maxima. *Tsessevich* (1966) examined the Harvard plate collection and succeeded in determining a great number of maxima between 1900-1950. His observations are unique and make it possible to construct the O-C diagram of AR Per from the very beginning of this century.

Krygier (1965) also investigated the star photographically but since the light curve around the maximum was not sufficiently covered by observations we were not able to determine a time of maximum from his observations.

Since 1954 accurate photoelectric observations are available. Although *Paczynski* (1965), *Sturch* (1966) and *Epstein* (1969) did not give any moments of maximum we were able to deduce reliable

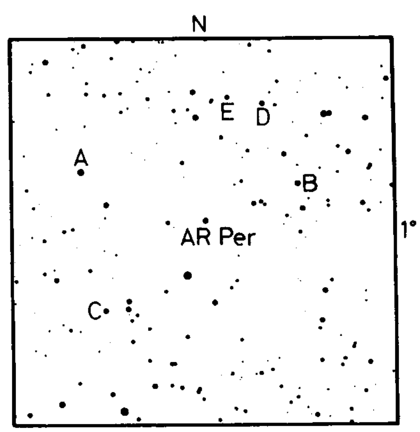

Figure 11

star	m_{pg}
A	9.37
B	10.37
C	10.67
D	10.94
E	11.55

maxima from their observations. *Geyer* (1961) and *Fitch* et al. (1966) published exact times of maximum for the years 1958, 1959 and 1964.

At Konkoly Observatory the star was photographically observed in 1937 (Table 15). The comparison stars used are given in Figure 11. From these observations a maximum could be derived.

The star was first observed photoelectrically in 1954, on J.D. 2435093. For these observations BD +46°860 was used as a comparison star (m_V = 8.75, B-V = 0.47, U-B = 0.10 adopted from *Geyer*, 1961). Later on we used BD +46°858 for comparison purposes (V = 9.73, B-V = 0.89, U-B = 0.35 given by *Paczynski*, 1965). Our photoelectric observations are given in Table 14 and presented in

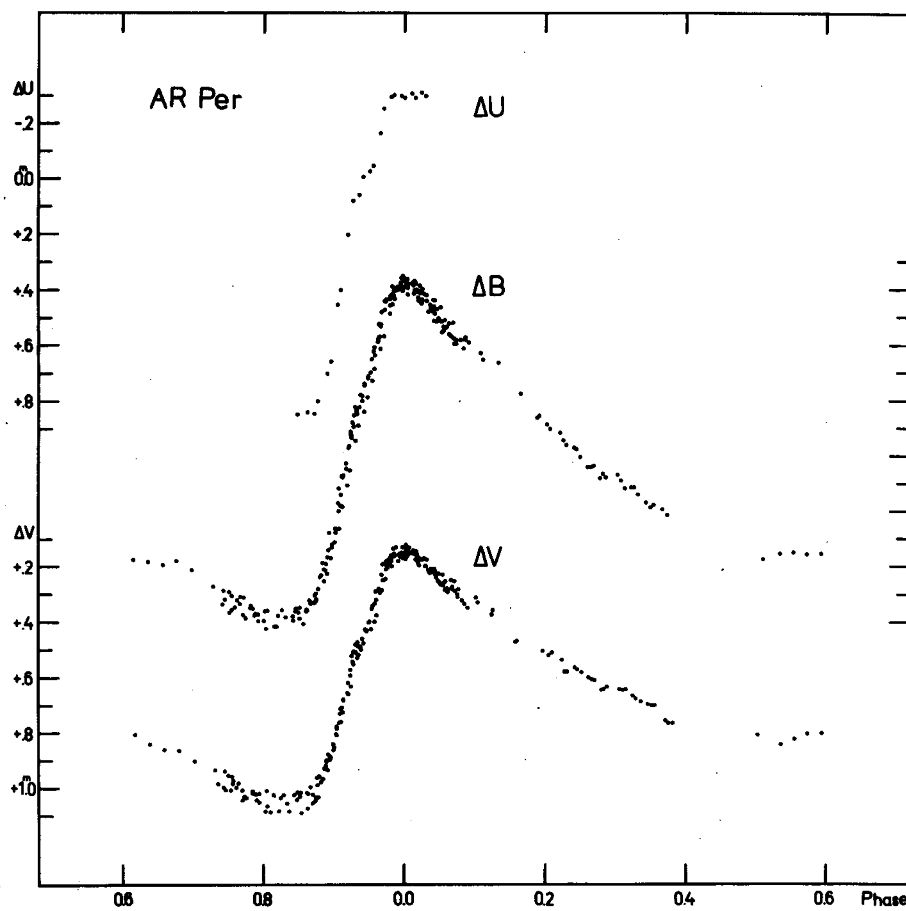

Figure 12: U, B and V light curves of AR Per

Table 7

Year	J.D.max.hel.	Type		O-C	E	$\overline{O-C}$	$\bar{E}$	Reference
1900	2415049.27	pg	n	+0.07	-28640			[1]Floria,(1932a, b)
	15236.878	pg	n	+0.007	-28200	+0.007	-28200	Tsessevich,(1966)
	15312.24	pg	n	+0.05	-28022			[1]Floria,(1932a, b)
1903	16303.726	pg	n	+0.004	-25692	+0.004	-25692	Tsessevich,(1966)
1905	17006.729	pg	n	0.000	-24040	0.000	-24040	-"-
1907	17850.589	pg	n	-0.003	-22057	-0.003	-22057	-"-
1910	18778.706	pg	n	-0.008	-19876	-0.008	-19876	-"-
1915	20511.541	pg	n	-0.008	-15804	-0.008	-15804	-"-
1918	21670.737	pg	n	-0.007	-13080	-0.007	-13080	-"-
1920	22500.986	pg	n	-0.003	-11129	-0.003	-11129	-"-
1921	23014.626	pg	n	-0.001	- 9922	-0.001	- 9922	-"-
1923	23562.730	pg	n	-0.004	- 8634	-0.004	- 8634	-"-
1924	24124.873	pg	n	-0.011	- 7313	-0.011	- 7313	-"-
1925	24462.762	pg	n	-0.007	- 6519	-0.007	- 6519	-"-
1927	25036.835	pg	n	0.000	- 5170	0.000	- 5170	-"-
1928	25556.00	pg	n	0.00	- 3950	0.00	- 3950	[2]Floria,(1932a, b)
1929	25939.426	vis	n	+0.002	- 3049	+0.002	- 3049	[3]Beyer,(1932)
1930	26156.866	pg	n	-0.013	- 2538	-0.010	- 2427	[3] -"-
	26251.344	vis	n	-0.007	- 2316			[3] -"-
1931	26576.460	vis		-0.010	- 1552	-0.010	- 1470	Lange,(1931)
	26576.461	vis		-0.009	- 1552			Floria,(1932a, b)
	26576.464	vis		-0.007	- 1552			Soloviev,(1939)
	26585.400	vis		-0.007	- 1531			Floria,(1932a, b)
	26597.322	vis		0.000	- 1503			-"-
	26600.295	vis		-0.006	- 1496			Tsessevich,(1966)
	26603.268	vis		-0.012	- 1489			Floria,(1932a, b)
	26605.404	vis		-0.004	- 1484			-"-
	26628.371	vis		-0.016	- 1430			-"-

Table 7 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	Reference
1931	2426649.220	vis	-0.019	- 1381			Floria,(1932a, b)
1932	26761.144	vis	-0.014	- 1118			-"-
	26979.464	vis	-0.001	- 605	+0.001	- 598	[3]Beyer,(1932)
	26985.425	vis	+0.002	- 591			[3] -"-
1933	27236.922	pg	0.000	0	-0.002	0	[3] -"-
	27353.519	vis	-0.003	+ 274			Lange,(1938)
1934	27460.323	vis	-0.012	+ 525	-0.006	+ 868	Tsessevich,(1966)
	27576.510	vis n	0.000	+ 798			Soloviev,(1935a)
	27782.470	vis	-0.006	+ 1282			Tsessevich,(1966)
1935	27858.209	vis	-0.014	+ 1460	-0.008	+ 1790	-"-
	27954.818	pg	-0.004	+ 1687			[3]Guriev,(1938)
	28087.164	vis	-0.005	+ 1998			Tsessevich,(1966)
1936	28397.389	vis n	-0.005	+ 2727	-0.005	+ 2727	Soloviev,(1937)
1937	28545.4760	pg	-0.0086	+ 3075	-0.007	+ 3266	present paper
	28632.292	vis n	-0.005	+ 3279			Kukarkin,(1937)
	28702.932	pg n	-0.006	+ 3445			Tsessevich,(1966)
1938	29226.792	pg n	+0.004	+ 4676	+0.004	+ 4676	-"-
1939	29613.623	pg n	+0.011	+ 5585	+0.005	+ 5598	-"-
	29624.675	pg n	-0.001	+ 5611			Payne-Gaposchkin,(1954)
1940	29968.529	pg n	+0.009	+ 6419	+0.009	+ 6419	Tsessevich,(1966)
1941	30337.891	pg n	-0.005	+ 7287	-0.005	+ 7287	-"-
1942	30705.987	pg n	-0.009	+ 8152	-0.009	+ 8152	-"-
1943	31075.802	pg n	+0.004	+ 9021	+0.004	+ 9021	-"-
1944	31431.551	pg n	-0.006	+ 9857	-0.006	+ 9857	-"-
1945	31793.270	vis n	-0.003	+10707	-0.003	+10707	[3]Miczaika,(1946)
1946	31962.642	pg n	0.000	+11105	0.000	+11105	Tsessevich,(1966)
1947	32530.751	pg n	+0.002	+12440	+0.002	+12440	-"-
1949	33030.763	pg n	-0.006	+13615	-0.006	+13615	-"-

Table 7 (cont.)

Year	J.D.max.hel.	Type	O-C	E	$\overline{O-C}$	$\overline{E}$	Reference
1950	2433588.667	pg n	+0.003	+14926	+0.003	+14926	Tsessevich,(1966)
1951	33898.463	vis	0.000	+15654	+0.001	+15709	Batyrev,(1957)
	33916.338	vis	+0.002	+15696			-"-
	33951.233	vis	+0.002	+15778			-"-
1952	34339.342	vis	+0.010	+16690	+0.006	+16755	-"-
	34343.593	pg	+0.006	+16700			Alania,(1954)
1953	34385.301	vis	+0.010	+16798			Batyrev,(1957)
	34399.329	vis	-0.005	+16831			-"-
1954	35093.4080	pe	+0.0039	+18462	+0.0039	+18462	present paper
1957	36070.4666	vis n	+0.0024	+20758	+0.0024	+20758	Steinman,(1958)
1958	36231.3203	pe	-0.0013	+21136	-0.0013	+21136	Geyer,(1961)
	36485.3792	pe	+0.0050	+21733	+0.0037	+21843	present paper
	36495.5914	pe	+0.0039	+21757			-"-
	36530.4855	pe	+0.0030	+21839			-"-
	36541.5501	pe	+0.0034	+21865			-"-
1959	36605.394	vis n	+0.015	+22015			[1]Ahnert,(1959a, c)
	36607.5100	pe	+0.0032	+22020			Geyer,(1961)
1963	38293.9620	pe	+0.0053	+25983	+0.0044	+26020	Paczynski,(1965)
	38299.9195	pe	+0.0051	+25997			-"-
	38334.8123	pe n	+0.0029	+26079			Sturch,(1966)
1964	38729.726	pe	+0.0073	+27007	+0.0073	+27007	Fitch et al.,(1966)
1966	39469.7561	pe n	+0.0080	+28746	+0.0080	+28746	Epstein,(1969)
1969	40528.5256	pe	+0.0121	+31234	+0.0121	+31234	present paper
1976	43124.3793	pe	+0.0180	+37334	+0.0180	+37334	-"-

Remarks: [1] omitted [2] observed by Guthnick [3] rediscussed by Tsessevich

Figure 12. The observations made on J.D. 2435093 were shifted by 1.281 in V and by 1.653 in B in the composite light curves.

Ahnert (1959a , c) claimed that the star exhibited a Blazhko-effect. A comparison of the photoelectric light curves made by *Geyer* (1961), *Paczynski* (1965), *Fitch* et al. (1966) and ourselves (present paper) in the years 1954,1958,1959,1963,1964,1969 and 1976 is proof of the stable character of the light variation of AR Per: any kind of light curve variation i.e. Blazhko-effect is out of the question. Nevertheless the small amplitude of the light variation as compared with the short period is remarkable.

The list of maxima observed are presented in Table 7. The letter "n" indicates that the maximum is a normal one. The O-C values were calculated by the linear formula:

$$\text{J.D. max. hel.} = 2427236.9220 + 0\overset{d}{.}42554881\text{xE}$$

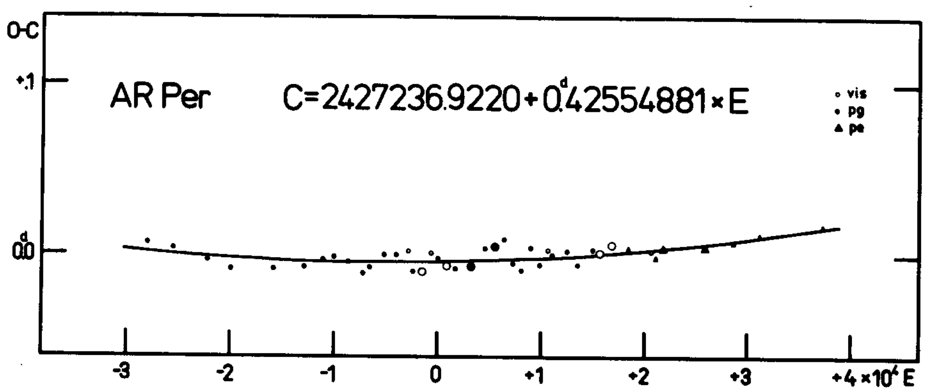

Figure 13: O-C diagram of AR Per

The seasonal means are plotted against epoch numbers in Fig. 13.

A quadratic fit of the O-C diagram gives the elements:

$$\text{J.D. max. hel.} = 2427236.9179 + 0\overset{d}{.}42554892\text{xE} + 1\overset{d}{.}18\text{x}10^{-11}\text{xE}^2$$

The steady increase of the period is:

$$1.18\text{x}10^{-11} \text{ days/cycle} = 1.01\text{x}10^{-8} \text{ days/year}$$

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Table 8

Photoelectric observations of AT And

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442277		2442303		2442307	
.3561	+1.086	.4470	+1.177	.5423	+1.471
.3571	1.106	.4529	1.209	.5433	1.449
.3583	1.112	.4540	1.191	.5467	1.444
.3597	1.120	.4568	1.210	.5488	1.440
.3650	1.079	.4602	1.221	.5502	1.385
.3664	1.086	.4609	1.219	.5523	1.372
.3675	1.065	.4637	1.207	.5534	1.354
.3685	1.068	.4647	+1.235	.5555	1.338
.3697	1.060			.5565	1.329
.3746	1.032	2442304		.5811	1.148
.3759	1.027	.5095	+1.092	.5839	1.154
.3772	1.030	.5105	1.099	.5849	+1.102
.3784	1.028	.5130	1.099		
.3795	1.020	.5143	1.092	2442309	
.3842	0.997	.5165	1.106	.4340	+1.163
.3854	0.990	.5175	1.077	.4347	1.157
.3864	0.996	.5202	1.077	.4372	1.133
.3878	0.988	.5216	1.065	.4382	1.122
.3890	0.994	.5244	1.050	.4414	1.145
.3935	0.960	.5255	1.035	.4424	1.128
.3947	0.979	.5279	1.056	.4449	1.112
.3961	0.967	.5290	1.055	.4463	1.058
.3971	0.985	.5312	1.033	.4486	1.116
.3982	0.981	.5326	1.041	.4500	1.088
.4025	0.966	.5355	1.030	.4525	1.047
.4039	0.969	.5366	1.026	.4539	1.053
.4051	0.956	.5397	0.982	.4567	1.025
.4062	0.949	.5411	1.000	.4577	1.035
.4073	0.940	.5439	0.976	.4608	1.030
.4218	0.955	.5450	0.971	.4622	1.058
.4239	0.966	.5480	0.945	.4650	1.003
.4286	0.986	.5494	0.975	.4664	1.010
.4299	0.996	.5519	1.012	.4688	1.019
.4312	0.985	.5533	1.018	.4699	1.015
.4324	0.980	.5554	1.000	.4719	0.967
.4382	0.992	.5568	0.988	.4733	0.995
.4395	1.004	.5591	0.997	.4761	0.959
.4406	1.003	.5605	0.993	.4768	0.961
.4417	0.997	.5630	0.997	.4803	0.955
.4429	+1.010	.5644	0.999	.4826	0.947
		.5668	1.007	.4837	0.960
2442303		.5679	1.022	.4861	0.942
.4304	+1.177	.5709	0.976	.4875	0.941
.4345	1.149	.5720	1.005	.4896	0.950
.4352	1.165	.5748	1.006	.4903	0.958
.4383	1.179	.5758	1.013	.4931	0.970
.4394	1.178	.5783	1.012	.4942	0.996
.4418	1.182	.5793	+0.995	.4976	0.970
.4432	1.202			.5000	1.019
.4459	+1.191			.5011	+1.000

Table 8 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442309		2442319		2442319	
.5039	+1.015	.3916	+1.078	.4493	+1.028
.5046	0.995	.3930	1.079	.4507	1.033
.5070	1.013	.3964	1.093	.4535	1.060
.5081	0.971	.3978	1.065	.4549	1.058
.5108	1.016	.4013	1.074	.4569	1.078
.5122	0.986	.4027	1.090	.4578	+1.071
.5150	1.011	.4055	1.081		
.5157	0.997	.4069	1.094	2442361	
.5185	1.013	.4103	1.112	.2293	+1.321
.5192	1.033	.4117	1.091	.2307	1.266
.5208	1.029	.4145	1.101	.2342	1.268
.5219	1.035	.4159	+1.087	.2355	1.225
.5251	1.025			.2386	1.200
.5282	1.021	2442343		.2400	1.196
.5292	1.023	.3417	+1.313	.2432	1.224
.5326	+1.057	.3431	1.279	.2446	1.189
		.3465	1.212	.2474	1.166
2442319		.3479	1.194	.2487	1.181
.2791	+1.320	.3563	1.157	.2515	1.167
.2798	1.323	.3577	1.147	.2529	1.144
.2812	1.298	.3611	1.147	.2557	1.134
.2819	1.288	.3625	1.120	.2571	1.125
.2846	1.246	.3660	1.145	.2599	1.129
.2860	1.263	.3688	1.129	.2612	1.093
.2888	1.238	.3722	1.143	.2647	1.108
.2902	1.229	.3736	1.117	.2661	1.089
.2937	1.203	.3764	1.132	.2689	1.052
.2951	1.197	.3778	1.114	.2730	1.032
.3041	1.122	.3847	1.075	.2744	1.030
.3089	1.095	.3861	1.066	.2772	1.031
.3138	1.071	.3889	1.048	.2786	1.049
.3159	1.082	.3903	1.057	.2821	1.025
.3187	1.111	.3944	1.027	.2835	1.026
.3201	1.076	.3958	1.031	.2862	1.027
.3235	1.069	.4000	1.026	.2876	1.025
.3249	1.072	.4014	1.015	.2911	1.007
.3277	1.071	.4042	1.029	.2925	1.004
.3291	1.050	.4056	1.030	.2953	1.023
.3339	1.044	.4083	1.032	.2967	0.996
.3360	1.032	.4097	1.009	.3099	0.962
.3388	1.027	.4125	1.026	.3113	0.975
.3409	1.049	.4139	0.996	.3140	1.013
.3444	1.042	.4167	0.989	.3154	0.984
.3465	1.008	.4181	0.984	.3376	1.027
.3499	1.003	.4208	1.015	.3390	1.027
.3520	0.981	.4250	1.008	.3418	1.042
.3735	1.029	.4292	1.023	.3432	1.030
.3784	1.020	.4306	1.011	.3460	1.050
.3812	1.019	.4333	1.017	.3474	1.040
.3826	1.024	.4347	1.023	.3501	1.044
.3860	1.060	.4375	1.031	.3515	1.029
.3874	+1.062	.4385	+1.025	.3543	+1.043

Table 8 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442361		2442369		2442422	
.3557	+1.050	.2869	+1.113	.2833	+1.481
.3585	1.056	.2879	1.083	.2861	1.453
.3592	1.044	.2900	1.107	.2875	1.451
.3619	1.063	.2932	1.103	.2910	1.461
.3633	+1.094	.2942	1.038	.2924	1.401
		.2945	1.049	.2958	1.390
2442367		.2969	1.031	.2972	1.376
.3885	+1.417	.2976	1.018	.3000	1.352
.3899	1.378	.3001	1.044	.3014	1.318
.3975	1.368	.3015	1.027	.3042	1.303
.4017	1.310	.3036	1.051	.3056	1.314
.4031	1.273	.3046	1.039	.3083	1.286
.4059	1.296	.3070	1.023	.3097	1.252
.4184	1.137	.3077	1.060	.3132	1.228
.4482	1.021	.3101	1.042	.3146	1.182
.4524	1.078	.3112	1.025	.3174	1.165
.4538	1.024	.3129	1.006	.3188	1.164
.4566	1.039	.3143	0.956	.3215	1.115
.4579	1.018	.3164	1.022	.3229	1.135
.4607	1.032	.3175	1.027	.3313	1.111
.4621	1.010	.3195	0.981	.3326	1.124
.4656	1.019	.3202	0.999	.3361	1.136
.4670	1.003	.3226	0.961	.3375	1.136
.4697	1.001	.3233	0.992	.3403	1.126
.4711	1.021	.3258	0.973	.3417	1.129
.4739	+1.020	.3268	0.943	.3444	1.089
		.3348	1.005	.3451	1.099
2442369		.3365	0.960	.3542	1.075
.2411	+1.349	.3376	0.972	.3556	1.079
.2418	1.343	.3400	0.967	.3583	1.081
.2445	1.329	.3411	0.972	.3597	1.074
.2452	1.337	.3435	0.962	.3625	1.051
.2476	1.305	.3445	0.983	.3639	1.024
.2487	1.354	.3469	0.975	.3667	0.995
.2515	1.325	.3480	+0.991	.3681	1.000
.2529	1.270			.3722	1.024
.2557	1.205	2442403		.3736	1.014
.2570	1.192	.2543	+1.018	.3764	1.035
.2594	1.199	.2557	1.014	.3778	1.003
.2605	1.182	.2599	0.967	.3806	1.011
.2626	1.206	.2613	0.948	.3819	1.026
.2636	1.193	.2641	0.948	.3847	0.976
.2661	1.135	.2655	0.982	.3861	0.982
.2671	1.113	.2682	0.948	.3889	0.990
.2695	1.150	.2696	0.963	.3938	1.002
.2702	1.113	.2731	0.994	.3962	1.026
.2730	1.129	.2745	+0.994	.3979	1.026
.2737	1.116			.4007	1.035
.2772	1.094	2442422		.4014	0.999
.2800	1.134	.2781	+1.482	.4049	1.031
.2830	1.095	.2792	1.492	.4063	+1.016
.2848	+1.139	.2819	+1.481		

Table 8 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442424		2442712		2442712	
.2144	+1.031	.2441	+1.362	.3547	+0.981
.2158	1.007	.2453	1.370	.3561	0.997
.2186	1.012	.2480	1.340	.3589	1.013
.2199	1.008	.2494	1.347	.3603	1.011
.2230	1.034	.2529	1.342	.3630	1.040
.2244	1.041	.2544	1.302	.3644	1.023
.2290	1.026	.2575	1.277	.3672	1.024
.2338	1.005	.2589	1.268	.3686	+1.023
.2373	0.989	.2617	1.238		
.2387	0.990	.2631	1.238	2442713	
.2422	0.988	.2658	1.180	.2393	+1.368
.2540	1.037	.2672	1.170	.2407	1.394
.2574	1.035	.2700	1.156	.2449	1.352
.2591	1.028	.2714	1.130	.2477	1.395
.2633	1.040	.2742	1.179	.2491	1.380
.2651	1.061	.2756	1.142	.2532	1.388
.2686	1.047	.2783	1.110	.2560	1.370
.2699	1.058	.2797	1.093	.2574	1.374
.2734	1.058	.2825	1.131	.2602	1.404
.2748	1.067	.2839	1.125	.2643	1.382
.2779	1.067	.2867	1.103	.2657	1.382
.2793	+1.067	.2881	1.122	.2685	1.412
		.2908	1.114	.2699	1.417
2442432		.2922	1.072	.2831	1.422
.2163	+1.107	.2950	1.106	.2841	1.386
.2197	1.066	.2964	1.077	.2872	1.383
.2211	1.074	.2992	1.108	.2886	1.426
.2239	1.070	.3006	1.050	.2914	1.383
.2260	1.071	.3033	1.020	.2928	1.404
.2288	1.053	.3047	1.027	.2956	1.383
.2302	1.026	.3082	1.047	.2970	1.390
.2336	1.014	.3096	1.097	.2997	1.415
.2350	1.002	.3123	1.024	.3011	1.408
.2385	1.023	.3137	1.038	.3039	1.422
.2399	1.027	.3165	1.054	.3081	1.428
.2427	1.030	.3179	0.999	.3096	1.381
.2440	0.981	.3207	1.010	.3122	1.403
.2489	0.961	.3221	1.007	.3136	1.408
.2524	1.011	.3248	0.958	.3164	1.413
.2538	0.981	.3262	0.984	.3178	1.391
.2565	0.982	.3290	0.984	.3206	1.424
.2586	0.994	.3304	0.987	.3220	1.420
.2628	0.998	.3332	1.013	.3254	1.393
.2642	0.997	.3350	0.994	.3268	1.384
.2670	1.028	.3380	0.990	.3296	1.376
.2684	0.982	.3394	0.996	.3310	1.400
.2718	0.992	.3422	0.998	.3328	1.423
.2732	1.009	.3436	0.974	.3342	1.409
.2767	+0.991	.3464	0.964	.3991	1.441
		.3478	0.974	.4018	1.433
2442712		.3505	0.991	.4032	1.458
.2411	+1.401	.3519	+0.994	.4157	+1.490

Table 8 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442713		2442725		2443422	
.4171	+1.444	.4136	+1.158	.3357	+1.209
.4303	1.457	.4150	1.156	.3387	1.139
.4317	1.480	.4212	1.174	.3401	1.155
.4345	1.517	.4247	1.159	.3432	1.118
.4359	1.485	.4261	1.152	.3447	1.168
.4386	1.472	.4326	1.175	.3520	1.129
.4400	1.474	.4347	1.180	.3535	1.142
.4428	1.490	.4361	1.185	.3561	1.148
.4442	1.481	.4375	1.189	.3575	1.133
.4470	1.503	.4420	1.234	.3602	1.112
.4484	1.499	.4430	1.198	.3647	1.124
.4511	1.454	.4444	1.197	.3701	1.106
.4525	1.458	.4455	1.210	.3737	1.075
.4609	1.444	.4469	1.231	.3751	1.067
.4623	1.458	.4548	1.235	.3828	1.033
.4650	1.446	.4565	1.236	.3845	1.052
.4664	1.467	.4579	1.231	.3878	0.997
.4713	1.407	.4587	1.242	.3893	1.009
.4747	1.390	.4600	1.249	.3922	1.012
.4792	1.385	.4663	1.215	.3936	1.008
.4806	+1.377	.4677	1.226	.3963	1.029
		.4692	1.217	.3977	1.021
2442720		.4706	1.221	.4007	1.001
.3576	+0.967	.4781	1.241	.4050	0.992
.3590	0.984	.4795	1.257	.4062	0.975
.3597	0.985	.4806	1.245	.4106	0.982
.3609	0.980	.4837	1.265	.4117	1.015
.3624	0.964	.4851	1.221	.4147	1.015
.3674	0.970	.4906	1.257	.4196	0.989
.3685	0.974	.4920	1.261	.4211	0.977
.3702	0.980	.4934	1.252	.4239	1.021
.3715	0.963	.4944	1.250	.4260	0.999
.3727	+0.966	.4955	1.267	.4288	1.003
		.5006	1.247	.4300	1.034
2442725		.5020	1.256	.4331	1.013
.4003	+1.154	.5030	1.274	.4344	1.009
.4014	1.161	.5044	1.294	.4374	1.037
.4024	1.164	.5055	+1.304	.4392	1.061
.4038	1.154			.4418	1.074
.4052	1.148	2443422		.4430	1.076
.4101	1.196	.3299	+1.277	.4455	1.048
.4115	1.169	.3311	+1.251	.4468	+1.048
.4126	+1.148				

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442277		2442277		2442277	
.3589	+1.183	.3691	+1.136	.3789	+1.112
.3603	1.180	.3703	1.137	.3801	1.085
.3657	1.149	.3752	1.083	.3848	1.070
.3670	1.183	.3765	1.082	.3859	1.051
.3680	+1.124	.3778	+1.074	.3869	+1.072

Table 8 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442277		2442304		2442309	
.3884	+1.072	.5133	+1.143	.4344	+1.202
.3895	1.081	.5158	1.159	.4368	1.194
.3941	1.033	.5168	1.140	.4379	1.156
.3955	1.032	.5199	1.117	.4407	1.179
.3967	1.011	.5209	1.113	.4421	1.169
.3977	1.022	.5237	1.102	.4442	1.146
.3988	1.037	.5248	1.087	.4456	1.131
.4030	1.001	.5272	1.103	.4483	1.148
.4045	1.023	.5283	1.069	.4493	1.118
.4056	0.986	.5305	1.081	.4518	1.104
.4067	0.977	.5319	1.066	.4532	1.105
.4079	0.983	.5359	1.042	.4560	1.101
.4206	0.992	.5394	1.027	.4570	1.078
.4225	0.992	.5404	1.007	.4601	1.100
.4245	1.022	.5432	1.006	.4615	1.109
.4295	1.028	.5446	1.002	.4643	1.048
.4305	1.020	.5473	1.012	.4657	1.081
.4317	1.007	.5487	0.997	.4681	1.030
.4330	1.006	.5526	1.030	.4695	1.045
.4341	1.003	.5551	1.016	.4715	1.038
.4388	1.052	.5561	0.987	.4726	1.054
.4401	1.076	.5584	1.008	.4754	1.020
.4412	1.054	.5598	1.004	.4764	1.013
.4423	1.064	.5627	1.022	.4789	1.002
.4434	+1.052	.5637	1.033	.4799	0.983
		.5661	1.025	.4823	0.982
2442303		.5675	1.038	.4830	0.982
.4255	+1.237	.5702	1.026	.4858	0.999
.4297	1.270	.5716	1.012	.4868	0.986
.4338	1.239	.5741	1.064	.4893	0.993
.4348	1.244	.5751	1.050	.4900	0.985
.4376	1.259	.5776	1.049	.4924	0.991
.4387	1.255	.5790	+1.068	.4935	0.980
.4415	1.293			.4958	1.003
.4425	1.257	2442307		.4972	0.993
.4452	1.289	.5419	+1.549	.4997	0.980
.4526	1.283	.5426	1.552	.5007	0.979
.4533	1.317	.5450	1.540	.5032	1.027
.4561	1.313	.5460	1.521	.5042	1.010
.4575	1.314	.5485	1.529	.5067	1.031
.4595	1.320	.5495	1.531	.5077	1.008
.4605	1.300	.5520	1.473	.5101	1.025
.4630	1.320	.5530	1.441	.5115	1.001
.4644	1.346	.5548	1.428	.5143	1.029
.4699	1.367	.5562	1.467	.5153	1.035
.4713	1.369	.5793	1.238	.5178	1.049
.4738	+1.379	.5804	1.210	.5188	1.072
		.5832	1.226	.5205	1.066
2442304		.5842	+1.217	.5212	1.057
.5092	+1.180			.5248	1.072
.5098	1.143	2442309		.5258	1.077
.5127	+1.148	.4337	+1.203	.5278	+1.094

Table 8 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442309		2442343		2442361	
.5289	+1.081	.3556	+1.280	.2480	+1.234
.5310	1.092	.3570	1.229	.2508	1.205
.5320	+1.097	.3604	1.203	.2522	1.196
		.3618	1.224	.2550	1.192
2442319		.3653	1.209	.2564	1.186
.2794	+1.456	.3667	1.200	.2592	1.185
.2808	1.426	.3715	1.204	.2605	1.194
.2815	1.395	.3719	1.192	.2640	1.158
.2839	1.349	.3757	1.186	.2654	1.136
.2853	1.327	.3771	1.176	.2682	1.149
.2881	1.310	.3840	1.141	.1696	1.117
.2895	1.296	.3854	1.135	.2724	1.099
.2930	1.238	.3882	1.117	.2737	1.098
.2944	1.222	.3938	1.103	.2765	1.093
.3034	1.190	.3951	1.092	.2779	1.083
.3082	1.183	.3993	1.056	.2814	1.081
.3096	1.179	.4007	1.042	.2828	1.077
.3131	1.162	.4035	1.050	.2855	1.072
.3145	1.160	.4049	1.038	.2869	1.072
.3180	1.152	.4076	1.031	.2904	1.058
.3194	1.151	.4090	1.034	.2918	1.049
.3221	1.154	.4118	1.026	.2946	1.035
.3242	1.106	.4132	1.037	.2960	1.007
.3270	1.096	.4160	1.024	.3092	0.993
.3332	1.062	.4174	1.015	.3106	0.989
.3353	1.037	.4201	1.014	.3133	0.989
.3381	1.041	.4215	1.034	.3147	0.984
.3395	1.024	.4243	1.020	.3411	1.036
.3430	1.029	.4257	1.033	.3425	1.049
.3451	1.039	.4285	1.039	.3453	1.071
.3492	1.005	.4299	1.036	.3467	1.084
.3506	1.034	.4326	1.044	.3494	1.082
.3763	1.012	.4340	1.030	.3508	1.082
.3805	1.031	.4368	1.052	.3536	1.090
.3819	1.005	.4382	1.019	.3550	1.097
.3853	1.044	.4486	1.039	.3578	1.097
.3902	1.044	.4500	1.047	.3588	1.091
.3923	1.043	.4528	1.075	.3612	1.112
.3957	1.102	.4542	1.074	.3626	+1.097
.3971	1.093	.4566	1.079		
.4006	1.087	.4572	+1.090	2442367	
.4020	1.108			.3878	+1.474
.4048	1.092	2442361		.3892	1.462
.4062	1.099	.2286	+1.458	.3968	1.420
.4138	1.141	.2300	1.427	.3982	1.406
.4152	+1.150	.2335	1.398	.4010	1.371
		.2349	1.360	.4024	1.354
2442343		.2379	1.345	.4052	1.367
.3410	+1.405	.2393	1.336	.4177	1.237
.3424	1.386	.2425	1.304	.4475	1.076
.3458	1.355	.2439	1.279	.4489	1.111
.3472	+1.342	.2467	+1.238	.4517	+1.100

Table 8 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442367		2442369		2442422	
.4531	+1.062	.3198	+1.025	.3354	+1.171
.4559	1.079	.3223	1.003	.3368	1.174
.4572	1.077	.3230	0.987	.3396	1.189
.4600	1.045	.3251	1.014	.3410	1.183
.4614	1.026	.3261	1.013	.3438	1.167
.4649	1.017	.3341	0.994	.3447	1.145
.4663	0.995	.3362	0.997	.3486	1.152
.4691	0.982	.3372	1.008	.3500	1.136
.4704	1.006	.3397	1.006	.3525	1.104
.4732	+1.000	.3404	0.999	.3549	1.103
		.3428	0.993	.3576	1.088
2442369		.3442	1.004	.3590	1.078
.2404	+1.469	.3466	1.001	.3618	1.056
.2414	1.446	.3473	+1.015	.3632	1.031
.2439	1.473			.3660	1.027
.2448	1.488	2442403		.3674	1.024
.2473	1.482	.2536	+1.017	.3708	1.019
.2508	1.423	.2550	1.003	.3757	1.051
.2550	1.359	.2592	0.983	.3771	1.039
.2564	1.323	.2606	0.977	.3799	1.028
.2587	1.330	.2634	0.978	.3813	1.023
.2598	1.301	.2648	0.995	.3840	1.024
.2622	1.259	.2675	0.981	.3854	1.019
.2633	1.266	.2689	0.971	.3882	1.008
.2657	1.215	.2724	0.992	.3896	0.996
.2664	1.231	.2738	+1.002	.3917	0.996
.2689	1.215			.3931	1.004
.2698	1.186	2442422		.3958	0.998
.2723	1.171	.2778	+1.562	.3972	0.998
.2768	1.162	.2785	1.548	.4000	1.005
.2793	1.175	.2813	1.547	.4010	1.023
.2814	1.191	.2826	1.541	.4042	1.025
.2841	1.185	.2854	1.543	.4056	+1.033
.2862	1.179	.2868	1.551		
.2876	1.145	.2903	1.536	2442424	
.2897	1.139	.2917	1.548	.2137	+1.094
.2911	1.128	.2951	1.503	.2151	1.060
.2935	1.125	.2965	1.488	.2179	1.026
.2962	1.112	.2993	1.480	.2192	1.035
.2973	1.107	.3007	1.475	.2223	1.049
.2994	1.111	.3035	1.447	.2237	1.036
.3008	1.083	.3049	1.401	.2269	1.053
.3032	1.113	.3076	1.403	.2283	1.034
.3043	1.053	.3090	1.343	.2331	0.970
.3067	1.077	.3125	1.333	.2366	1.001
.3073	1.067	.3139	1.274	.2380	0.993
.3108	1.071	.3167	1.278	.2408	1.003
.3126	1.051	.3181	1.242	.2429	1.005
.3136	1.035	.3208	1.218	.2463	1.033
.3157	1.029	.3222	1.204	.2480	1.023
.3168	1.033	.3306	1.182	.2512	1.016
.3192	+1.032	.3319	+1.164	.2533	+1.054

Table 8 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442424		2442712		2442713	
.2564	+1.071	.2707	+1.223	.2511	+1.580
.2581	1.068	.2735	1.255	.2525	1.557
.2623	1.064	.2749	1.206	.2553	1.575
.2644	1.072	.2776	1.204	.2567	1.589
.2679	1.093	.2790	1.218	.2595	1.562
.2692	1.087	.2818	1.190	.2678	1.537
.2727	1.087	.2832	1.190	.2720	1.544
.2741	1.098	.2860	1.162	.2824	1.557
.2772	1.105	.2874	1.172	.2834	1.564
.2786	+1.112	.2901	1.154	.2865	1.557
		.2915	1.154	.2879	1.564
2442432		.2943	1.155	.2907	1.545
.2190	+1.136	.2957	1.132	.2949	1.589
.2204	1.117	.2985	1.140	.2963	1.579
.2232	1.104	.2999	1.109	.2990	1.556
.2246	1.111	.3026	1.096	.3004	1.545
.2281	1.090	.3040	1.091	.3032	1.590
.2295	1.057	.3075	1.104	.3046	1.592
.2329	1.026	.3089	1.132	.3074	1.576
.2343	1.037	.3116	1.062	.3115	1.595
.2378	1.033	.3130	1.101	.3129	1.553
.2392	1.024	.3158	1.051	.3157	1.573
.2420	1.012	.3172	1.045	.3171	1.542
.2433	1.011	.3200	1.043	.3199	1.593
.2468	1.004	.3241	1.044	.3213	1.563
.2482	0.991	.3255	1.014	.3247	1.585
.2517	0.995	.3283	1.009	.3261	1.576
.2531	1.008	.3297	1.021	.3289	1.565
.2558	1.026	.3325	0.994	.3321	1.549
.2579	1.018	.3339	1.027	.3335	1.568
.2621	1.033	.3373	1.017	.3984	1.576
.2635	1.034	.3387	0.997	.4011	1.584
.2663	1.046	.3415	1.012	.4025	1.582
.2677	1.043	.3429	1.016	.4053	1.594
.2725	1.060	.3457	1.011	.4150	1.574
.2760	+1.060	.3471	1.015	.4164	1.597
		.3498	1.009	.4296	1.642
2442712		.3512	1.007	.4310	1.653
.2403	+1.563	.3540	1.013	.4338	1.656
.2434	1.531	.3554	1.017	.4352	1.650
.2447	1.516	.3582	1.049	.4379	1.625
.2473	1.501	.3596	1.015	.4393	1.628
.2488	1.505	.3623	1.034	.4421	1.621
.2521	1.469	.3637	1.040	.4435	1.615
.2536	1.435	.3665	1.045	.4477	1.597
.2567	1.407	.3679	+1.058	.5504	1.641
.2582	1.383			.4518	1.621
.2610	1.353	2442713		.4532	1.637
.2624	1.353	.2400	+1.539	.4556	1.593
.2651	1.273	.2428	1.571	.2474	1.615
.2665	1.274	.2470	1.538	.4602	1.629
.2693	+1.245	.2484	+1.573	.4643	+1.588

Table 8 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442713		2442725		2443422	
.4657	+1.618	.4427	+1.384	.3512	+1.193
.4688	1.600	.4437	1.385	.3528	1.165
.4706	1.530	.4449	1.360	.3568	1.183
.4740	1.549	.4462	1.381	.3595	1.176
.4754	1.526	.4476	1.342	.3609	1.188
.4785	1.498	.4558	1.385	.3652	1.162
.4799	+1.515	.4572	1.349	.3682	1.140
		.4583	1.390	.3695	1.117
2442720		.4593	1.408	.3731	1.105
.3580	+1.032	.4607	1.378	.3744	1.089
.3594	1.002	.4670	1.430	.3822	1.071
.3603	1.005	.4685	1.423	.3872	1.055
.3617	0.995	.4699	1.393	.3915	1.019
.3630	1.019	.4713	1.384	.3929	1.054
.3681	1.022	.4724	1.401	.3956	1.055
.3695	1.029	.4788	1.431	.3970	1.007
.3709	1.029	.4802	1.437	.3999	1.009
.3733	+0.996	.4810	1.454	.4014	0.998
		.4844	1.470	.4042	1.021
2442725		.4858	1.467	.4056	1.021
.3910	+1.206	.4913	1.433	.4099	0.995
.3921	1.244	.4927	1.440	.4112	0.987
.3934	1.206	.4938	1.477	.4142	1.040
.3942	1.232	.4949	1.468	.4157	1.036
.3956	1.210	.4962	1.434	.4190	0.996
.4010	1.266	.5013	1.484	.4203	1.036
.4018	1.265	.5024	1.476	.4232	1.031
.4031	1.258	.5037	1.507	.4253	1.055
.4045	1.249	.5051	+1.457	.4281	1.053
.4059	1.270			.4293	1.052
.4143	1.304	2443422		.4323	1.068
.4157	1.298	.3292	+1.374	.4337	1.043
.4216	1.282	.3304	1.336	.4369	1.065
.4240	1.273	.3336	1.324	.4385	1.072
.4253	1.305	.3351	1.330	.4411	1.084
.4319	1.302	.3380	1.294	.4424	1.089
.4333	1.332	.3394	1.270	.4450	1.093
.4368	1.329	.3424	1.202	.4461	+1.082
.4382	+1.327	.3441	+1.188		

Table 9

Photoelectric observations of SU Dra

J.D.	Δm*	J.D.	Δm*	J.D.	Δm*
2435186		2435186		2435186	
.4607	−0.264	.4777	−0.440	.4960	−0.442
.4620	0.306	.4788	0.426	.4970	0.425
.4628	0.327	.4798	0.454	.4992	0.422
.4642	0.365	.4809	0.443	.5003	0.402
.4688	0.405	.4815	0.450	.5054	0.397
.4696	0.419	.4877	0.423	.5064	0.383
.4707	0.392	.4890	0.423	.5075	0.331
.4721	0.422	.4899	0.431	.5092	−0.316
.4726	−0.426	.4910	−0.421		

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436152		2436164		2436187	
.5607	+0.978	.4952	+0.840	.4875	+0.902
.5621	0.983	.4975	0.814	.4917	0.876
.5729	0.994	.5037	0.718	.4980	0.908
.5742	0.989	.5048	0.699	.4993	0.892
.5864	0.986	.5060	0.693	.5106	0.921
.5881	0.971	.5072	0.657	.5128	0.946
.5976	0.931	.5106	0.600	.5243	0.949
.5991	0.925	.5135	0.548	.5304	0.935
.6079	0.916	.5195	0.389	.5426	0.950
.6089	0.888	.5207	0.377	.5828	1.008
.6180	0.683	.5250	0.355	.5883	0.988
.6192	0.676	.5261	0.337	.6005	0.941
.6280	0.488	.5326	0.247	.6051	0.910
.6291	0.460	.5348	0.239	.6123	0.860
.6358	0.370	.5379	0.184	.6175	0.762
.6369	0.380	.5444	0.105	.6251	0.622
.6437	0.304	.5505	+0.021	.6305	0.521
.6449	0.295	.5571	−0.001	.6402	0.343
.6519	0.191	.5618	−0.005	.6458	0.318
.6530	0.168	.5631	+0.006	.6525	0.199
.6602	0.064	.5753	−0.005	.6575	0.148
.6667	+0.009	.5801	+0.006	.6635	+0.062
.6767	−0.012	.5876	0.042		
.6826	−0.026	.5960	0.060	2436199	
.6889	+0.006	.6038	0.075	.4759	+0.945
		.6054	0.081	.4780	0.963
2436163		.6125	0.136	.5168	0.540
.6099	+0.795	.6175	0.142	.5198	0.431
.6159	0.810	.6280	0.190	.5223	0.394
.6244	0.809	.6294	0.188	.5279	0.318
.6308	0.807	.6368	0.233	.5313	0.309
.6337	+0.821	.6449	0.236	.5337	0.257
		.6525	0.271	.5390	0.202
2436164		.6576	0.282	.5421	0.133
.4799	+0.972	.6659	0.292	.5497	0.062
.4862	0.972	.6738	+0.350	.5525	0.019
.4892	+0.894			.5556	+0.012

Table 9 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436199		2436619		2436619	
.5588	-0.014	.4755	+0.943	.6473	+0.147
.5626	0.016	.4841	0.944	.6514	0.154
.5657	0.037	.4859	0.968	.6535	0.164
.5733	0.009	.4899	0.979	.6556	0.187
.5765	0.001	.4917	0.972	.6598	0.190
.5796	-0.024	.4936	0.984	.6619	0.194
.5827	+0.010	.4973	0.953	.6639	0.188
.5907	+0.080	.4991	0.937	.6681	0.231
		.5010	0.953	.6702	0.236
2436203		.5047	0.972	.6723	0.246
.4341	+0.998	.5190	0.928	.6764	+0.246
.4372	1.001	.5209	0.876		
.4515	0.927	.5246	0.822	2436624	
.4549	0.882	.5331	0.716	.4251	+0.562
.4586	0.872	.5371	0.633	.4271	0.548
.4617	0.827	.5394	0.611	.4292	0.573
.4654	0.778	.5413	0.542	.4334	0.581
.4711	+0.684	.5454	0.459	.4355	0.585
		.5473	0.425	.4376	0.604
2436617		.5491	0.400	.4417	0.610
.6155	-0.007	.5528	0.329	.4438	0.612
.6207	-0.002	.5547	0.321	.4501	0.627
.6228	+0.023	.5565	0.311	.4521	0.630
.6249	0.034	.5607	0.262	.4542	+0.648
.6270	0.021	.5625	0.248		
.6311	0.037	.5644	0.215	2436626	
.6332	0.031	.5693	0.157	.3281	+0.366
.6381	0.064	.5711	0.095	.3320	0.387
.6402	0.070	.5730	0.070	.3338	0.382
.6422	0.071	.5767	0.060	.3357	0.397
.6579	0.126	.5785	0.017	.3415	0.446
.6600	0.134	.5804	+0.024	.3433	0.447
.6641	0,117	.5852	-0.014	.3470	0.465
.6662	0.139	.5873	0.021	.3489	0.451
.6683	0.161	.5892	-0.016	.3549	0.483
.6745	0.164	.5929	+0.001	.3568	0.462
.6766	+0.179	.5947	-0.020	.3586	0.446
		.5966	0.020	.3632	0.481
2436619		.6003	0.013	.3651	0.480
.4004	+0.867	.6021	0.009	.3669	0.492
.4059	0.867	.6040	-0.016	.3706	0.553
.4466	0.906	.6181	+0.053	.3744	0.543
.4487	0.914	.6202	0.065	.3818	0.555
.4507	0.926	.6223	0.062	.3855	0.555
.4553	0.930	.6264	0.067	.3873	0.549
.4573	0.935	.6285	0.066	.3892	0.535
.4594	0.937	.6306	0.098	.4278	0.637
.4636	0.948	.6348	0.102	.4297	0.630
.4657	0.919	.6369	0.111	.4334	0.641
.4678	0.930	.6389	0.123	.4352	0.646
.4718	0.925	.6431	0.125	.4371	0.653
.4737	+0.943	.6452	+0.130	.4410	+0.660

Table 9 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436626		2436626		2442403	
.4429	+0.653	.6165	+0.800	.4981	+0.597
.4447	0.653	.6186	0.849	.4990	0.548
.4484	0.657	.6206	0.845	.5022	0.480
.4503	0.657	.6248	0.798	.5034	0.473
.4521	0.657	.6269	0.834	.5061	0.394
.4558	0.675	.6290	0.839	.5075	0.386
.4577	0.681	.6338	0.826	.5102	0.381
.4595	0.680	.6366	0.864	.5116	0.336
.4632	0.693	.6394	0.820	.5244	0.337
.4651	0.699	.6446	0.831	.5158	0.342
.4669	0.699	.6474	0.844	.5186	0.311
.4706	0.709	.6502	+0.838	.5199	0.270
.4725	0.702			.5220	0.259
.4744	0.697	2436645		.5234	0.233
.4781	0.694	.3174	+0.278	.5262	0.184
.4799	0.690	.3195	0.230	.5276	0.148
.4892	0.694	.3237	0.194	.5304	0.127
.4929	0.697	.3258	0.169	.5317	0.108
.4947	0.705	.3278	0.123	.5345	0.108
.4968	0.704	.3320	0.043	.5359	0.085
.5005	0.707	.3341	0.026	.5387	0.029
.5024	0.715	.3362	+0.032	.5401	0.024
.5042	0.719	.3403	-0.010	.5429	+0.004
.5079	0.730	.3424	0.035	.5442	-0.012
.5098	0.723	.3445	0.027	.5477	0.013
.5116	0.728	.3487	0.015	.5501	0.034
.5153	0.730	.3508	0.008	.5554	0.023
.5172	0.742	.3528	-0.014	.5623	0.011
.5190	0.756	.3570	+0.018	.5637	-0.018
.5230	0.737	.3591	0.020	.5665	+0.005
.5248	0.727	.3657	0.014	.5672	0.006
.5267	0.748	.3678	0.014	.5699	0.010
.5415	0.780	.3699	0.015	.5713	0.028
.5436	0.778	.3740	0.022	.5741	0.027
.5456	0.791	.3761	0.039	.5755	0.033
.5519	0.787	.3782	0.059	.5790	0.013
.5540	0.786	.3827	0.088	.5804	0.030
.5581	0.775	.3848	0.105	.5827	0.033
.5623	0.795	.3869	0.114	.5841	0.052
.5665	0.796	.3924	0.091	.5869	0.051
.5686	0.816	.3949	0.098	.5883	0.084
.5748	0.794	.3973	0.111	.5911	0.093
.5769	0.786	.4022	0.128	.5925	+0.085
.5790	0.806	.4088	0.196		
.5831	0.784	.4129	0.218	2442415	
.5852	0.786	.4150	0.223	.3597	+0.947
.5873	0.815	.4171	0.232	.3607	0.954
.5956	0.814	.4216	0.242	.3639	0.921
.5998	0.817	.4237	0.249	.3653	0.916
.6081	0.840	.4258	+0.252	.3681	0.924
.6102	0.824			.3694	0.886
.6123	+0.840			.3729	+0.813

Table 9 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442415		2442452		2442452	
.3743	+0.798	.4409	−0.002	.6438	+0.584
.3819	0.678	.4500	+0.028	.6457	0.582
.3833	0.638	.4515	0.030	.6473	0.592
.3868	0.573	.4536	0.043	.6493	0.590
.3882	0.542	.4550	0.067	.6512	0.602
.3910	0.433	.4569	0.057	.6529	+0.616
.3924	0.417	.4652	0.090		
.3951	0.381	.4672	0.094	2442454	
.3965	0.360	.4689	0.100	.2926	+0.999
.3993	0.314	.4706	0.119	.2944	0.990
.4007	0.315	.4720	0.102	.2956	0.978
.4042	0.311	.4899	0.204	.2971	0.958
.4056	0.301	.4917	0.191	.2986	0.951
.4090	0.283	.4934	0.189	.3039	0.955
.4104	0.262	.4953	0.198	.3052	0.966
.4142	0.211	.4969	0.196	.3065	0.969
.4153	0.228	.5096	0.270	.3079	0.966
.4188	0.155	.5112	0.264	.3095	0.962
.4201	0.143	.5125	0.261	.3150	0.971
.4236	0.072	.5141	0.271	.3163	0.959
.4250	0.078	.5155	0.251	.3175	0.950
.4285	0.041	.5280	0.293	.3188	0.955
.4299	0.018	.5296	0.288	.3200	0.959
.4333	0.006	.5312	0.302	.3248	0.944
.4347	+0.018	.5331	0.295	.3263	0.918
.4382	−0.002	.5348	0.306	.3276	0.914
.4396	0.017	.5602	0.399	.3294	0.904
.4424	0.010	.5618	0.393	.3307	0.892
.4438	0.010	.5632	0.399	.3323	0.875
.4472	0.019	.5646	0.411	.3382	0.812
.4486	0.018	.5662	0.402	.3396	0.798
.4514	0.008	.5732	0.426	.3407	0.788
.4528	−0.003	.5748	0.428	.3421	0.768
.4563	+0.003	.5766	0.437	.3436	0.744
.4576	−0.002	.5782	0.445	.3479	0.663
.4604	+0.009	.5800	0.440	.3490	0.618
.4618	0.039	.5894	0.473	.3503	0.601
.4646	0.031	.5929	0.483	.3515	0.567
.4660	0.035	.5952	0.493	.3529	0.529
.4691	0.084	.5982	0.509	.3579	0.440
.4701	+0.074	.5997	0.498	.3595	0.388
		.6078	0.538	.3604	0.379
2442452		.6098	0.526	.3615	0.378
.4166	−0.027	.6115	0.541	.3625	0.360
.4187	0.017	.6132	0.540	.3664	0.323
.4222	0.036	.6151	0.541	.3673	0.314
.4251	−0.010	.6221	0.541	.3685	0.309
.4335	0.000	.6238	0.551	.3695	0.296
.4350	+0.001	.6258	0.539	.3707	0.286
.4365	0.003	.6289	0.535	.3746	0.243
.4381	+0.005	.6306	0.550	.3756	0.221
.4395	−0.004	.6419	+0.584	.3766	+0.199

Table 9 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442454		2442532		2442948	
.3776	+0.190	.3836	+0.139	.3683	+0.236
.3790	0.168	.3905	0.181	.3717	0.204
.3841	0.121	.3921	0.180	.3731	0.158
.3854	0.093	.3941	0.187	.3766	0.137
.3869	0.077	.3955	0.193	.3780	0.125
.3885	0.082	.3969	0.197	.3811	0.067
.3898	0.060	.4041	0.221	.3825	0.031
.3942	0.025	.4059	0.237	.3856	0.009
.3955	0.014	.4069	0.235	.3870	0.017
.3969	+0.007	.4086	0.244	.3905	+0.014
.3981	-0.008	.4097	0.266	.3919	-0.002
.3994	0.005	.4159	0.271	.3950	-0.005
.4004	0.014	.4174	0.269	.3964	+0.004
.4024	0.025	.4188	0.283	.3998	0.001
.4037	0.015	.4204	0.297	.4015	+0.004
.4050	0.030	.4218	0.282		
.4063	0.035	.4289	0.293	2443204	
.4085	0.014	.4303	0.293	.5984	+0.336
.4098	0.019	.4321	0.307	.6001	0.318
.4154	0.009	.4337	0.307	.6041	0.282
.4167	0.012	.4353	0.313	.6055	0.300
.4181	0.012	.4412	0.338	.6096	0.242
.4192	-0.007	.4428	0.334	.6110	0.222
.4206	+0.005	.4445	0.336	.6152	0.152
.4224	-0.005	.4459	0.338	.6169	0.128
		.4471	0.362	.6210	0.097
2442532		.4535	0.363	.6225	0.091
.3509	+0.020	.4552	0.378	.6267	0.041
.3530	0.039	.4567	0.372	.6306	0.003
.3556	0.051	.4584	0.374	.6326	+0.002
.3575	0.062	.4602	0.388	.6365	-0.005
.3588	0.068	.4653	0.401	.6384	0.015
.3655	0.085	.4674	0.404	.6426	0.026
.3669	0.085	.4688	0.406	.6442	0.029
.3686	0.088	.4704	0.410	.6489	0.020
.3703	0.099	.4720	+0.406	.6504	0.018
.3718	0.109			.6545	-0.019
.3779	0.128	2442948		.6560	+0.002
.3793	0.131	.3627	+0.328	.6596	0.014
.3808	0.130	.3641	0.306	.6610	+0.029
.3822	+0.138	.3669	+0.283		

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436152		2436152		2436152	
.5571	+0.293	.6109	+0.093	.6394	-0.511
.5586	0.312	.6122	+0.063	.6465	0.612
.5693	0.320	.6213	-0.158	.6477	0.615
.5709	0.308	.6227	0.154	.6544	0.730
.5820	0.279	.6307	0.416	.6556	0.752
.5946	0.287	.6318	0.433	.6618	0.846
.5956	+0.282	.6381	-0.486	.6684	-0.927

Table 9 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436152		2436187		2436617	
.6751	−0.942	.6020	+0.241	.6363	−0.870
.6810	0.919	.6031	0.200	.6391	0.871
.6873	−0.956	.6141	0.094	.6412	−0.855
		.6158	+0.057		
2436163		.6272	−0.211	2436619	
.6174	+0.142	.6286	0.256	.3990	+0.143
.6232	0.148	.6418	0.526	.4046	0.133
.6258	0.138	.6437	0.557	.4073	0.162
.6324	+0.138	.6543	0.704	.4129	0.182
		.6560	−0.726	.4157	0.168
2436164				.4184	0.154
.4785	+0.308	2436199		.4455	0.187
.4815	0.272	.4770	+0.332	.4476	0.197
.4877	0.239	.4791	+0.332	.4497	0.203
.4964	0.111	.5153	−0.210	.4542	0.208
.5022	+0.029	.5184	0.328	.4563	0.232
.5121	−0.207	.5210	0.384	.4584	0.225
.5224	0.456	.5268	0.502	.4625	0.259
.5235	0.464	.5296	0.529	.4646	0.240
.5311	0.569	.5325	0.583	.4667	0.243
.5363	0.645	.5351	0.607	.4709	0.224
.5395	0.700	.5407	0.693	.4727	0.226
.5460	0.810	.5438	0.778	.4746	0.262
.5521	0.880	.5511	0.891	.4889	0.269
.5589	0.924	.5539	0.921	.4908	0.275
.5603	0.929	.5571	0.943	.4926	0.288
.5649	0.928	.5608	0.937	.4963	0.249
.5787	0.890	.5643	0.944	.4982	0.230
.5860	0.878	.5719	0.925	.5075	0.292
.5941	0.841	.5751	0.961	.5153	0.227
.6021	0.799	.5788	0.943	.5179	0.206
.6070	0.782	.5810	0.933	.5200	0.185
.6143	0.752	.5847	0.893	.5237	0.093
.6157	0.739	.5925	−0.873	.5271	+0.063
.6259	0.684			.5322	−0.090
.6310	0.657	2436203		.5362	0.126
.6386	0.633	.4357	+0.318	.5403	0.229
.6467	0.600	.4393	0.306	.5445	0.365
.6543	0.588	.4535	0.176	.5463	0.403
.6557	0.566	.4566	0.142	.5482	0.427
.6640	0.538	.4602	0.117	.5519	0.499
.6721	−0.505	.4635	0.073	.5538	0.508
		.4672	+0.019	.5556	0.533
2436187		.4692	−0.019	.5598	0.584
.4964	+0.209			.5616	0.617
.5013	0.212	2436617		.5635	0.651
.5090	0.225	.6166	−0.962	.5683	0.720
.5154	0.209	.6218	0.927	.5702	0.778
.5390	0.264	.6238	0.896	.5720	0.802
.5409	0.271	.6259	0.901	.5757	0.853
.5847	0.340	.6301	0.902	.5776	0.894
.5863	+0.312	.6322	−0.913	.5794	−0.902

Table 9 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436619		2436626		2436626	
.5843	−0.919	.3329	−0.361	.4938	−0.024
.5864	0.948	.3348	0.355	.4959	0.022
.5882	0.947	.3387	0.373	.4996	0.012
.5919	0.940	.3406	0.373	.5014	−0.003
.5938	0.940	.3424	0.343	.5033	+0.004
.5956	0.941	.3461	0.340	.5070	0.012
.5994	0.948	.3480	0.340	.5088	0.009
.6012	0.930	.3498	0.349	.5107	0.017
.6031	0.914	.3450	0.324	.5144	0.022
.6068	0.921	.3558	0.339	.5163	0.026
.6107	0.918	.3623	0.311	.5181	0.032
.6171	0.888	.3642	0.305	.5220	0.027
.6191	0.882	.3660	0.295	.5239	0.014
.6212	0.873	.3697	0.278	.5257	0.018
.6254	0.844	.3716	0.218	.5404	0.067
.6275	0.837	.3734	0.215	.5425	0.066
.6296	0.821	.3790	0.206	.5446	0.065
.6337	0.812	.3808	0.203	.5488	0.108
.6358	0.787	.3845	0.198	.5509	0.051
.6379	0.771	.3864	0.205	.5529	0.087
.6421	0.764	.3882	0.214	.5571	0.101
.6441	0.743	.3919	0.199	.5592	0.077
.6462	0.736	.3938	0.154	.5613	0.079
.6504	0.730	.3956	0.184	.5654	0.103
.6525	0.715	.3993	0.161	.5675	0.112
.6546	0.712	.4012	0.161	.5696	0.109
.6587	0.685	.4031	0.155	.5738	0.116
.6608	0.700	.4068	0.155	.5759	0.113
.6629	0.679	.4086	0.152	.5779	0.109
.6671	0.659	.4105	0.140	.5821	0.127
.6691	0.637	.4288	0.138	.5842	0.134
.6712	0.614	.4325	0.132	.5863	0.099
.6754	0.588	.4343	0.126	.5904	0.131
.6775	−0.608	.4362	0.100	.5925	0.131
		.4401	0.096	.5946	0.118
2436624		.4419	0.103	.5988	0.113
.4344	−0.155	.4438	0.086	.6071	0.139
.4365	0.150	.4475	0.099	.6092	0.158
.4428	0.143	.4494	0.093	.6113	0.149
.4448	0.154	.4512	0.087	.6154	0.104
.4490	0.124	.4549	0.075	.6175	0.152
.4511	0.126	.4568	0.067	.6238	0.096
.4573	0.120	.4586	0.059	.6279	0.114
.4615	0.099	.4623	0.053	.6325	0.115
.4657	0.097	.4642	0.043	.6352	0.123
.4698	−0.075	.4660	0.043	.6432	0.132
		.4697	0.040	.6460	0.120
2436626		.4716	0.044	.6488	+0.122
.3193	−0.463	.4734	0.049		
.3259	0.434	.4771	0.050	2436645	
.3271	0.407	.4790	0.050	.3164	−0.556
.3311	−0.373	.4919	−0.036	.3185	−0.574

Table 9 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436645		2442403		2442415	
.3226	-0.670	.5533	-0.956	.4431	-0.920
.3247	0.679	.5547	0.938	.4465	0.933
.3268	0.712	.5616	0.947	.4479	0.926
.3310	0.789	.5630	0.929	.4507	0.923
.3351	0.847	.5658	0.916	.4521	0.915
.3414	0.910	.5668	0.905	.4556	0.908
.3435	0.918	.5692	0.922	.4569	0.918
.3476	0.959	.5706	0.904	.4597	0.887
.3497	0.950	.5734	0.893	.4611	0.885
.3518	0.953	.5748	0.885	.4639	0.858
.3560	0.932	.5783	0.885	.4653	0.862
.3581	0.923	.5797	0.889	.4688	0.864
.3667	0.883	.5820	0.875	.4694	-0.842
.3730	0.871	.5834	0.874		
.3751	0.864	.5862	0.858	2442452	
.3772	0.857	.5876	0.832	.4173	-0.958
.3817	0.847	.5904	0.821	.4198	0.958
.3838	0.843	.5918	-0.829	.4230	0.949
.3858	0.845			.4258	0.932
.3935	0.810	2442415		.4340	0.940
.3963	0.789	.3593	+0.225	.4355	0.928
.4011	0.727	.3604	0.238	.4371	0.930
.4039	0.700	.3632	0.212	.4386	0.933
.4119	0.663	.3646	0.221	.4400	0.921
.4160	0.626	.3674	0.189	.4414	0.933
.4206	-0.605	.3688	0.176	.4505	0.900
		.3722	0.144	.4520	0.886
2442403		.3736	0.143	.4541	0.844
.4977	-0.154	.3764	+0.098	.4557	0.863
.4987	0.201	.3813	-0.051	.4574	0.847
.5015	0.259	.3826	0.071	.4657	0.806
.5029	0.291	.3861	0.138	.4678	0.799
.5054	0.364	.3875	0.194	.4694	0.800
.5068	0.398	.3903	0.317	.4711	0.788
.5095	0.445	.3917	0.350	.4725	0.785
.5109	0.489	.3944	0.427	.4903	0.679
.5151	0.541	.3958	0.434	.4924	0.654
.5179	0.565	.3986	0.472	.4943	0.668
.5192	0.597	.4000	0.483	.4958	0.655
.5227	0.603	.4035	0.525	.4974	0.645
.5258	0.654	.4049	0.517	.5100	0.581
.5269	0.696	.4083	0.571	.5116	0.574
.5297	0.767	.4097	0.592	.5130	0.567
.5311	0.776	.4181	0.754	.5146	0.562
.5338	0.830	.4194	0.738	.5160	0.558
.5352	0.824	.4229	0.844	.5286	0.510
.5380	0.867	.4278	0.881	.5302	0.504
.5394	0.881	.4292	0.889	.5317	0.512
.5422	0.891	.4340	0.924	.5336	0.495
.5436	0.900	.4375	0.966	.5355	0.493
.5470	0.922	.4389	0.934	.5607	0.382
.5484	-0.928	.4417	-0.922	.5623	-0.376

Table 9 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442452		2442454		2442532	
.5636	-0.383	.3387	+0.107	.3415	-0.910
.5650	0.378	.3400	0.078	.3433	0.916
.5667	0.370	.3410	0.053	.3447	0.910
.5737	0.337	.3426	0.030	.3512	0.926
.5754	0.336	.3440	+0.008	.3537	0.905
.5771	0.332	.3482	-0.107	.3563	0.907
.5788	0.311	.3494	0.124	.3579	0.880
.5805	0.312	.3507	0.175	.3594	0.868
.5916	0.262	.3520	0.203	.3659	0.845
.5936	0.271	.3533	0.244	.3676	0.846
.5961	0.261	.3582	0.386	.3691	0.832
.5988	0.253	.3598	0.406	.3708	0.834
.6002	0.246	.3609	0.421	.3722	0.817
.6082	0.217	.3618	0.430	.3784	0.790
.6103	0.202	.3628	0.462	.3798	0.780
.6120	0.203	.3668	0.512	.3815	0.774
.6137	0.211	.3677	0.527	.3828	0.778
.6158	0.192	.3690	0.532	.3843	0.757
.6226	0.192	.3700	0.547	.3910	0.722
.6244	0.178	.3710	0.558	.3927	0.715
.6270	0.197	.3748	0.622	.3948	0.697
.6296	0.165	.3761	0.642	.3962	0.703
.6311	0.166	.3768	0.655	.3977	0.682
.6424	0.128	.3781	0.673	.4046	0.640
.6462	0.113	.3793	0.693	.4064	0.639
.6478	0.124	.3846	0.783	.4074	0.629
.6500	0.106	.3860	0.784	.4092	0.626
.6517	0.101	.3873	0.810	.4102	0.607
.6533	-0.107	.3888	0.839	.4162	0.594
		.3902	0.850	.4177	0.576
2442454		.3947	0.907	.4190	0.553
.2932	+0.316	.3961	0.912	.4221	0.550
.2948	0.343	.3974	0.917	.4295	0.538
.2962	0.315	.3986	0.926	.4309	0.534
.2976	0.299	.3997	0.925	.4327	0.523
.2991	0.319	.4008	0.932	.4342	0.513
.3043	0.333	.4027	0.943	.4359	0.509
.3056	0.337	.4040	0.941	.4417	0.488
.3068	0.338	.4055	0.949	.4433	0.478
.3087	0.316	.4069	0.953	.4448	0.485
.3101	0.305	.4088	0.947	.4462	0.462
.3154	0.319	.4101	0.928	.4479	0.465
.3166	0.282	.4159	0.937	.4540	0.428
.3180	0.283	.4171	0.921	.4557	0.434
.3192	0.293	.4184	0.928	.4574	0.433
.3204	0.257	.4197	0.923	.4589	0.442
.3253	0.238	.4211	0.910	.4604	0.426
.3267	0.255	.4227	-0.923	.4660	0.416
.3285	0.222			.4680	0.394
.3300	0.194	2442532		.4692	0.399
.3313	0.180	.3377	-0.922	.4709	0.398
.3328	+0.185	.3395	-0.913	.4725	-0.390

Table 9 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442948		2442948		2443204	
.3620	-0.501	.3991	-0.925	.6217	-0.789
.3634	0.512	.4005	0.929	.6260	0.840
.3662	0.548	.4039	0.905	.6300	0.926
.3676	0.575	.4051	-0.903	.6316	0.909
.3710	0.639			.6358	0.904
.3724	0.668	2443204		.6374	0.926
.3759	0.724	.5977	-0.427	.6418	0.922
.3773	0.744	.6033	0.521	.6434	0.932
.3804	0.799	.6048	0.524	.6481	0.904
.3818	0.811	.6089	0.581	.6496	0.902
.3849	0.859	.6103	0.591	.6537	0.926
.3863	0.861	.6143	0.680	.6554	0.902
.3912	0.903	.6161	0.706	.6589	0.876
.3943	0.915	.6202	-0.788	.6603	-0.864
.3957	-0.924				

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2442452		2442452		2442454	
.4180	-1.914	.5341	-1.459	.2937	-0.696
.4211	1.921	.5360	1.472	.2951	0.706
.4240	1.906	.5613	1.465	.2966	0.747
.4262	1.920	.5628	1.457	.2981	0.702
.4345	1.886	.5641	1.506	.2995	0.693
.4360	1.880	.5655	1.486	.3047	0.764
.4376	1.890	.5671	1.499	.3061	0.706
.4390	1.901	.5742	1.496	.3073	0.737
.4404	1.878	.5760	1.468	.3091	0.758
.4419	1.911	.5777	1.462	.3159	0.737
.4510	1.874	.5794	1.441	.3170	0.775
.4526	1.892	.5810	1.424	.3184	0.817
.4545	1.840	.5922	1.402	.3207	0.861
.4562	1.856	.5943	1.487	.3259	0.908
.4579	1.794	.5969	1.479	.3271	0.948
.4664	1.765	.5994	1.495	.3290	0.957
.4684	1.757	.6127	1.458	.3303	0.983
.4698	1.746	.6144	1.421	.3319	1.008
.4715	1.763	.6164	1.406	.3333	1.019
.4729	1.735	.6233	1.399	.3391	1.121
.4909	1.755	.6251	1.412	.3403	1.120
.4928	1.735	.6275	1.426	.3414	1.157
.4947	1.727	.6301	1.380	.3431	1.158
.4963	1.709	.6316	1.403	.3445	1.193
.4980	1.691	.6430	1.390	.3487	1.381
.5106	1.610	.6452	1.348	.3499	1.408
.5121	1.628	.6467	1.382	.3512	1.512
.5135	1.595	.6482	1.339	.3523	1.549
.5150	1.581	.6506	1.307	.3538	1.624
.5165	1.597	.6522	1.316	.3591	1.775
.5291	1.535	.6538	-1.318	.3612	1.770
.5307	1.543			.3621	1.773
.5323	-1.512	2442454		.3632	-1.752

Table 9 (cont.)

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2442454		2442454		2442532	
.3670	−1.750	.4164	−1.896	.3965	−1.638
.3680	1.712	.4176	1.892	.3983	1.632
.3692	1.731	.4189	1.876	.4052	1.570
.3703	1.776	.4202	1.888	.4066	1.573
.3714	1.753	.4214	1.873	.4080	1.553
.3751	1.795	.4232	−1.841	.4107	1.543
.3764	1.813			.4169	1.550
.3773	1.835	2442532		.4183	1.548
.3784	1.831	.3454	−1.838	.4197	1.560
.3797	1.835	.3516	1.836	.4211	1.562
.3851	1.889	.3540	1.805	.4226	1.571
.3866	1.904	.3567	1.809	.4300	1.602
.3878	1.911	.3584	1.820	.4316	1.568
.3893	1.956	.3598	1.770	.4332	1.548
.3905	1.956	.3664	1.771	.4348	1.524
.3952	1.974	.3681	1.786	.4364	1.524
.3964	1.981	.3698	1.783	.4420	1.508
.3977	2.002	.3725	1.775	.4440	1.510
.3991	1.982	.3791	1.792	.4454	1.501
.4000	1.988	.3801	1.783	.4467	1.478
.4019	1.976	.3818	1.774	.4484	1.517
.4034	1.957	.3831	1.787	.4545	1.485
.4045	1.956	.3851	1.738	.4562	1.469
.4058	1.947	.3916	1.715	.4581	1.475
.4072	1.946	.3932	1.707	.4596	1.431
.4095	1.910	.3951	−1.656	.4609	−1.423
.4107	−1.860				

Table 10

Photographic observations of SU Dra

J.D.	Δm_{pg}	J.D.	Δm_{pg}	J.D.	Δm_{pg}
2428657		2428657		2429336	
.5319	10.04	.5674	9.48	.3582	10.42
.5340	10.00	.5694	9.40	.3603	10.44
.5361	9.88	.5715	9.42	.3624	10.46
.5375	9.96			.3645	10.53
.5395	9.86	2429336		.3666	10.52
.5419	9.76	.3353	10.32	.3687	10.48
.5444	9.80	.3374	10.24	.3707	10.54
.5475	9.68	.3395	10.34	.3728	10.56
.5486	9.64	.3416	10.34	.3749	10.46
.5507	9.60	.3437	10.30	.3770	10.52
.5549	9.66	.3457	10.38	.3791	10.48
.5569	9.62	.3478	10.36	.3812	10.54
.5590	9.58	.3499	10.44	.3832	10.54
.5611	9.50	.3520	10.42	.3853	10.50
.5632	9.52	.3541	10.48	.3874	10.50
.5653	9.50	.3562	10.50	.3895	10.54

Table 10 (cont.)

J.D.	Δm_{pg}	J.D.	Δm_{pg}	J.D.	Δm_{pg}
2429336		2429366		2429375	
.3916	10.52	.3959	9.88	.4663	9.21
.3937	10.54	.3980	9.87	.4746	9.24
.3957	10.48	.4001	9.91	.4767	9.22
.3978	10.52	.4022	9.86	.4809	9.26
.3999	10.54	.4043	9.90	.4829	9.20
.4020	10.52	.4070	9.92	.4850	9.20
.4041	10.56	.4091	9.92	.4871	9.28
.4062	10.54	.4112	9.92	.4892	9.24
.4082	10.56	.4133	9.94	.4913	9.28
.4103	10.56	.4189	9.92	.4934	9.22
.4124	10.50	.4209	9.99	.4954	9.24
.4145	10.50			.4975	9.30
		2429375		.4996	9.28
2429366		.3746	10.54	.5059	9.32
.3068	9.50	.3788	10.48	.5079	9.31
.3084	9.52	.3809	10.52	.5100	9.30
.3105	9.50	.3829	10.56	.5121	9.33
.3126	9.54	.3850	10.54	.5142	9.34
.3147	9.52	.3871	10.50	.5163	9.32
.3168	9.58	.3892	10.55	.5184	9.36
.3189	9.60	.3913	10.50	.5204	9.38
.3209	9.60	.3934	10.50	.5225	9.44
.3230	9.62	.3954	10.42	.5246	9.40
.3251	9.58	.3975	10.36	.5267	9.42
.3272	9.56	.3996	10.34	.5288	9.42
.3314	9.64	.4017	10.36	.5309	9.46
.3334	9.66	.4038	10.30	.5329	9.50
.3355	9.60	.4059	10.22	.5350	9.44
.3376	9.68	.4079	10.16	.5371	9.50
.3397	9.70	.4100	10.04	.5392	9.48
.3418	9.68	.4121	9.99	.5413	9.48
.3439	9.72	.4142	9.90	.5468	9.54
.3466	9.66	.4163	9.86	.5489	9.60
.3522	9.72	.4204	9.74	.5510	9.59
.3543	9.76	.4225	9.68		
.3564	9.78	.4246	9.76	2429450	
.3584	9.80	.4267	9.60	.3614	10.02
.3605	9.77	.4288	9.60	.3635	10.04
.3626	9.74	.4309	9.60	.3656	10.04
.3647	9.76	.4329	9.54	.3677	10.10
.3689	9.78	.4350	9.48	.3697	10.10
.3716	9.76	.4371	9.42	.3718	10.12
.3730	9.82	.4392	9.44	.3739	10.16
.3751	9.80	.4413	9.40	.3760	10.18
.3772	9.82	.4441	9.32	.3781	10.12
.3800	9.80	.4496	9.26	.3802	10.15
.3820	9.82	.4538	9.20	.3822	10.14
.3841	9.82	.4559	9.22	.3843	10.15
.3876	9.84	.4579	9.18	.3864	10.18
.3897	9.86	.4600	9.20	.3885	10.20
.3918	9.83	.4621	9.22	.3927	10.18
.3939	9.84	.4642	9.16	.3947	10.20

Table 10 (cont.)

J.D.	Δm_{pg}	J.D.	Δm_{pg}	J.D.	Δm_{pg}
2429450		2432061		2432061	
.3968	10.24	.3409	9.88	.4652	9.50
.4079	10.26	.3430	9.82	.4714	9.55
.4100	10.30	.3450	9.82	.4735	9.54
.4121	10.28	.3471	9.76	.4756	9.56
.4142	10.22	.3492	9.72	.4777	9.60
.4170	10.30	.3513	9.68	.4798	9.54
.4211	10.26	.3534	9.62	.4819	9.55
.4232	10.26	.3555	9.60	.4860	9.60
.4253	10.32	.3575	9.50	.4881	9.58
.4274	10.30	.3596	9.50	.4902	9.66
.4295	10.34	.3617	9.40	.4923	9.62
.4336	10.36	.3638	9.40	.4964	9.64
.4357	10.34	.3659	9.32	.4985	9.70
		.3680	9.34		
2432030		.3700	9.30	2434099	
.3457	9.30	.3721	9.24	.4132	9.42
.3478	9.24	.3742	9.24	.4153	9.38
.3499	9.28	.3763	9.26	.4174	9.36
.3520	9.32	.3784	9.22	.4194	9.30
.3541	9.34	.3825	9.18	.4236	9.18
.3562	9.34	.3867	9.08	.4257	9.12
.3603	9.36	.3888	9.10	.4278	9.12
.3624	9.34	.3909	9.14	.4299	9.18
.3645	9.32	.3930	9.12	.4319	9.16
.3666	9.34	.3950	9.12	.4382	9.10
.3707	9.36	.3971	9.10	.4403	9.16
.3728	9.44	.3992	9.16	.4424	9.20
.3749	9.40	.4013	9.12	.4444	9.18
.3770	9.46	.4034	9.12	.4486	9.22
.3791	9.44	.4055	9.18	.4528	9.20
.3812	9.40	.4075	9.16	.4570	9.24
.3839	9.42	.4096	9.20	.4590	9.30
.3860	9.42	.4117	9.22	.4611	9.30
.3881	9.46	.4138	9.22	.4632	9.24
.3902	9.46	.4159	9.24	.4674	9.30
.3923	9.46	.4180	9.28	.4694	9.34
.3964	9.52	.4200	9.34	.4715	9.32
.4006	9.58	.4242	9.32	.4736	9.38
.4027	9.54	.4263	9.30	.4757	9.37
.4048	9.60	.4284	9.28	.4778	9.44
.4069	9.56	.4325	9.34	.4819	9.42
.4110	9.58	.4367	9.36	.4840	9.50
.4131	9.60	.4444	9.38	.4861	9.42
.4152	9.58	.4464	9.42	.4882	9.48
.4173	9.66	.4492	9.40	.4903	9.52
		.4506	9.42	.4924	9.54
2432061		.4527	9.36	.4944	9.54
.3305	10.10	.4548	9.40		
.3325	10.04	.4569	9.46	2434126	
.3346	9.96	.4589	9.48	.4819	9.58
.3367	9.92	.4610	9.46	.4839	9.52
.3388	9.90	.4631	9.52	.4860	9.57

Table 10 (cont.)

J.D.	Δm_{pg}	J.D.	Δm_{pg}	J.D.	Δm_{pg}
2434126		2434130		2434196	
.4881	9.54	.4323	9.73	.5014	9.32
.4902	9.48	.4344	9.74	.5035	9.32
.4923	9.45	.4365	9.72	.5056	9.28
.4944	9.44	.4392	9.64	.5076	9.30
.4964	9.46	.4407	9.60	.5097	9.34
.4986	9.44	.4428	9.60	.5118	9.28
.5006	9.40	.4448	9.58	.5139	9.24
.5027	9.34	.4469	9.54	.5160	9.21
.5048	9.40	.4490	9.50	.5181	9.30
.5069	9.36	.4511	9.48	.5201	9.26
.5089	9.36	.4532	9.46	.5264	9.27
.5110	9.31	.4553	9.41	.5285	9.30
.5152	9.34	.4574	9.34	.5326	9.32
.5173	9.26	.4594	9.30	.5347	9.36
.5194	9.28	.4615	9.30		
.5214	9.28	.4636	9.32	2434830	
.5256	9.24	.4657	9.30	.4840	9.63
.5277	9.28	.4698	9.28	.4861	9.58
.5298	9.28	.4719	9.30	.4882	9.59
.5319	9.23	.4740	9.28	.4903	9.50
.5360	9.32	.4761	9.26	.4924	9.50
.5381	9.32	.4782	9.22	.4944	9.44
.5402	9.30	.4840	9.26	.4965	9.44
.5423	9.32	.4865	9.20	.4986	9.37
.5444	9.28	.4886	9.22	.5007	9.34
.5464	9.32	.4907	9.26	.5028	9.33
.5485	9.32	.4928	9.26	.5049	9.30
.5506	9.30	.4948	9.23	.5069	9.25
.5527	9.34	.4969	9.24	.5090	9.23
.5548	9.36	.4990	9.28	.5111	9.20
				.5132	9.14
2434130		2434196		.5153	9.16
.3844	10.48	.4514	10.10	.5174	9.17
.3865	10.42	.4557	10.01	.5194	9.19
.3886	10.42	.4577	9.98	.5215	9.18
.3907	10.40	.4597	9.90	.5236	9.20
.3948	10.43	.4618	9.92	.5257	9.25
.3969	10.36	.4639	9.88	.5278	9.25
.3990	10.33	.4660	9.80	.5299	9.24
.4032	10.34	.4681	9.82	.5319	9.27
.4054	10.24	.4701	9.78	.5340	9.29
.4073	10.30	.4722	9.72	.5361	9.31
.4115	10.22	.4743	9.68	.5383	9.30
.4136	10.23	.4785	9.68	.5403	9.28
.4157	10.22	.4802	9.66	.5424	9.31
.4178	10.17	.4826	9.60	.5444	9.32
.4198	10.12	.4847	9.54		
.4219	10.10	.4889	9.48	2434832	
.4240	10.00	.4910	9.50	.5055	9.24
.4261	9.82	.4931	9.40	.5075	9.24
.4282	9.76	.4971	9.42	.5096	9.23
.4303	9.76	.4993	9.42	.5117	9.23

Table 10 (cont.)

J.D.	Δm_{pg}	J.D.	Δm_{pg}	J.D.	Δm_{pg}
2434832		2434840		2434949	
.5138	9.24	.3571	10.23	.4623	9.49
.5159	9.25	.3594	10.24	.4644	9.53
.5180	9.27	.3613	10.26	.4665	9.54
.5200	9.30			.4686	9.56
.5221	9.32	2434949			
.5242	9.33	.4249	9.32	2434964	
.5263	9.33	.4269	9.28	.5409	9.67
.5284	9.33	.4290	9.36	.5430	9.64
.5305	9.35	.4311	9.33	.5450	9.55
.5346	9.37	.4352	9.36	.5471	9.54
.5367	9.36	.4373	9.40	.5492	9.47
.5388	9.37	.4394	9.35	.5513	9.46
		.4415	9.39	.5534	9.43
2434840		.4436	9.40	.5555	9.43
.3405	10.09	.4456	9.42	.5575	9.44
.3426	10.10	.4477	9.43	.5638	9.37
.3446	10.11	.4498	9.45	.5659	9.34
.3467	10.18	.4519	9.42	.5700	9.32
.3488	10.18	.4540	9.47	.5721	9.29
.3509	10.23	.4561	9.46	.5742	9.29
.3530	10.16	.4582	9.50	.5784	9.27
.3551	10.24	.4602	9.47	.5805	9.23

Table 11

Photoelectric observations of RR Leo

J.D.	Δm*	J.D.	Δm*	J.D.	Δm*
2435068		2435068		2435068	
.6565	+0.984	.6729	+0.544	.6891	−0.275
.6570	1.012	.6736	0.538	.6897	0.318
.6578	0.956	.6743	0.498	.6904	0.326
.6582	0.956	.6750	0.476	.6925	0.375
.6588	0.955	.6757	0.433	.6930	0.404
.6595	0.980	.6764	0.385	.6941	0.389
.6601	0.951	.6770	0.341	.6949	0.406
.6608	0.925	.6776	0.331	.6957	0.415
.6633	0.859	.6783	0.280	.6964	0.422
.6638	0.823	.6789	0.257	.6973	−0.451
.6644	0.819	.6796	0.222		
.6650	0.846	.6802	0.184	2435069	
.6657	0.796	.6809	0.175	.5636	+0.956
.6662	0.785	.6815	0.143	.5642	0.972
.6669	0.811	.6822	+0.130	.5648	0.914
.6675	0.770	.6849	−0.002	.5653	0.909
.6683	0.745	.6856	0.104	.5659	0.894
.6704	0.677	.6862	0.114	.5687	0.881
.6710	0.600	.6872	0.163	.5692	0.893
.6716	0.625	.6876	0.190	.5697	0.879
.6723	+0.576	.6885	−0.248	.5703	+0.852

Table 11 (cont.)

J.D.	Δm*	J.D.	Δm*	J.D.	Δm*
2435069		2435069		2435127	
.5709	+0.816	.6180	-0.397	.5086	-0.451
.5713	0.799	.6184	0.397	.5096	0.452
.5719	0.752	.6210	0.365	.5108	0.449
.5744	0.723	.6214	-0.364	.5118	0.454
.5758	0.687			.5129	0.441
.5764	0.680	2435127		.5140	0.435
.5771	0.589	.4336	+0.976	.5167	0.444
.5779	0.572	.4351	0.988	.5177	0.448
.5785	0.531	.4362	1.004	.5187	0.445
.5793	0.477	.4372	1.016	.5199	0.438
.5816	0.368	.4407	1.003	.5206	-0.441
.5822	0.338	.4417	1.035		
.5829	0.309	.4427	1.032	2435479	
.5835	0.265	.4442	1.019	.4509	-0.003
.5839	0.236	.4451	1.027	.4520	0.049
.5845	0.194	.4478	1.061	.4532	0.148
.5852	0.182	.4488	1.046	.4543	0.191
.5872	0.077	.4499	1.041	.4552	0.222
.5878	0.041	.4510	1.023	.4586	0.328
.5884	0.037	.4560	1.037	.4638	0.404
.5889	+0.007	.4569	1.015	.4650	0.442
.5894	-0.001	.4580	0.997	.4661	0.436
.5901	0.076	.4591	0.990	.4693	0.419
.5906	0.089	.4597	0.997	.4704	0.382
.5930	0.190	.4634	0.976	.4717	0.395
.5936	0.225	.4645	0.955	.4724	-0.388
.5941	0.265	.4658	0.966		
.5948	0.294	.4675	0.936	2435489	
.5959	0.325	.4726	0.864	.3832	+0.859
.5968	0.363	.4742	0.873	.3842	0.798
.5974	0.390	.4756	0.818	.3849	0.783
.5997	0.427	.4769	0.760	.3861	0.756
.6005	0.439	.4785	0.716	.3871	0.711
.6012	0.445	.4792	0.685	.3880	0.711
.6018	0.446	.4823	0.578	.3908	0.601
.6024	0.452	.4835	0.517	.3921	0.557
.6030	0.466	.4848	0.479	.3930	0.512
.6037	0.473	.4861	0.416	.3939	0.410
.6060	0.473	.4872	0.365	.3949	0.391
.6067	0.456	.4902	0.199	.3960	0.332
.6073	0.467	.4912	0.138	.3989	0.154
.6080	0.455	.4930	0.089	.3998	0.117
.6085	0.464	.4938	0.014	.4008	0.077
.6091	0.469	.4946	+0.002	.4018	+0.013
.6099	0.458	.4951	-0.037	.4029	-0.031
.6118	0.446	.4984	0.217	.4057	0.183
.6125	0.437	.4997	0.269	.4067	0.208
.6131	0.426	.5008	0.329	.4078	0.266
.6136	0.422	.5022	0.369	.4098	0.372
.6144	0.432	.5035	0.398	.4109	0.406
.6150	0.417	.5045	0.414	.4119	0.420
.6157	-0.415	.5074	-0.433	.4145	-0.458

Table 11 (cont.)

J.D.	Δm*	J.D.	Δm*	J.D.	Δm*
2435489		2435542		2435561	
.4157	−0.481	.3231	+0.368	.3156	+0.826
.4168	0.470	.3244	0.300	.3165	0.732
.4180	0.472	.3253	0.290	.3175	0.647
.4192	0.485	.3278	0.184	.3184	0.655
.4224	0.481	.3288	0.130	.3191	0.621
.4237	0.491	.3296	0.098	.3230	0.410
.4247	0.487	.3304	0.066	.3240	0.357
.4258	0.475	.3313	0.044	.3250	0.326
.4268	0.493	.3322	+0.010	.3277	0.199
.4278	0.474	.3331	−0.029	.3286	0.158
.4306	0.455	.3357	0.156	.3294	0.077
.4317	0.454	.3367	0.168	.3302	+0.073
.4329	0.445	.3392	0.310	.3322	−0.008
.4339	0.433	.3402	0.338	.3330	0.021
.4350	0.424	.3411	0.325	.3377	0.274
.4360	0.403	.3422	0.360	.3388	0.310
.4388	0.376	.3431	0.390	.3396	0.340
.4399	0.379	.3464	0.449	.3404	0.385
.4409	0.338	.3474	0.443	.3428	0.425
.4419	0.341	.3484	0.448	.3436	0.456
.4429	0.330	.3494	0.473	.3446	0.445
.4440	0.337	.3505	0.476	.3468	0.485
.4467	0.290	.3546	0.473	.3494	0.474
.4505	0.261	.3554	0.453	.3503	0.471
.4537	0.224	.3565	0.444	.3528	0.476
.4580	−0.231	.3572	0.443	.3539	0.464
		.3582	0.437	.3547	0.457
2435542		.3611	0.435	.3557	0.426
.3111	+0.802	.3622	0.421	.3581	0.410
.3121	0.785	.3633	0.411	.3589	0.399
.3129	0.790	.3642	0.400	.3597	0.378
.3137	0.741	.3650	−0.389	.3605	0.384
.3165	0.636			.3627	0.370
.3174	0.586	2435561		.3636	0.379
.3184	0.599	.3114	+0.909	.3644	0.377
.3193	0.536	.3123	0.881	.3653	0.352
.3202	+0.519	.3149	+0.821	.3664	−0.366

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436288		2436513		2436513	
.2989	+0.663	.6051	+0.005	.6323	−0.366
.3018	0.642	.6069	−0.069	.6340	0.371
.3079	0.339	.6107	0.246	.6356	−0.342
.3112	0.260	.6123	0.321		
.3169	+0.034	.6141	0.353	2436530	
.3196	−0.107	.6176	0.417	.5376	+0.579
.3229	0.216	.6193	0.424	.5418	0.529
.3262	−0.316	.6215	0.409	.5439	0.555
		.6249	0.406	.5481	0.575
2436513		.6266	0.399	.5505	0.591
.6028	+0.101	.6283	−0.394	.5526	+0.597

Table 11 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436530		2436545		2436586	
.5567	+0.638	.6454	+0.736	.4767	−0.334
.5588	0.604	.6493	0.731	.4788	0.321
.5609	0.642	.6522	0.762	.4829	0.294
.5651	0.660	.6543	0.776	.4850	0.276
.5672	0.643	.6824	0.900	.4871	0.263
.5696	0.653	.6845	0.867	.4916	0.213
.5741	0.644	.6864	0.858	.4937	0.198
.5762	0.663	.6901	0.870	.4958	0.174
.5783	0.677	.6919	0.877	.4999	0.139
.5824	0.691	.6939	+0.858	.5020	0.124
.5845	0.701			.5041	−0.099
.5866	0.700	2436556			
.5908	0.702	.5478	+0.854	2436604	
.5929	0.690	.5519	0.845	.5070	+0.810
.5949	0.718	.5540	0.808	.5091	0.737
.5991	0.687	.5612	0.737	.5112	0.743
.6012	0.720	.5629	0.681	.5154	0.707
.6033	0.724	.5646	0.685	.5174	0.650
.6081	0.729	.5683	0.575	.5195	0.593
.6102	0.761	.5702	0.531	.5237	0.471
.6123	0.723	.5718	0.452	.5258	0.358
.6165	0.732	.5763	0.209	.5279	0.277
.6186	0.728	.5787	0.122	.5320	+0.086
.6206	0.743	.5807	+0.045	.5341	−0.026
.6248	0.729			.5362	0.094
.6269	0.719	2436560		.5404	0.265
.6290	0.694	.5754	+0.718	.5424	0.333
.6349	0.728	.5791	0.749	.5445	0.376
.6376	0.728	.5829	0.779	.5487	0.423
.6404	0.757	.5845	0.777	.5508	0.457
.6456	0.750	.5861	0.794	.5529	0.448
.6481	0.743	.5892	0.843	.5570	0.451
.6508	0.740	.5909	0.801	.5591	0.453
.6564	0.731	.5926	0.843	.5612	0.440
.6592	0.763	.5973	0.841	.5654	0.412
.6620	0.717	.5994	0.831	.5674	0.403
.6675	0.724	.6013	0.846	.5695	0.401
.6703	0.740	.6055	+0.838	.5737	0.344
.6731	+0.762			.5758	0.330
		2436586		.5779	0.297
2436545		.4437	−0.195	.5820	0.279
.6172	+0.760	.4475	0.337	.5841	0.268
.6193	0.744	.4496	0.393	.5862	0.246
.6210	0.742	.4517	0.427	.5904	0.218
.6250	0.738	.4538	0.448	.5924	0.222
.6271	0.743	.4679	0.454	.5945	−0.175
.6290	0.760	.4600	0.468		
.6334	0.736	.4621	0.455	2436614	
.6352	0.742	.4663	0.431	.4545	+0.892
.6371	0.729	.4683	0.401	.4587	0.818
.6417	0.745	.4705	0.395	.4608	0.779
.6436	+0.743	.4746	−0.342	.4649	+0.756

Table 11 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436614		2436614		2437316	
.4670	+0.723	.6184	+0.303	.6009	−0.362
.4691	0.685	.6205	0.294	.6022	0.389
.4712	0.646	.6226	0.315	.6056	0.403
.4754	0.504	.6267	0.358	.6080	0.447
.4774	0.408	.6288	0.378	.6107	0.453
.4795	0.328	.6309	0.378	.6138	0.451
.4816	0.230	.6354	0.398	.6154	0.460
.4858	+0.033	.6382	0.401	.6171	0.430
.4879	−0.063	.6410	0.409	.6210	0.395
.4899	0.143	.6465	0.434	.6224	0.393
.4920	0.230	.6493	0.440	.6238	0.369
.4962	0.340	.6521	0.439	.6262	0.360
.4983	0.377	.6535	0.437	.6279	0.327
.5004	0.399	.6590	0.453	.6292	0.328
.5045	0.416	.6618	0.480	.6331	0.305
.5066	0.405	.6646	0.471	.6346	0.280
.5087	0.415	.6701	0.522	.6365	0.269
.5129	0.407	.6722	0.498	.6407	0.264
.5149	0.418	.6750	+0.482	.6432	0.227
.5170	0.398			.6462	0.201
.5212	0.382	2437316		.6500	0.148
.5233	0.332	.5416	+0.867	.6517	0.155
.5254	0.330	.5426	0.857	.6533	0.160
.5295	0.299	.5435	0.843	.6571	0.133
.5316	0.278	.5458	0.842	.6607	−0.104
.5337	0.261	.5469	0.865		
.5399	0.210	.5481	0.827	2438114	
.5420	0.204	.5509	0.828	.3012	+0.340
.5441	0.164	.5523	0.818	.3096	0.413
.5483	0.151	.5540	0.855	.3124	0.385
.5504	0.135	.5579	0.804	.3200	0.417
.5524	0.129	.5590	0.808	.3220	0.399
.5566	0.079	.5601	0.808	.3262	0.418
.5587	0.090	.5625	0.827	.3304	0.477
.5608	0.074	.5635	0.806	.3332	0.467
.5649	0.063	.5653	0.765	.3360	0.465
.5670	0.005	.5683	0.739	.3386	0.501
.5691	−0.008	.5693	0.751	.3422	0.476
.5733	+0.008	.5706	0.724	.3491	0.564
.5754	0.016	.5730	0.670	.3512	0.573
.5774	0.026	.5741	0.627	.3623	0.579
.5816	0.056	.5752	0.605	.3644	0.588
.5837	0.064	.5780	0.541	.3672	0.640
.5858	0.093	.5790	0.529	.3693	0.620
.5868	0.115	.5801	0.494	.3735	0.652
.5976	0.153	.5833	0.332	.3770	0.649
.6017	0.208	.5850	0.278	.3832	0.659
.6038	0.213	.5870	+0.173	.3860	0.642
.6059	0.232	.5913	−0.056	.3881	0.689
.6101	0.273	.5939	0.137	.3901	0.671
.6122	0.262	.5961	0.222	.3929	0.654
.6142	+0.282	.5997	−0.353	.3985	+0.726

Table 11 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2438114		2438414		2439146	
.4013	+0.715	.5229	+0.617	.5089	-0.249
.4033	0.733	.5260	0.528	.5117	0.316
.4054	0.753	.5321	0.258	.5127	0.334
.4075	0.762	.5342	0.123	.5141	0.370
.4123	0.729	.5367	+0.020	.5169	0.427
.4144	0.752	.5416	-0.124	.5276	0.419
.4179	0.729	.5444	0.203	.5308	0.432
.4207	+0.713	.5466	0.326	.5349	0.394
		.5512	0.395	.5363	0.408
2438118		.5541	0.428	.5384	0.399
.3542	+0.297	.5625	0.419	.5419	0.356
.3577	0.348	.5711	0.354	.5433	0.363
.3598	0.317	.5765	-0.336	.5450	0.304
.3646	0.357			.5488	0.255
.3674	0.392	2438881		.5502	-0.246
.3744	0.381	.3764	+0.809		
.3765	0.395	.3778	0.805	2439503	
.3834	0.438	.3792	0.739	.4079	+0.859
.3882	0.439	.3855	0.676	.4093	0.860
.3917	0.472	.3889	0.570	.4155	0.805
.3966	0.483	.3907	0.532	.4176	0.770
.3987	0.482	.3920	0.496	.4190	0.748
.4132	0.558	.3952	0.376	.4218	0.665
.4223	+0.584	.3966	+0.272	.4232	0.676
		.4070	-0.161	.4287	0.454
2438413		.4084	0.194	.4298	0.379
.4599	+0.791	.4112	0.316	.4322	0.241
.4620	0.762	.4125	0.357	.4332	0.174
.4707	0.771	.4139	0.395	.4339	0.160
.4759	0.742	.4226	0.442	.4364	+0.025
.4807	0.786	.4240	0.457	.4374	-0.010
.4835	0.797	.4271	0.433	.4381	0.027
.4856	0.779	.4285	0.429	.4419	0.155
.5037	0.792	.4299	0.431	.4440	0.265
.5064	0.776	.4334	0.406	.4447	0.306
.5106	0.792	.4348	0.373	.4457	0.318
.5155	0.768	.4362	0.395	.4475	0.375
.5182	0.777	.4396	0.335	.4506	0.424
.5287	0.763	.4410	0.335	.4534	0.424
.5342	0.747	.4438	-0.342	.4548	0.427
.5370	0.737			.4558	0.434
.5453	0.723	2439146		.4589	0.426
.5481	0.748	.4905	+0.544	.4600	0.432
.5696	0.745	.4922	0.485	.4610	0.433
.5724	0.773	.4933	0.421	.4634	0.387
.5814	+0.799	.4960	0.334	.4645	0.375
		.4974	0.246	.4655	0.368
2438414		.4985	0.203	.4676	0.368
.5031	+0.830	.5009	0.057	.4690	0.362
.5085	0.846	.5023	+0.020	.4697	0.337
.5113	0.773	.5064	-0.156	.4721	0.332
.5173	+0.754	.5078	-0.211	.4732	-0.336

Table 11 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2439503		2439906		2440654	
.4739	−0.326	.5102	+0.293	.2898	+0.848
.4766	0.289	.5130	0.164	.2940	0.844
.4777	0.282	.5144	0.100	.2954	0.795
.4787	0.275	.5172	+0.005	.2981	0.767
.4811	0.281	.5213	−0.201	.3023	0.666
.4822	0.256	.5227	0.266	.3037	0.629
.4832	−0.257	.5255	0.360	.3065	0.477
		.5269	0.382	.3079	0.436
2439507		.5297	0.405	.3106	0.334
.4911	+0.740	.5311	0.439	.3120	0.292
.4925	0.685	.5339	0.441	.3148	0.136
.4939	0.639	.5353	0.430	.3162	+0.054
.4974	0.528	.5380	0.428	.3231	−0.239
.4988	0.464	.5394	0.441	.3273	0.338
.4998	0.444	.5422	0.427	.3287	0.377
.5022	0.358	.5436	0.407	.3315	0.407
.5029	0.285	.5478	0.384	.3329	0.422
.5043	0.208	.5505	0.379	.3356	0.458
.5071	0.116	.5519	0.354	.3398	0.428
.5085	+0.051	.5547	0.363	.3412	0.428
.5099	−0.006	.5561	−0.373	.3440	0.401
.5140	0.215			.3481	0.358
.5154	0.268	2440232		.3495	−0.326
.5189	0.356	.6584	+0.859		
.5200	0.400	.6598	0.825	2440980	
.5210	0.407	.6625	0.802	.4797	+0.441
.5238	0.431	.6639	0.776	.4806	0.430
.5248	0.426	.6667	0.760	.4827	0.323
.5259	0.441	.6681	0.736	.4838	0.266
.5283	0.452	.6709	0.693	.4861	0.181
.5297	0.433	.6750	0.604	.4871	0.110
.5307	0.440	.6764	0.554	.4893	+0.038
.5335	0.410	.6792	0.470	.4905	0.000
.5349	0.386	.6806	0.425	.4924	−0.087
.5363	0.373	.6834	0.337	.4935	0.119
.5390	0.373	.6848	0.247	.4955	0.220
.5404	0.363	.6876	0.163	.4967	0.270
.5418	0.367	.6890	+0.085	.4996	0.357
.5446	0.346	.6917	−0.052	.5007	0.383
.5460	0.338	.6931	0.121	.5029	0.398
.5474	0.335	.6959	0.224	.5063	0.438
.5502	0.332	.6973	0.284	.5074	0.451
.5516	−0.323	.7000	0.383	.5093	0.452
		.7014	0.417	.5104	0.458
2439906		.7042	0.430	.5121	0.461
.4963	+0.750	.7056	0.430	.5141	0.450
.4977	0.736	.7084	0.459	.5164	0.412
.5005	0.688	.7098	0.464	.5179	−0.408
.5019	0.637	.7126	0.455		
.5047	0.547	.7140	0.437	2441003	
.5061	0.516	.7167	−0.413	.5611	+0.098
.5088	+0.418			.5639	+0.005

Table 11 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2441003		2441311		2441682	
.5653	-0.066	.6764	-0.329	.6088	-0.325
.5681	0.165	.6778	0.325	.6106	0.375
.5695	0.231	.6792	0.328	.6125	0.367
.5722	0.339	.6820	0.320	.6145	0.445
.5736	0.378	.6834	0.309	.6169	0.452
.5764	0.396	.6848	-0.300	.6198	0.460
.5778	0.416			.6222	0.424
.5806	0.412	2441312		.6246	0.448
.5820	0.412	.5361	+0.383	.6268	0.434
.5861	0.399	.5375	0.371	.6340	0.343
.5889	0.402	.5389	0.323	.6371	0.375
.5903	0.409	.5417	0.153	.6394	0.359
.5945	0.361	.5431	+0.099	.6418	-0.334
.5972	0.351	.5486	-0.103		
.5986	0.336	.5500	0.168	2442019	
.6028	0.290	.5583	0.370	.5881	+0.825
.6056	0.282	.5611	0.438	.5895	0.822
.6070	-0.253	.5625	0.405	.5923	0.831
		.5639	0.414	.5937	0.840
2441311		.5667	0.425	.5964	0.835
.6097	+0.871	.5681	0.429	.5978	0.849
.6111	0.850	.5696	-0.423	.6006	0.841
.6139	0.793			.6089	0.795
.6153	0.800	2441679		.6103	0.774
.6167	0.793	.4736	-0.332	.6135	0.688
.6194	0.741	.4750	0.336	.6149	0.668
.6208	0.711	.4797	0.302	.6180	0.589
.6222	0.705	.4846	0.269	.6194	0.542
.6250	0.674	.4861	0.256	.6319	+0.097
.6264	0.602	.4880	0.255	.6346	-0.026
.6278	0.574	.4938	-0.204	.6360	0.137
.6305	0.509			.6395	0.249
.6319	0.450	2441682		.6409	0.307
.6333	0.388	.5519	+0.859	.6437	0.394
.6361	0.246	.5542	0.860	.6451	0.428
.6375	0.176	.5583	0.861	.6485	0.467
.6389	+0.146	.5610	0.866	.6499	0.477
.6417	-0.012	.5644	0.858	.6527	0.480
.6431	0.059	.5688	0.854	.6548	0.482
.6445	0.115	.5717	0.841	.6576	0.455
.6472	0.255	.5745	0.822	.6593	0.458
.6486	0.314	.5784	0.781	.6645	0.389
.6500	0.324	.5803	0.745	.6673	0.393
.6528	0.397	.5887	0.569	.6687	0.393
.6542	0.411	.5915	0.445	.6721	0.338
.6556	0.413	.5934	0.360	.6735	0.319
.6583	0.426	.5961	0.210	.6770	0.306
.6667	0.402	.5979	0.132	.6784	-0.286
.6681	0.419	.5997	+0.052		
.6708	0.383	.6025	-0.055	2442433	
.6722	0.375	.6046	0.158	.5204	+0.837
.6736	-0.364	.6069	-0.246	.5221	+0.869

Table 11 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2442433		2442443		2442829	
.5308	+0.877	.5411	-0.422	.4110	+0.138
.5322	0.855	.5488	0.377	.4119	+0.087
.5350	0.861	.5502	0.365	.4138	-0.001
.5364	0.867	.5529	0.352	.4148	0.065
.5395	0.866	.5543	0.336	.4167	0.122
.5409	0.869	.5571	0.316	.4175	0.158
.5440	0.835	.5581	0.305	.4199	0.257
.5454	0.812	.5613	0.285	.4208	0.278
.5481	0.771	.5627	0.261	.4230	0.314
.5495	0.735	.5654	0.261	.4238	0.332
.5523	0.742	.5668	-0.262	.4260	0.390
.5537	0.701			.4269	0.400
.5565	0.622	2442829		.4291	0.409
.5579	0.573	.3576	+0.856	.4301	0.412
.5607	0.451	.3586	0.847	.4322	0.415
.5621	0.440	.3627	0.865	.4333	0.427
.5649	0.231	.3635	0.874	.4356	0.439
.5663	0.205	.3666	0.867	.4364	0.414
.5690	+0.045	.3677	0.883	.4384	0.420
.5704	-0.017	.3698	0.863	.4393	0.420
.5739	0.106	.3709	0.860	.4413	0.402
.5753	0.175	.3733	0.871	.4420	0.409
.5795	0.335	.3744	0.878	.4444	0.397
.5809	0.366	.3766	0.846	.4455	0.389
.5837	-0.390	.3776	0.842	.4475	0.386
		.3799	0.843	.4485	-0.377
2442443		.3809	0.826		
.4918	+0.807	.3833	0.849	2443213	
.4932	0.793	.3842	0.847	.4945	+0.021
.4974	0.797	.3862	0.873	.4961	-0.020
.4995	0.799	.3940	0.784	.4991	0.153
.5029	0.751	.3949	0.737	.5005	0.200
.5043	0.744	.3971	0.673	.5033	0.361
.5092	0.610	.3978	0.642	.5047	0.355
.5106	0.554	.3999	0.557	.5078	0.376
.5147	0.374	.4007	0.573	.5091	0.397
.5161	+0.291	.4026	0.433	.5128	0.402
.5314	-0.353	.4035	0.422	.5144	0.416
.5328	0.376	.4055	0.325	.5227	0.395
.5356	0.388	.4065	0.273	.5246	0.374
.5370	0.397	.4084	0.211	.5283	0.359
.5397	-0.406	.4092	+0.157	.5297	-0.359

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436288		2436288		2436513	
.2979	+0.918	.3210	-0.169	.6040	+0.124
.3004	0.821	.3246	0.340	.6061	+0.037
.3064	0.605	.3282	-0.391	.6099	-0.191
.3096	0.478			.6116	0.277
.3156	0.110	2436513		.6131	0.318
.3184	+0.018	.6019	+0.195	.6167	-0.398

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436513		2436530		2436586	
.6185	-0.425	.6689	+1.019	.4256	+0.852
.6201	0.439	.6717	+0.988	.4447	-0.211
.6240	0.455			.4485	0.363
.6257	0.464	2436545		.4506	0.417
.6275	0.464	.6161	+1.019	.4527	0.442
.6313	0.452	.6182	1.010	.4569	0.472
.6331	0.411	.6202	1.005	.4590	0.491
.6349	-0.417	.6241	0.994	.4610	0.485
		.6260	1.001	.4652	0.471
2436530		.6281	1.016	.4673	0.431
.5366	+0.780	.6324	1.003	.4694	0.410
.5408	0.801	.6341	1.006	.4735	0.376
.5429	0.815	.6361	1.006	.4756	0.372
.5470	0.800	.6408	0.986	.4777	0.339
.5491	0.848	.6426	0.984	.4819	0.322
.5515	0.847	.6445	0.973	.4840	0.312
.5557	0.854	.6484	0.967	.4860	0.276
.5599	0.854	.6508	0.988	.4906	0.232
.5640	0.890	.6533	0.993	.4926	0.210
.5661	0.895	.6814	1.104	.4947	0.144
.5682	0.941	.6835	1.124	.4989	0.122
.5731	0.956	.6855	1.114	.5010	0.103
.5751	0.962	.6892	1.116	.5031	-0.087
.5772	0.937	.6910	1.112		
.5814	0.960	.6929	+1.117	2436604	
.5835	0.953			.5060	+1.069
.5856	1.006	2436556		.5081	1.049
.5897	1.000	.5467	+1.108	.5102	1.041
.5918	0.989	.5509	1.059	.5143	0.989
.5939	1.035	.5530	1.058	.5164	1.002
.5981	0.989	.5604	0.996	.5185	0.885
.6001	0.973	.5620	0.931	.5227	0.725
.6022	1.024	.5638	0.880	.5247	0.597
.6071	1.008	.5674	0.791	.5268	0.468
.6092	1.004	.5693	0.724	.5310	0.268
.6113	1.054	.5711	0.629	.5331	0.143
.6154	1.024	.5748	0.420	.5352	+0.038
.6175	1.016	.5776	0.271	.5393	-0.172
.6196	1.005	.5796	+0.153	.5414	0.308
.6238	1.042			.5435	0.386
.6258	1.010	2436560		.5477	0.462
.6279	0.991	.5781	+0.997	.5497	0.463
.6335	1.032	.5819	0.977	.5518	0.479
.6363	1.008	.5853	1.040	.5560	0.469
.6390	1.017	.5885	1.069	.5581	0.456
.6446	1.019	.5899	1.036	.5602	0.444
.6467	1.023	.5917	1.059	.5643	0.423
.6494	0.987	.5965	1.059	.5664	0.390
.6550	0.984	.5982	1.093	.5685	0.405
.6578	0.976	.6046	+1.106	.5727	0.327
.6606	1.011			.5747	0.309
.6661	+1.008			.5768	-0.304

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436604		2436614		2437316	
.5810	−0.251	.5764	+0.128	.5735	+0.901
.5831	0.230	.5806	0.143	.5746	0.885
.5852	0.225	.5826	0.194	.5774	0.769
.5893	0.199	.5847	0.189	.5785	0.722
.5914	0.192	.5924	0.241	.5795	0.696
.5935	−0.165	.5945	0.279	.5822	0.531
		.5965	0.306	.5841	0.451
2436614		.6007	0.327	.5860	0.383
.4535	+1.140	.6028	0.326	.5903	+0.106
.4576	1.099	.6049	0.369	.5926	−0.038
.4597	1.067	.6090	0.388	.5948	0.119
.4639	1.000	.6111	0.420	.5992	0.323
.4660	0.971	.6132	0.426	.6002	0.364
.4681	0.940	.6174	0.448	.6015	0.382
.4701	0.859	.6195	0.451	.6048	0.426
.4743	0.745	.6215	0.467	.6070	0.439
.4764	0.624	.6257	0.487	.6132	0.459
.4785	0.518	.6278	0.508	.6146	0.483
.4806	0.405	.6299	0.515	.6162	0.476
.4847	0.181	.6340	0.567	.6202	0.442
.4868	+0.091	.6368	0.562	.6217	0.451
.4889	−0.022	.6396	0.580	.6231	0.431
.4910	0.136	.6451	0.611	.6256	0.381
.4951	0.347	.6479	0.638	.6268	0.399
.4972	0.394	.6507	0.640	.6286	0.375
.4993	0.428	.6576	0.694	.6312	0.321
.5035	0.472	.6604	0.664	.6337	0.316
.5056	0.473	.6632	0.720	.6354	0.289
.5076	0.474	.6688	0.708	.6395	0.249
.5118	0.462	.6712	0.767	.6416	0.232
.5139	0.443	.6736	+0.756	.6450	0.210
.5160	0.423			.6491	0.143
.5201	0.390	2437316		.6509	0.137
.5222	0.346	.5411	1.082	.6526	0.129
.5243	0.334	.5422	1.109	.6559	0.106
.5285	0.297	.5431	1.115	.6579	0.076
.5306	0.296	.5453	1.097	.6599	−0.092
.5326	0.284	.5464	1.134		
.5389	0.205	.5475	1.107	2438114	
.5410	0.195	.5502	1.153	.3026	+0.540
.5431	0.172	.5516	1.083	.3082	0.583
.5472	0.135	.5531	1.104	.3103	0.583
.5493	0.129	.5573	1.123	.3186	0.635
.5514	0.122	.5584	1.094	.3311	0.656
.5556	0.060	.5596	1.089	.3339	0.686
.5576	0.045	.5619	1.048	.3367	0.716
.5597	0.023	.5630	1.048	.3402	0.716
.5639	−0.007	.5648	1.081	.3498	0.784
.5660	+0.044	.5678	1.035	.3519	0.776
.5681	0.070	.5688	0.989	.3630	0.829
.5722	0.074	.5700	0.966	.3651	0.826
.5743	+0.084	.5725	+0.926	.3679	+0.855

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2438114		2438413		2438881	
.3700	+0.880	.4613	+1.036	.4077	-0.169
.3783	0.918	.4710	1.045	.4091	0.212
.3839	0.913	.4731	1.039	.4118	0.301
.3867	0.951	.4821	1.035	.4132	0.370
.3889	0.903	.5092	1.034	.4146	0.389
.3908	0.942	.5148	1.027	.4233	0.498
.3936	0.978	.5176	1.038	.4247	0.496
.3992	0.973	.5231	1.039	.4278	0.466
.4020	1.007	.5280	1.061	.4292	0.482
.4040	0.994	.5335	1.054	.4306	0.458
.4061	0.972	.5363	1.042	.4341	0.438
.4082	1.008	.5439	1.057	.4355	0.444
.4130	1.027	.5474	1.030	.4403	0.338
.4151	1.037	.5682	1.078	.4431	0.305
.4193	1.018	.5710	1.074	.4445	-0.326
.4214	+1.046	.5787	1.119		
		.5808	+1.120	2439146	
2438118				.4898	+0.854
.2961	-0.021	2438414		.4915	0.709
.2987	+0.011	.5040	+1.105	.4926	0.681
.3019	0.015	.5095	1.069	.4953	0.525
.3039	0.035	.5122	1.056	.4967	0.437
.3056	0.052	.5166	0.975	.4981	0.380
.3084	0.088	.5210	0.880	.5002	0.240
.3105	0.093	.5244	0.731	.5016	+0.142
.3139	0.086	.5269	0.654	.5058	-0.084
.3155	0.124	.5313	0.431	.5071	0.141
.3180	0.126	.5335	0.318	.5082	0.187
.3214	0.153	.5359	+0.145	.5110	0.308
.3239	0.169	.5408	-0.046	.5124	0.358
.3263	0.219	.5436	0.187	.5134	0.386
.3278	0.247	.5460	0.288	.5162	0.442
.3312	0.226	.5504	0.393	.5183	0.460
.3327	0.254	.5530	0.432	.5203	0.466
.3352	0.265	.5558	0.468	.5262	0.462
.3584	0.435	.5702	0.387	.5287	0.476
.3605	0.440	.5755	-0.305	.5335	0.452
.3660	0.511			.5356	0.430
.3681	0.501	2438881		.5377	0.405
.3751	0.560	.3771	+1.137	.5412	0.375
.3772	0.618	.3785	1.114	.5426	0.356
.3821	0.616	.3799	1.080	.5440	0.334
.3841	0.634	.3834	0.972	.5474	0.262
.3896	0.655	.3848	0.909	.5495	-0.224
.3931	0.667	.3862	0.856		
.3973	0.689	.3896	0.795	2439150	
.3994	0.682	.3914	0.773	.4975	+1.059
.4139	0.759	.3931	0.698	.4996	1.044
.4230	+0.825	.3959	0.505	.5031	1.057
		.3973	0.403	.5044	1.052
2438413		.3987	0.331	.5058	1.072
.4592	+1.054	.4042	+0.042	.5086	+1.057

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2439150		2439150		2439507	
.5100	+1.082	.6121	-0.377	.4932	+0.914
.5114	1.095			.4967	0.849
.5142	1.089	2439503		.4981	0.749
.5156	1.089	.4072	+1.084	.4995	0.655
.5170	1.101	.4086	1.091	.5015	0.530
.5218	1.095	.4114	1.079	.5026	0.469
.5232	1.115	.4127	1.092	.5036	0.433
.5246	1.132	.4173	1.008	.5064	0.296
.5281	1.114	.4193	0.934	.5078	0.200
.5294	1.117	.4211	0.903	.5092	+0.132
.5308	1.134	.4225	0.867	.5120	-0.033
.5343	1.109	.4266	0.700	.5134	0.133
.5357	1.125	.4280	0.679	.5147	0.203
.5371	1.133	.4294	0.544	.5182	0.335
.5399	1.125	.4315	0.487	.5196	0.373
.5413	1.089	.4329	0.372	.5203	0.408
.5426	1.111	.4336	0.350	.5231	0.440
.5461	1.100	.4357	0.174	.5245	0.467
.5475	1.094	.4370	0.139	.5252	0.485
.5489	1.095	.4377	+0.087	.5279	0.503
.5517	1.049	.4395	-0.007	.5290	0.499
.5531	1.014	.4402	0.022	.5300	0.507
.5551	0.991	.4412	0.075	.5328	0.481
.5579	0.927	.4436	0.176	.5342	0.476
.5600	0.841	.4443	0.246	.5356	0.468
.5614	0.812	.4454	0.327	.5384	0.425
.5642	0.687	.4471	0.369	.5394	0.426
.5656	0.630	.4482	0.361	.5411	0.408
.5670	0.534	.4541	0.493	.5439	0.369
.5697	0.371	.4554	0.479	.5453	0.361
.5711	0.285	.4582	0.478	.5467	0.356
.5725	0.222	.4593	0.468	.5495	0.333
.5753	+0.093	.4603	0.474	.5509	0.321
.5767	-0.024	.4627	0.446	.5522	-0.306
.5781	0.085	.4641	0.437		
.5808	0.272	.4652	0.437	2439906	
.5822	0.300	.4673	0.435	.4956	+1.047
.5836	0.354	.4683	0.411	.4970	0.097
.5864	0.457	.4693	0.404	.4998	0.912
.5878	0.479	.4714	0.383	.5012	0.860
.5892	0.480	.4725	0.403	.5040	0.816
.5919	0.478	.4735	0.373	.5054	0.746
.5933	0.480	.4759	0.360	.5081	0.617
.5947	0.473	.4770	0.357	.5095	0.563
.5975	0.467	.4780	0.347	.5123	0.336
.5989	0.464	.4804	0.327	.5137	0.267
.6003	0.454	.4815	0.327	.5165	0.139
.6031	0.421	.4829	-0.327	.5179	+0.083
.6044	0.414			.5206	-0.117
.6065	0.416	2439507		.5220	0.216
.6093	0.403	.4897	+1.021	.5248	0.290
.6107	-0.395	.4918	+1.015	.5262	-0.352

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2439906		2440654		2441003	
.5290	-0.408	.3072	+0.694	.5715	-0.333
.5332	0.467	.3099	0.537	.5729	0.351
.5346	0.478	.3113	0.472	.5757	0.410
.5373	0.479	.3141	0.297	.5799	0.469
.5387	0.482	.3155	0.241	.5813	0.480
.4515	0.447	.3183	0.085	.5840	0.460
.5429	0.465	.3224	-0.183	.5854	0.443
.5471	0.412	.3238	0.252	.5882	0.451
.5498	0.401	.3266	0.361	.5896	0.445
.5512	0.390	.3280	0.391	.5924	0.439
.5540	0.390	.3308	0.434	.5938	0.437
.5554	-0.373	.3322	0.446	.5965	0.407
		.3349	0.467	.5979	0.406
2440232		.3363	0.460	.6007	0.366
.6591	+1.120	.3391	0.456	.6021	0.354
.6618	1.085	.3405	0.460	.6049	0.306
.6632	1.071	.3433	0.434	.6063	-0.307
.6660	1.067	.3447	0.401		
.6674	1.054	.3474	-0.386	2441311	
.6702	0.976			.6132	+1.138
.6716	0.962	2440980		.6146	1.095
.6743	0.865	.4800	+0.683	.6160	1.088
.6757	0.824	.4808	0.637	.6187	1.058
.6785	0.728	.4833	0.509	.6201	1.043
.6799	0.647	.4840	0.416	.6215	1.017
.6827	0.513	.4867	0.312	.6243	0.965
.6841	0.428	.4878	0.234	.6257	0.906
.6869	0.268	.4898	0.111	.6271	0.862
.6883	0.202	.4909	+0.072	.6298	0.740
.6910	+0.043	.4931	-0.030	.6312	0.655
.6924	-0.031	.4938	0.090	.6326	0.579
.6952	0.184	.4961	0.202	.6354	0.407
.6966	0.254	.4972	0.249	.6368	0.339
.6993	0.358	.5003	0.375	.6382	0.256
.7007	0.398	.5014	0.400	.6410	0.130
.7035	0.443	.5035	0.433	.6424	+0.075
.7049	0.448	.5045	0.453	.6438	-0.017
.7077	0.469	.5068	0.474	.6465	0.133
.7091	0.459	.5078	0.476	.6493	0.310
.7119	0.455	.5098	0.478	.6521	0.392
.7133	-0.459	.5109	0.473	.6535	0.405
		.5136	0.473	.6549	0.424
2440654		.5146	0.465	.6576	0.454
.2891	+1.090	.5171	0.420	.6590	0.459
.2905	1.089	.5182	-0.422	.6604	0.459
.2933	1.061			.6660	0.445
.2947	1.037	2441003		.6674	0.466
.2974	0.995	.5590	+0.304	.6701	0.429
.2988	0.954	.5632	0.090	.6715	0.414
.3016	0.922	.5646	+0.050	.6757	0.355
.3030	0.900	.5674	-0.099	.6771	0.348
.3058	+0.761	.5688	-0.174	.6813	-0.322

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2441311		2441682		2442433	
.6827	−0.298	.6230	−0.484	.5388	+1.092
.6841	−0.271	.6251	0.476	.5402	1.084
		.6274	0.468	.5433	1.049
2441312		.6349	0.392	.5447	0.994
.5354	+0.617	.6380	0.383	.5474	0.954
.5368	0.583	.6403	0.371	.5488	0.927
.5382	0.531	.6429	−0.353	.5516	0.925
.5410	0.340			.5530	0.918
.5424	0.276	2442019		.5558	0.845
.5438	0.205	.5888	+1.075	.5572	0.780
.5465	+0.011	.5902	1.086	.5600	0.655
.5479	−0.070	.5930	1.104	.5614	0.598
.5493	0.129	.5944	1.101	.5642	0.427
.5521	0.260	.5971	1.113	.5656	0.372
.5576	0.429	.5985	1.110	.5683	0.173
.5604	0.439	.6013	1.100	.5697	+0.126
.5618	0.451	.6055	1.113	.5732	−0.002
.5632	0.479	.6069	1.099	.5746	0.082
.5660	0.475	.6096	1.035	.5787	0.286
.5674	0.487	.6110	0.988	.5802	0.366
.5689	−0.477	.6142	0.924	.5830	0.409
		.6156	0.914	.5843	−0.441
2441679		.6187	0.792		
.4729	−0.316	.6201	0.743	2442443	
.4743	0.324	.6312	0.210	.4911	+1.120
.4786	0.288	.6326	+0.122	.4967	1.088
.4840	0.258	.6353	−0.031	.4988	1.064
.4852	0.252	.6367	0.140	.5022	1.001
.4871	0.244	.6402	0.285	.5036	0.969
.4955	−0.153	.6416	0.348	.5078	0.897
		.6444	0.428	.5099	0.829
2441682		.6465	0.446	.5133	0.621
.5527	+1.144	.6492	0.483	.5154	0.545
.5550	1.159	.6506	0.472	.5203	0.238
.5756	1.117	.6534	0.468	.5217	+0.172
.5790	1.057	.6555	0.466	.5307	−0.268
.5821	0.989	.6583	0.463	.5321	0.333
.5896	0.746	.6600	0.449	.5349	0.406
.5921	0.625	.6635	0.408	.5363	0.443
.5943	0.515	.6652	0.392	.5404	0.492
.5967	0.330	.6680	0.393	.5432	0.481
.5985	0.248	.6694	0.381	.5446	0.494
.6004	+0.127	.6728	−0.352	.5481	0.476
.6033	−0.022			.5522	0.431
.6053	0.146	2442433		.5536	0.437
.6075	0.256	.5197	+1.131	.5564	0.404
.6094	0.337	.5214	1.126	.5578	0.381
.6112	0.395	.5245	1.122	.5606	0.344
.6130	0.427	.5266	1.117	.5620	0.331
.6153	0.467	.5315	1.107	.5647	0.296
.6183	0.474	.5343	1.076	.5661	−0.291
.6207	−0.495	.5357	+1.076		

Table 11 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442829		2442829		2442829	
.3571	+1.110	.4021	+0.725	.4388	-0.460
.3581	1.090	.4031	0.695	.4408	0.453
.3622	1.088	.4050	0.615	.4417	0.451
.3632	1.108	.4059	0.569	.4439	0.421
.3660	1.113	.4080	0.405	.4450	0.403
.3671	1.123	.4089	0.362	.4470	0.394
.3693	1.116	.4106	0.285	.4480	-0.388
.3704	1.092	.4114	0.220		
.3728	1.088	.4133	0.143	2443213	
.3739	1.091	.4144	+0.070	.4937	+0.152
.3762	1.077	.4163	-0.044	.4953	+0.053
.3771	1.080	.4170	0.096	.4984	-0.083
.3794	1.099	.4194	0.181	.4998	0.176
.3804	1.092	.4204	0.234	.5026	0.318
.3827	1.083	.4225	0.311	.5040	0.367
.3837	1.080	.4235	0.363	.5072	0.401
.3858	1.093	.4254	0.412	.5084	0.439
.3867	1.077	.4265	0.415	.5121	0.453
.3913	1.021	.4286	0.422	.5136	0.470
.3935	0.964	.4296	0.455	.5172	0.481
.3945	0.926	.4317	0.477	.5189	0.435
.3966	0.896	.4328	0.456	.5220	0.406
.3975	0.871	.4351	0.463	.5236	0.394
.3994	0.815	.4360	0.472	.5274	0.392
.4003	+0.778	.4379	-0.469	.5290	-0.363

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2438414		2439150		2439150	
.5046	+1.117	.5024	+1.084	.5482	+1.017
.5106	1.025	.5038	0.992	.5510	0.944
.5158	0.932	.5051	1.038	.5524	0.956
.5202	0.911	.5079	1.088	.5538	0.945
.5237	0.787	.5093	1.066	.5572	0.890
.5251	0.668	.5107	1.091	.5586	0.828
.5305	0.449	.5135	1.043	.5607	0.797
.5328	0.352	.5149	1.026	.5635	0.665
.5350	+0.148	.5163	1.062	.5649	0.635
.5398	-0.002	.5211	1.068	.5663	0.567
.5427	0.141	.5225	1.097	.5690	0.356
.5453	0.221	.5239	1.040	.5704	0.282
.5494	0.374	.5274	1.077	.5718	0.171
.5520	0.397	.5288	1.056	.5746	0.127
.5550	0.478	.5301	1.057	.5760	+0.017
.5609	0.499	.5336	1.106	.5774	-0.094
.5632	0.422	.5350	1.114	.5801	0.243
.5695	0.468	.5364	1.121	.5815	0.303
.5745	-0.362	.5392	1.116	.5829	0.323
		.5406	1.096	.5857	0.455
2439150		.5420	1.008	.5871	0.501
.4968	+1.029	.5454	1.039	.5885	0.499
.4989	+1.044	.5468	+1.031	.5912	-0.502

Table 11 (cont.)

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2439150		2441682		2441682	
.5926	−0.519	.5560	+1.133	.6017	+0.052
.5940	0.509	.5601	1.141	.6039	−0.072
.5968	0.487	.5668	1.137	.6060	0.158
.5982	0.498	.5701	1.072	.6081	0.260
.5996	0.487	.5737	1.061	.6100	0.332
.6024	0.485	.5765	1.030	.6118	0.385
.6038	0.486	.5796	0.955	.6137	0.437
.6058	0.463	.5828	0.899	.6163	0.459
.6086	0.428	.5907	0.648	.6191	0.434
.6100	0.407	.5927	0.463	.6213	0.470
.6114	−0.405	.5954	0.371	.6238	0.434
		.5973	0.246	.6260	0.423
2441682		.5991	+0.130	.6279	−0.434
.5535	+1.126				

Table 12

Photographic observations of RR Leo

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2434126		2434443		2435068	
.3374	11.37	.4729	10.87	.6577	11.17
.3395	11.25	.4750	10.82	.6591	11.14
.3416	11.20	.4771	10.80	.6619	11.07
.3437	11.08	.4792	10.73	.6633	11.07
.3457	11.16	.4813	10.55	.6647	10.97
.3499	10.96	.4833	10.44	.6661	10.93
.3520	10.97	.4854	10.25	.6675	10.81
.3541	10.75	.4875	10.13	.6688	10.75
.3582	10.60	.4896	10.00	.6702	10.69
.3603	10.55	.4917	9.92	.6716	10.60
.3624	10.40	.4938	9.78	.6730	10.50
.3714	9.90	.4958	9.72	.6744	10.45
.3735	9.95	.5000	9.60	.6758	10.41
.3756	9.60	.5021	9.70	.6772	10.33
.3777	9.60	.5042	9.65	.6786	10.25
.3798	9.52	.5063	9.70	.6821	10.05
		.5083	9.64	.6835	9.94
2434443		.5104	9.80	.6849	9.90
.4479	11.30	.5125	9.69	.6863	9.82
.4500	11.31	.5146	9.83	.6877	9.73
.4521	11.39	.5167	9.79	.6891	9.73
.4542	11.40	.5188	9.83	.6905	9.74
.4583	11.18	.5208	9.82	.6919	9.71
.4604	11.23				
.4625	11.30	2435068		2435069	
.4646	11.12	.6508	11.34	.5540	11.38
.4667	11.00	.6522	11.35	.5554	11.36
.4688	11.09	.6536	11.35	.5581	11.32
.4708	10.89	.6550	11.26	.5595	11.29

Table 12 (cont.)

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2435069		2435507		2435896	
.5609	11.28	.5069	9.77	.5437	10.73
.5693	11.08	.5083	9.73	.5457	10.55
.5706	11.07	.5097	9.65	.5478	10.39
.5734	10.93	.5111	9.59	.5499	10.30
.5762	10.89	.5125	9.65	.5520	9.93
.5776	10.90	.5139	9.59	.5541	9.82
.5790	10.85	.5153	9.60		
.5804	10.68			2435925	
.5817	10.60	2435869		.4422	11.26
.5831	10.61	.3605	11.33	.4436	11.26
.5845	10.52	.3626	11.39	.4449	11.41
.5859	10.43	.3647	11.41	.4477	11.40
.5873	10.30	.3668	11.35	.4505	11.46
.5887	10.32	.3689	11.30	.4519	11.37
.5901	10.22	.3709	11.38	.4533	11.38
.5915	10.10	.3730	11.30	.4547	11.38
.5929	10.01	.3751	11.32	.4561	11.39
.5956	9.90	.3772	11.36	.4574	11.32
.5970	9.84	.3793	11.30	.4588	11.45
.5984	9.85	.3820	11.38	.4602	11.48
.6005	9.73	.3841	11.24	.4630	11.36
.6033	9.69	.3862	11.18	.4658	11.42
.6060	9.66	.3890	11.18	.4672	11.42
.6081	9.67	.3911	11.10	.4686	11.42
.6095	9.65	.3932	11.01	.4699	11.37
.6109	9.72	.3952	10.95	.4713	11.31
.6123	9.66	.3973	10.81	.4727	11.35
.6137	9.73	.3994	10.76	.4741	11.35
.6151	9.73	.4015	10.66	.4755	11.30
.6165	9.78	.4057	10.51	.4769	11.22
.6179	9.80	.4077	10.30	.4783	11.28
.6193	9.79			.4797	11.24
		2435896		.4811	11.26
2435507		.5020	11.27	.4824	11.15
.4792	11.26	.5041	11.30	.4838	11.17
.4806	11.26	.5062	11.39	.4852	11.16
.4819	11.15	.5082	11.33	.4887	10.99
.4833	11.14	.5103	11.25	.4901	11.07
.4847	11.08	.5124	11.35	.4915	10.95
.4875	10.84	.5145	11.35	.4943	10.76
.4889	10.80	.5166	11.24	.4956	10.70
.4903	10.80	.5187	11.18	.4970	10.60
.4917	10.65	.5107	11.19	.4984	10.57
.4931	10.63	.5228	11.26	.4998	10.49
.4944	10.45	.5249	11.25	.5012	10.43
.4958	10.41	.5270	11.25	.5026	10.32
.4972	10.37	.5291	11.15	.5040	10.20
.4986	10.25	.5312	11.05	.5054	10.14
.5000	10.13	.5353	11.00	.5074	9.88
.5014	10.03	.5374	10.99	.5109	9.72
.5042	9.88	.5395	10.90	.5123	9.72
.5056	9.82	.5416	10.81	.5137	9.67

Table 12 (cont.)

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2435925		2435925		2435925	
.5151	9.67	.5193	9.70	.5234	9.66
.5165	9.64	.5206	9.60	.5248	9.71
.5179	9.63				

Table 13

Photoelectric observations of TT Lyn

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436648		2436649		2436649	
.4294	+0.428	.3555	+0.886	.5070	+0.595
.4315	0.450	.3631	0.879	.5092	0.541
.4364	0.472	.3652	0.907	.5121	0.536
.4384	0.487	.3673	0.877	.5213	0.516
.4405	0.481	.3718	0.874	.5293	0.461
.4463	0.481	.3739	0.884	.5315	0.457
.4484	0.478	.3760	0.887	.5344	0.432
.4505	0.518	.4027	0.916	.5431	+0.364
.4566	0.539	.4048	0.928		
.4589	0.539	.4069	0.884	2436650	
.4616	0.528	.4138	0.937	.2779	+0.571
.4668	0.564	.4159	0.924	.2812	0.573
.4694	0.579	.4180	0.921	.2837	0.613
.4717	0.569	.4225	0.948	.2887	0.582
.4778	+0.592	.4246	0.969	.2908	0.584
		.4267	0.952	.2929	0.600
2436649		.4319	0.973	.2975	0.636
.2694	+0.842	.4340	0.963	.2998	0.626
.2735	0.860	.4360	0.970	.3022	0.624
.2756	0.869	.4402	0.982	.3066	0.652
.2798	0.885	.4423	0.981	.3167	0.636
.2819	0.864	.4444	0.966	.3191	0.653
.2840	0.891	.4489	0.994	.3211	0.636
.2881	0.888	.4510	1.026	.3255	0.666
.2906	0.887	.4531	0.983	.3276	0.681
.2926	0.887	.4572	1.009	.3297	0.689
.2968	0.883	.4593	1.009	.3342	0.681
.2989	0.883	.4614	0.981	.3363	0.690
.3010	0.870	.4673	0.996	.3384	0.692
.3051	0.886	.4694	0.993	.3429	0.681
.3072	0.892	.4715	0.979	.3450	0.691
.3183	0.895	.4760	0.967	.3471	0.699
.3329	0.906	.4781	1.000	.3516	0.703
.3350	0.893	.4801	0.944	.3537	0.710
.3371	0.895	.4881	0.914	.3557	0.709
.3416	0.888	.4901	0.905	.3603	0.730
.3437	0.863	.4922	0.837	.3623	0.757
.3458	0.866	.4975	0.759	.3644	0.748
.3513	0.876	.4996	0.691	.3703	0.757
.3534	+0.891	.5014	+0.669	.3731	+0.751

Table 13 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436650		2436651		2436679	
.3759	+0.741	.3194	+0.500	.3985	+0.455
.3807	0.754	.3237	0.481	.4041	0.428
.3828	0.772	.3257	0.443	.4061	0.418
.3849	0.759	.3278	0.429	.4082	0.417
.3894	0.763	.3320	0.402	.4169	0.332
.3915	0.770	.3339	0.412	.4190	0.332
.3936	0.775	.3360	0.398	.4211	0.315
.3978	0.775	.3403	0.339	.4256	0.307
.3998	0.779	.3421	0.356	.4277	0.326
.4019	0.791	.3443	0.344	.4297	0.308
.4061	0.789	.3495	0.321	.4343	0.296
.4082	0.792	.3513	0.325	.4363	0.290
.4103	0.805	.3529	0.307	.4388	0.295
.4144	0.811	.3565	0.293	.4433	0.324
.4165	0.823	.3580	0.290	.4454	0.330
.4186	0.810	.3593	0.298	.4475	0.340
.4228	0.828	.3622	0.289	.4520	+0.352
.4247	0.824	.3636	0.289		
.4268	0.843	.3649	0.317	2443580	
.4326	0.842	.3677	0.334	.3490	+0.617
.4351	0.861	.3691	0.339	.3522	0.592
.4386	0.846	.3705	0.331	.3537	0.572
.4437	0.846	.3749	0.361	.3566	0.580
.4459	0.846	.3766	0.363	.3578	0.552
.4479	0.874	.3785	0.359	.3659	0.459
.4525	0.855	.3826	0.365	.3672	0.440
.4549	0.847	.3840	+0.371	.3712	0.430
.4570	0.874			.3724	0.409
.4633	0.870	2436679		.3756	0.365
.4657	0.870	.3096	+1.002	.3770	0.345
.4678	+0.859	.3155	0.999	.3810	0.327
		.3183	0.999	.3824	0.314
2436651		.3238	0.997	.3858	0.307
.2640	+0.958	.3266	0.997	.3875	0.325
.2675	0.983	.3294	0.996	.3909	0.311
.2697	0.954	.3350	1.009	.3922	0.302
.2732	0.942	.3377	1.003	.3959	0.314
.2747	0.935	.3405	1.013	.3975	0.319
.2766	0.900	.3572	0.919	.4007	0.307
.2818	0.859	.3600	0.876	.4021	0.315
.2840	0.854	.3627	0.836	.4058	0.326
.2860	0.836	.3676	0.721	.4077	0.357
.2907	0.750	.3697	0.704	.4125	0.338
.2928	0.716	.3718	0.707	.4172	0.333
.2947	0.671	.3770	0.599	.4204	0.344
.2992	0.623	.3791	0.585	.4218	+0.379
.3011	0.611	.3811	0.556		
.3030	0.558	.3856	0.502	2443583	
.3066	0.525	.3877	0.477	.3478	+0.468
.3086	0.525	.3898	0.471	.3489	0.461
.3104	0.505	.3943	0.457	.3529	0.444
.3147	+0.494	.3964	+0.458	.3565	+0.431

Table 13 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2443583		2443583		2443595	
.3579	+0.424	.4079	+0.368	.3227	+0.368
.3614	0.392	.4091	0.371	.3240	0.301
.3625	0.389	.4125	0.383	.3270	0.326
.3665	0.375	.4137	+0.393	.3285	0.321
.3680	0.377			.3316	0.323
.3717	0.349	2443595		.3378	0.295
.3730	0.311	.3009	+0.434	.3412	0.311
.3759	0.326	.3024	0.458	.3426	0.323
.3772	0.329	.3057	0.433	.3460	0.337
.3820	0.337	.3068	0.444	.3472	0.333
.3851	0.323	.3098	0.425	.3509	0.342
.3863	0.322	.3109	0.424	.3521	0.356
.3898	0.312	.3137	0.387	.3553	0.373
.3908	0.313	.3150	0.395	.3567	0.362
.3954	0.349	.3183	0.374	.3596	0.345
.4035	0.357	.3197	+0.349	.3610	+0.358
.4047	+0.339				

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436648		2436649		2436649	
.4283	+0.470	.3319	+1.062	.4499	+1.137
.4305	0.452	.3340	1.061	.4520	1.152
.4353	0.499	.3360	1.060	.4562	1.124
.4375	0.512	.3406	1.064	.4583	1.157
.4394	0.499	.3426	1.048	.4603	1.174
.4453	0.542	.3447	1.043	.4663	1.166
.4475	0.524	.3503	1.026	.4683	1.162
.4492	0.532	.3524	1.052	.4704	1.119
.4555	0.577	.3544	1.048	.4749	1.098
.4578	0.572	.3621	1.035	.4791	1.122
.4601	0.592	.3642	1.036	.4870	1.007
.4660	0.608	.3663	1.015	.4890	0.999
.4682	0.580	.3708	1.034	.4910	0.945
.4706	+0.607	.3728	1.020	.4963	0.847
		.3749	1.014	.4984	0.850
2436649		.4017	1.052	.5005	0.799
.2683	+1.052	.4038	1.068	.5058	0.670
.2725	1.081	.4058	1.070	.5081	0.629
.2746	1.067	.4128	1.099	.5129	0.600
.2788	1.054	.4149	1.111	.5167	0.560
.2808	1.062	.4169	1.082	.5227	0.539
.2829	1.049	.4215	1.104	.5283	0.498
.2871	1.034	.4235	1.119	.5304	0.494
.2892	1.058	.4256	1.119	.5327	0.459
.2916	1.074	.4308	1.120	.5422	0.386
.2958	1.048	.4329	1.121	.5443	+0.394
.2978	1.044	.4350	1.132		
.2999	1.050	.4392	1.137	2436650	
.3041	1.027	.4413	1.131	.2760	+0.636
.3062	1.056	.4433	1.161	.2805	0.626
.3083	+1.066	.4478	+1.142	.2822	+0.643

Table 13 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436650		2436650		2436651	
.2876	+0.652	.4490	+1.026	.3833	+0.357
.2897	0.670	.4540	1.041		
.2917	0.688	.4561	1.037	2436679	
.2964	0.702	.4584	1.048	.3087	+1.136
.2987	0.702	.4644	1.060	.3141	1.136
.3010	0.702	.4667	1.058	.3169	1.135
.3056	0.716	.4691	+1.055	.3225	1.133
.3077	0.741			.3252	1.133
.3153	0.763	2436651		.3280	1.133
.3181	0.761	.2630	+1.137	.3336	1.138
.3202	0.740	.2666	1.115	.3363	1.139
.3245	0.760	.2685	1.082	.3391	1.156
.3266	0.785	.2725	1.070	.3558	1.052
.3287	0.753	.2739	1.055	.3586	1.042
.3328	0.797	.2755	1.041	.3613	0.994
.3353	0.794	.2808	0.957	.3662	0.845
.3373	0.805	.2830	0.937	.3686	0.829
.3419	0.797	.2851	0.943	.3707	0.829
.3439	0.791	.2897	0.855	.3759	0.685
.3460	0.792	.2918	0.803	.3780	0.677
.3505	0.804	.2938	0.783	.3801	0.646
.3526	0.830	.2983	0.707	.3846	0.587
.3547	0.820	.3001	0.674	.3867	0.569
.3592	0.817	.3020	0.643	.3888	0.556
.3613	0.857	.3058	0.591	.3933	0.516
.3634	0.884	.3075	0.566	.3954	0.511
.3689	0.884	.3095	0.545	.3975	0.507
.3717	0.903	.3136	0.551	.4030	0.447
.3745	0.866	.3159	0.512	.4051	0.448
.3797	0.919	.3182	0.535	.4072	0.444
.3818	0.906	.3247	0.469	.4159	0.339
.3839	0.925	.3268	0.461	.4179	0.320
.3884	0.932	.3311	0.441	.4200	0.305
.3905	0.936	.3329	0.381	.4245	0.293
.3926	0.936	.3350	0.357	.4266	0.303
.3967	0.934	.3393	0.340	.4287	0.297
.3988	0.939	.3412	0.343	.4332	0.271
.4009	0.938	.3486	0.296	.4353	0.267
.4071	0.949	.3505	0.288	.4374	+0.272
.4092	0.997	.3521	0.285		
.4134	1.008	.3557	0.255	2443580	
.4155	1.001	.3572	0.279	.3470	+0.642
.4176	1.005	.3586	0.255	.3483	0.617
.4217	0.994	.3615	0.256	.3516	0.595
.4238	0.985	.3629	0.267	.3529	0.591
.4256	0.999	.3642	0.275	.3560	0.571
.4280	0.992	.3670	0.301	.3573	0.554
.4339	1.020	.3684	0.300	.3593	0.553
.4373	1.022	.3737	0.318	.3620	0.537
.4398	1.020	.3758	0.349	.3654	0.496
.4448	1.057	.3776	0.336	.3666	0.464
.4469	+1.048	.3821	+0.359	.3706	+0.446

Table 13 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2443580		2443583		2443595	
.3718	+0.417	.3557	+0.446	.3002	+0.488
.3750	0.400	.3572	0.433	.3016	0.469
.3763	0.355	.3620	0.419	.3050	0.473
.3802	0.323	.3673	0.330	.3063	0.437
.3815	0.341	.3707	0.329	.3093	0.394
.3851	0.280	.3724	0.326	.3104	0.380
.3866	0.265	.3753	0.293	.3132	0.370
.3902	0.261	.3765	0.310	.3143	0.356
.3915	0.263	.3802	0.321	.3176	0.355
.3952	0.276	.3844	0.297	.3189	0.321
.3968	0.278	.3856	0.298	.3222	0.340
.4001	0.280	.3891	0.279	.3233	0.299
.4014	0.286	.3905	0.283	.3264	0.281
.4053	0.315	.3934	0.314	.3279	0.277
.4066	0.323	.3948	0.309	.3310	0.260
.4118	0.312	.3981	0.322	.3323	0.286
.4149	0.317	.3995	0.315	.3371	0.273
.4165	0.308	.4027	0.340	.3406	0.280
.4196	0.360	.4042	0.339	.3418	0.304
.4211	+0.354	.4072	0.352	.3454	0.298
		.4086	0.361	.3466	0.305
2443583		.4120	0.334	.3501	0.303
.3399	+0.528	.4131	+0.347	.3514	0.310
.3441	0.518			.3546	0.324
.3482	0.508	2443595		.3560	0.331
.3511	0.484	.2954	+0.527	.3589	0.326
.3523	+0.483	.2966	+0.534	.3604	+0.350

Table 14

Photoelectric observations of AR Per

J.D.	Δm*	J.D.	Δm*	J.D.	Δm*
2435095		2435095		2435095	
.4738	+1.157	.4874	+0.895	.5094	+0.377
.4747	1.150	.4886	0.844	.5104	0.363
.4754	1.175	.4908	0.773	.5114	0.348
.4762	1.146	.5011	0.561	.5125	0.318
.4790	1.079	.5023	0.561	.5173	0.177
.4798	1.034	.5034	0.528	.5183	0.163
.4806	1.000	.5044	0.502	.5193	0.136
.4815	0.996	.5050	0.494	.5203	0.143
.4827	0.965	.5084	+0.373	.5216	+0.097
.4865	+0.897				

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2435093		2435093		2435093	
.3853	+1.707	.4032	+1.447	.4114	+1.429
.3954	+1.474	.4041	+1.450	.4123	+1.441

Table 14 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2335093		2436485		2336495	
.4477	+1.594	.5120	+0.643	.6215	+0.253
.4487	1.611	.5159	0.666	.6240	0.282
.4568	1.656	.5179	0.678	.6292	+0.349
.4577	1.639	.5212	0.687		
.4714	1.754	.5254	0.698	2436530	
.4722	+1.751	.5277	0.700	.4393	+0.903
		.5294	0.699	.4436	0.863
2436477		.5354	0.755	.4453	0.806
.5105	+0.809	.5375	0.765	.4487	0.708
.5205	0.842	.5403	+0.764	.4517	0.655
.5288	0.822			.4550	0.543
.5366	0.805	2436495		.4566	0.510
.5455	0.802	.4830	+0.937	.4583	0.487
.5557	0.805	.4851	0.954	.4618	0.477
.5646	0.839	.4872	0.957	.4634	0.436
.5734	0.859	.4913	0.982	.4654	0.398
.5821	0.862	.4934	1.007	.4693	0.319
.5915	0.902	.4997	1.017	.4711	0.281
.6040	0.936	.5018	1.023	.4728	0.229
.6152	0.972	.5038	1.020	.4763	0.204
.6263	+1.010	.5080	1.010	.4782	0.165
		.5122	1.025	.4801	0.163
2436485		.5163	1.034	.4842	0.150
.3666	+0.192	.5184	1.026	.4865	0.159
.3704	0.162	.5205	1.054	.4883	0.162
.3719	0.154	.5247	1.025	.4925	0.155
.3770	0.155	.5268	1.014	.4944	0.187
.3791	0.123	.5288	1.015	.4962	0.175
.3811	0.132	.5330	1.020	.5006	0.215
.3853	0.144	.5358	1.022	.5026	0.211
.3874	0.175	.5379	1.033	.5041	0.218
.3936	0.225	.5420	0.967	.5077	0.259
.3968	0.219	.5441	0.904	.5097	0.263
.4030	0.255	.5462	0.886	.5115	0.279
.4072	0.274	.5504	0.777	.5149	0.277
.4615	0.506	.5524	0.729	.5167	0.289
.4650	0.519	.5545	0.682	.5183	+0.303
.4671	0.510	.5587	0.572		
.4732	0.537	.5608	0.507	2436541	
.4750	0.580	.5629	0.472	.4381	+0.985
.4767	0.579	.5837	0.201	.4413	0.998
.4813	0.566	.5858	0.180	.4427	1.007
.4831	0.579	.5903	0.131	.4455	1.007
.4851	0.583	.5924	0.127	.4470	0.986
.4895	0.601	.5955	0.152	.4490	0.998
.4917	0.608	.5997	0.167	.4525	1.044
.4932	0.611	.6021	0.172	.4541	1.031
.4970	0.646	.6045	0.199	.4556	1.034
.4988	0.642	.6097	0.211	.4598	1.020
.5006	0.635	.6122	0.228	.4614	1.045
.5079	0.643	.6146	0.229	.4632	1.053
.5101	+0.645	.6195	+0.249	.4664	+1.085

Table 14 (cont.)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2436541		2436541		2440528	
.4679	+1.064	.5689	+0.230	.5402	+0.175
.4695	1.087	.5707	0.252		
.4745	1.083	.5751	0.286	2443124	
.4811	1.085	.5767	0.292	.3258	+0.963
.4882	1.091	.5826	0.309	.3272	0.957
.4920	1.072	.5852	0.323	.3313	0.920
.4950	1.056	.5869	+0.334	.3327	0.936
.4968	1.047			.3365	0.853
.4986	1.032	2440528		.3375	0.811
.5022	0.930	.4610	+1.042	.3407	0.759
.5042	0.877	.4631	1.030	.3421	0.724
.5060	0.889	.4673	1.017	.3453	0.661
.5099	0.786	.4694	0.996	.3467	0.632
.5117	0.762	.4735	0.990	.3505	0.529
.5132	0.724	.4756	0.977	.3522	0.489
.5163	0.619	.4812	0.898	.3559	0.432
.5180	0.593	.4832	0.840	.3577	0.399
.5195	0.553	.4874	0.712	.3605	0.397
.5229	0.519	.4895	0.680	.3621	0.375
.5242	0.499	.4944	0.523	.3654	0.286
.5294	0.401	.4964	0.481	.3675	0.245
.5313	0.353	.5006	0.459	.3709	0.172
.5329	0.332	.5027	0.427	.3729	0.162
.5360	0.294	.5069	0.343	.3755	0.158
.5378	0.251	.5089	0.291	.3769	0.165
.5397	0.210	.5131	0.193	.3798	0.173
.5455	0.176	.5152	0.180	.3852	0.156
.5471	0.180	.5194	0.136	.3869	0.171
.5503	0.171	.5214	0.131	.3900	0.176
.5520	0.166	.5256	0.157	.3916	0.199
.5536	0.150	.5277	0.141	.3963	0.213
.5575	0.174	.5319	0.142	.3979	0.241
.5598	0.197	.5339	0.156	.4008	0.268
.5672	+0.216	.5381	+0.171	.4022	+0.270

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2435093		2435093		2436477	
.3804	+1.796	.4856	+1.907	.6138	+0.905
.3886	1.643			.6249	0.948
.3895	1.626	2436477		.6346	+1.022
.3977	1.476	.5096	+0.773		
.3985	1.457	.5195	0.752	2436485	
.4060	1.433	.5279	0.748	.3658	-0.156
.4139	1.441	.5357	0.755	.3695	0.175
.4231	1.495	.5445	0.752	.3712	0.175
.4414	1.588	.5545	0.776	.3759	0.222
.4505	1.684	.5637	0.781	.3780	0.231
.4520	1.709	.5724	0.792	.3801	0.217
.4612	1.718	.5810	0.777	.3843	0.231
.4742	1.831	.5900	0.811	.3863	0.170
.4848	+1.915	.6027	+0.869	.3884	-1.162

Table 14 (cont.)

J.D	ΔB	J.D	ΔB	J.D.	ΔB
2436485		2436495		2436530	
.3926	−0.118	.5431	+0.810	.5087	−0.082
.3957	0.138	.5451	0.765	.5106	0.088
.4016	0.063	.5514	0.570	.5157	0.022
.4061	0.031	.5535	0.472	.5176	−0.001
.4082	−0.001	.5576	0.371		
.4642	+0.288	.5597	0.281	2436541	
.4660	0.302	.5618	+0.225	.4407	+0.936
.4719	0.314	.5826	−0.110	.4420	0.918
.4740	0.342	.5847	0.195	.4449	0.964
.4759	0.361	.5892	0.240	.4463	0.956
.4803	0.370	.5913	0.237	.4482	0.945
.4822	0.376	.5934	0.236	.4517	0.932
.4840	0.406	.5986	0.198	.4532	0.973
.4887	0.440	.6007	0.184	.4548	0.985
.4907	0.441	.6035	0.182	.4590	0.950
.4924	0.434	.6087	0.159	.4605	0.967
.4961	0.479	.6111	0.127	.4623	0.995
.4978	0.465	.6132	0.135	.4657	0.993
.4997	0.478	.6181	0.075	.4720	1.016
.5069	0.467	.6205	0.078	.4734	1.016
.5090	0.491	.6281	0.018	.4835	0.993
.5110	0.518	.6302	−0.008	.4875	0.985
.5150	0.514			.4897	1.004
.5169	0.516	2436530		.4913	0.957
.5191	0.540	.4386	+0.812	.4943	0.932
.5244	0.570	.4427	0.729	.4961	0.929
.5266	0.588	.4446	0.677	.4975	0.918
.5285	0.577	.4479	0.581	.5014	0.786
.5337	0.592	.4495	0.470	.5034	0.789
.5366	+0.615	.4510	0.446	.5050	0.677
		.4541	0.323	.5090	0.662
2436495		.4557	0.294	.5110	0.599
.4820	+0.884	.4574	0.238	.5125	0.541
.4861	0.890	.4610	0.186	.5156	0.427
.4903	0.919	.4625	0.144	.5172	0.366
.4924	0.908	.4645	0.114	.5187	0.336
.4945	0.911	.4684	+0.037	.5221	0.249
.4986	0.941	.4702	−0.020	.5236	0.224
.5007	0.974	.4719	0.068	.5251	0.202
.5028	0.971	.4755	0.163	.5285	0.119
.5070	0.959	.4773	0.164	.5304	0.099
.5090	0.957	.4791	0.182	.5321	+0.022
.5153	0.975	.4833	0.209	.5352	−0.075
.5174	0.954	.4852	0.195	.5368	0.072
.5195	0.981	.4873	0.207	.5388	0.124
.5236	0.978	.4915	0.216	.5446	0.165
.5257	0.950	.4933	0.193	.5464	0.197
.5278	0.948	.4954	0.191	.5496	0.237
.5320	0.954	.4996	0.157	.5512	0.210
.5347	0.931	.5016	0.142	.5528	0.204
.5368	0.903	.5034	0.119	.5565	0.194
.5410	+0.831	.5068	−0.092	.5589	−0.158

Table 14 (cont.)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2436541		2440528		2443124	
.5607	−0.148	.4999	+0.179	.3446	+0.507
.5663	0.128	.5020	0.148	.3460	0.452
.5680	0.086	.5062	0.052	.3498	0.344
.5699	0.082	.5082	+0.010	.3515	0.289
.5742	0.048	.5124	−0.117	.3549	0.241
.5759	0.063	.5145	0.155	.3569	0.191
.5774	0.038	.5187	0.209	.3598	0.129
.5817	0.018	.5249	0.245	.3612	0.087
.5844	−0.018	.5270	0.227	.3647	+0.014
.5861	+0.015	.5312	0.219	.3667	−0.031
		.5332	0.219	.3700	0.139
2440528		.5374	0.199	.3716	0.146
.4603	+0.960	.5395	−0.177	.3748	0.207
.4624	0.965			.3762	0.209
.4666	0.961	2443124		.3790	0.206
.4687	0.920	.3251	+0.924	.3804	0.179
.4728	0.897	.3265	0.881	.3845	0.183
.4749	0.837	.3303	0.852	.3862	0.189
.4805	0.741	.3320	0.825	.3893	0.151
.4826	0.720	.3348	0.768	.3950	0.134
.4867	0.518	.3368	0.712	.3973	0.110
.4888	0.478	.3399	0.663	.4001	0.085
.4937	0.313	.3416	+0.583	.4015	−0.044
.4958	+0.253				

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2440528		2440528		2440528	
.4617	+0.849	.4923	+0.205	.5180	−0.292
.4680	0.843	.4951	0.080	.5201	0.301
.4721	0.848	.4992	+0.061	.5242	0.298
.4742	0.803	.5013	−0.005	.5263	0.291
.4798	0.703	.5055	0.025	.5305	0.306
.4819	0.661	.5076	0.045	.5326	0.290
.4860	0.456	.5117	0.163	.5367	0.309
.4881	+0.402	.5138	−0.250	.5388	−0.297

Table

Photographic observations of AR Per

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2428459		2428459		2428459	
.5879	10.76	.6025	10.82	.6171	10.84
.5900	10.74	.6046	10.83	.6192	10.87
.5921	10.77	.6067	10.82	.6212	10.89
.5942	10.78	.6087	10.83	.6233	10.92
.5962	10.80	.6108	10.86	.6254	10.90
.5983	10.81	.6129	10.87	.6275	10.91
.6004	10.82	.6150	10.93	.6296	10.87

Table 15 (cont.)

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2428459		2428545		2428545	
.6317	10.94	.4651	10.35	.5213	10.58
.6337	10.89	.4672	10.31	.5234	10.60
.6358	10.92	.4693	10.31		
.6379	10.91	.4720	10.29	2428547	
.6400	10.94	.4776	10.26	.4628	11.35
.6421	10.92	.4797	10.31	.4649	11.30
.6476	11.08	.4818	10.30	.4670	11.33
.6497	11.03	.4838	10.30	.4691	11.34
.6518	11.07	.4859	10.32	.4711	11.37
.6539	11.09	.4880	10.34	.4732	11.38
		.4901	10.30	.4753	11.35
2428545		.4922	10.30	.4795	11.36
.4443	11.00	.4943	10.39	.4816	11.37
.4463	11.02	.4984	10.38	.4836	11.36
.4484	10.82	.5005	10.48	.4857	11.38
.4505	10.78	.5026	10.50	.4878	11.35
.4526	10.78	.5047	10.50	.4899	11.33
.4547	10.66	.5088	10.49	.4961	11.36
.4568	10.64	.5109	10.53	.4982	11.40
.4588	10.50	.5130	10.50	.5003	11.41
.4609	10.44	.5151	10.49	.5024	11.40
.4630	10.40	.5175	10.59		

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TUDOMÁNYOS AKADÉMIA
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MITTEILUNGEN
DER
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DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

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SPACE DISTRIBUTION OF STARS AND DIFFUSE MATTER IN THE REGION OF IC 1396

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SPACE DISTRIBUTION OF STARS AND DIFFUSE MATTER
IN THE REGION OF IC 1396

ABSTRACT

Space distribution of stars and the interstellar absorbing medium have been investigated in a field of 19.5 square degrees containing the galactic cluster IC 1396 by means of objective prism spectral classification and photographic UBV photometry. This open cluster is a central region of the large OB association Cep OB2 and the field itself is the densest part of the association. Distribution of the absorbing material is very irregular in the region. The average absorption at the distance of the association is $1^{m}.5$. In addition to the earliest type stars, late B and early A stars also show some concentration at the distance of the association.

INTRODUCTION

OB associations are known to be groups of the earliest type stars associated with a large amount of interstellar gas and dust. They are considered to be places of star formation. OB stars within an association probably do not form a gravitationally bound group; they seem to expand (*Ambartsumian* 1949). It is natural to suppose that OB associations contain stars of lower mass too, for they may arise during the same processes as OB stars. However, large volumes and low spatial densities of the associations make it difficult to find the possible fainter association members. It would be interesting to investigate what kinds of stars other than OB stars originate from OB associations and what sort of relationship exists between space densities and kinematics of different type of stars within an association. The answers to these questions might well help us to understand the processes by which associations come into being. This is of special interest in the case of the local spiral arm which is probably not a density-wave arm (*Lin* et al. 1969) so there must be a triggering mechanism of star formation different from the galactic shock accompanying the density wave.

The present work is based on the observational material gathered from the field around IC 1396 in the period 1969-1972 at Konkoly Observatory. The aim of this study is to search for stars having lower absolute magnitude than OB stars in the association Cep OB2 by investigating the stellar space density along the line of sight in the direction of the association.

Association Cep OB2 lies near the outer edge of the local spiral arm. Its galactic coordinates are: $l=97^{o}-107^{o}$; $b=+2^{o}-+8^{o}$. It contains two galactic clusters: IC 1396 and NGC 7160. IC 1396 is an O-type cluster (*Markarian*, 1951) embedded in a large HII region (*Markarian*,1957); NGC 7160 is a very small B1 type cluster (*Markarian*, 1953). These clusters seem to be the centres of the expansion (*Ambartsumian*,1959). The average distance of the association from the Sun is 830 pc (*Simonson* , 1968). Because of the large dimensions and low spatial density of the stars its structural investigations in the optical wavelenghts were restricted to the most luminous stars. I have tried to extend the study to the fainter stars in the densest part of the association. The dark material is concentrated in the same volume as the association stars so it reduces the limiting distance of the study. The observational material available here allows a rough mapping of the space distribution of the absorbing clouds as well as the plotting of the distribution of different type stars in the direction of this part of the association.

OBSERVATIONAL DATA

a) Spectral classification

Spectral classes of stars up to 13^{m} in B colour have been derived from objective prism spectra obtained from four objective prism plates. These plates were taken with aid of the 60/90/180cm Schmidt telescope at Konkoly Observatory using an objective prism giving a dispersion of 580 A/mm at Hγ. One exposure was taken on Kodak OaO plate with an exposure time of 24^{m}, and three were taken on Kodak IIIa-J plates with the exposure times 120^{m}, 96^{m} and 60^{m}. The widening was 18" on each plate (i. e. 0.16mm). Classification criteria are virtually the same as those described by *Nassau* and *Seyfert* (1946). The number of classified stars is 843.

Sharpness of the classification criteria necessitates a dividing of classified stars into the following groups: earlier than B3; B3-B7; B8-A1; A2-A6; A7-F1; F2-F8; G0-G8; K-M. The numbers of stars in each of the different spectral groups are given below:

earlier than B3	38
B3-B7	63
B8-A1	203
A2-A6	112
A7-F1	75
F2-F8	151
G0-G8	81
K0-M0	120

In principle, it is possible to distinguish the different luminosity classes of G-K stars at such a dispersion (*Seitter*, 1975) but as most K stars are between $7-9^m$ they are somewhat overexposed on our plates. Because of this, their two-colour diagrams and distance modulus - colour excess diagrams were used estimating their luminosity classes (see below).

b) Photographic photometry

UBV photographic magnitudes of stars having objective prism spectra have been determined. Five plates were taken in each colour. The plate - filter combinations and exposure times were the following:

	plate	filter	exposure time
U	Kodak 103a-O	Schott UG1 2mm	10^m
B	Kodak 103a-O	Schott GG13 "	4^m
V	Kodak 103a-D	Schott GG14 "	4^m

The photometric scale based on photoelectric magnitudes of 14 stars of the cluster IC 1396, was determined by B. A. Balázs at Kitt Peak National Observatory in 1967-68 using 36 and 16 inch telescopes. The transformation equations between the instrumental and international colour systems are the following:

$$V_{instr} = V + 0.07(B-V) - 0.07$$

$$B-V_{instr} = 1.04(B-V) - 0.03$$

$$U-B_{instr} = 0.91(U-B) - 0.11(B-V) + 0.01$$

The plates were measured using the Becker type iris photometer of the Konkoly Observatory. Mean errors of the photometry: $\pm 0\overset{m}{.}06$ for both V and B; $\pm 0\overset{m}{.}08$ for U. These errors are independent of the magnitude. In addition to these random errors the ultraviolet filter had a field error in a restricted area. Figure 1

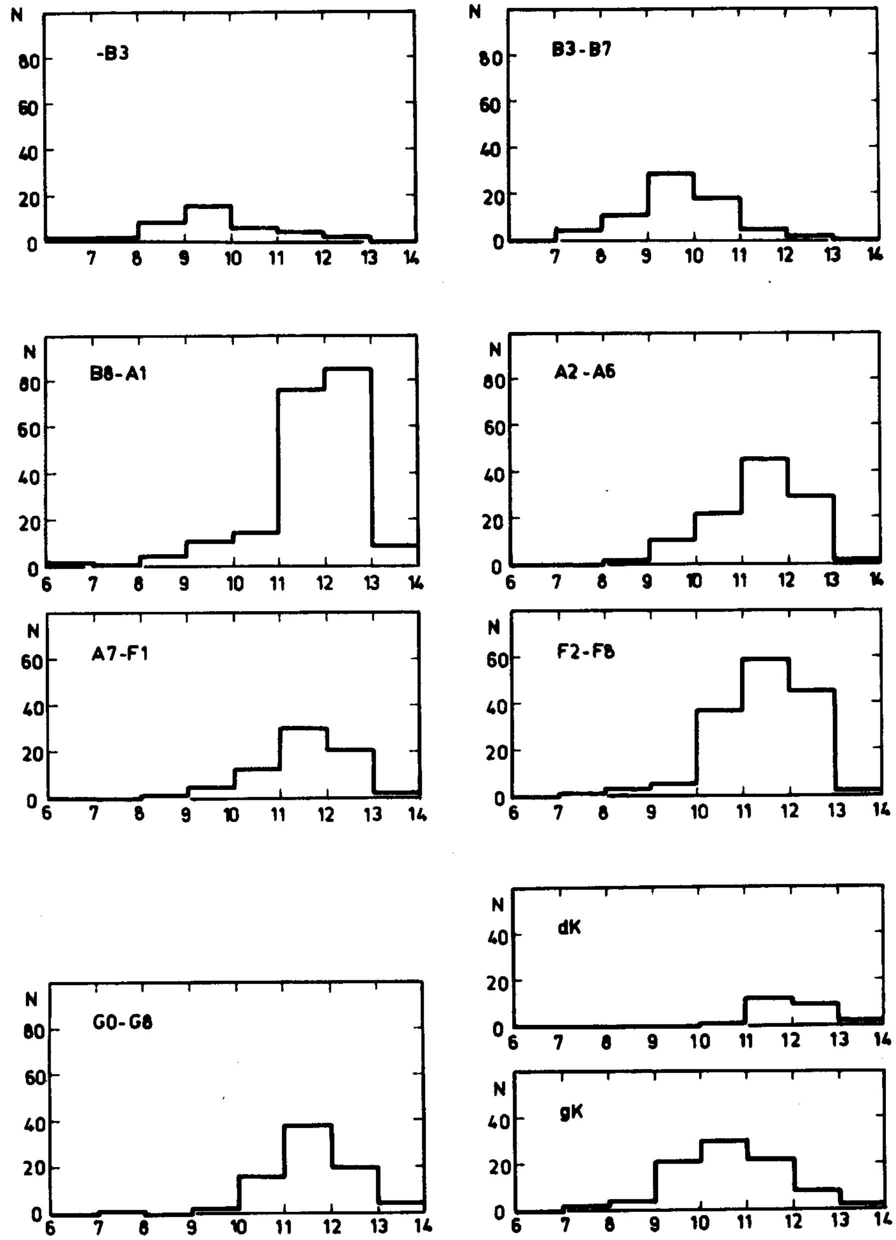

N
-B3
B3-B7
B8-A1
A2-A6
A7-F1
F2-F8
G0-G8
dK
gK
0
20
40
60
80
6 7 8 9 10 11 12 13 14

Figure 1.

shows the distribution of the stars of different spectral groups as a function of the apparent B magnitude. A comparison of the present spectral classification with the HD spectral types can be seen in Fig. 2.

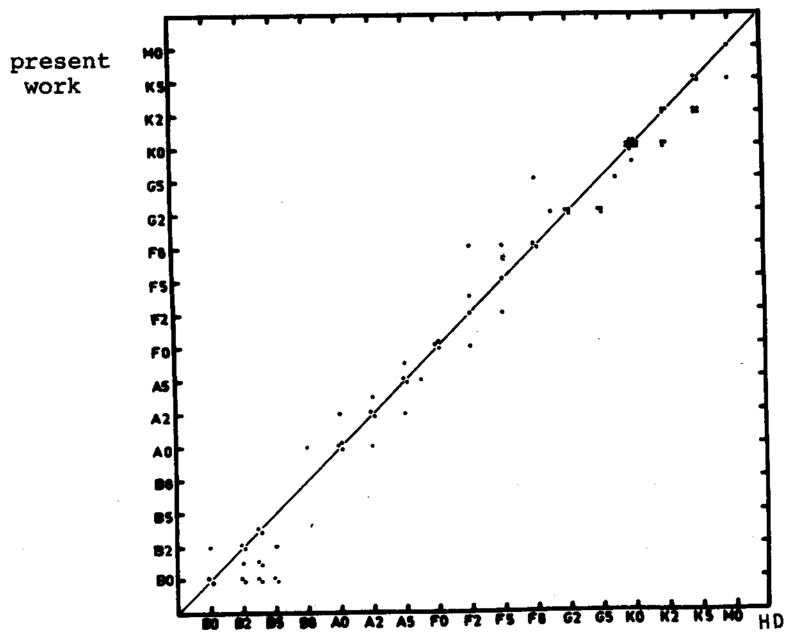


Figure 2.

INTERSTELLAR REDDENING AND ABSORPTION

Apparent stellar density strongly changes within the field presumably due to dark foreground clouds. According to the surface stellar density the field can be divided into six parts (Fig. 3). The surfaces of these parts (A), the number of stars (N) and the surface stellar densities (σ) are given in the following table:

Part	A(□°)	N	σ(star/square degree)
1	2.3	94	40.84
2	5.3	148	27.92
3	1.6	85	53.12
4	2.0	62	31.09
5	5.8	359	61.81
6	2.6	90	34.61

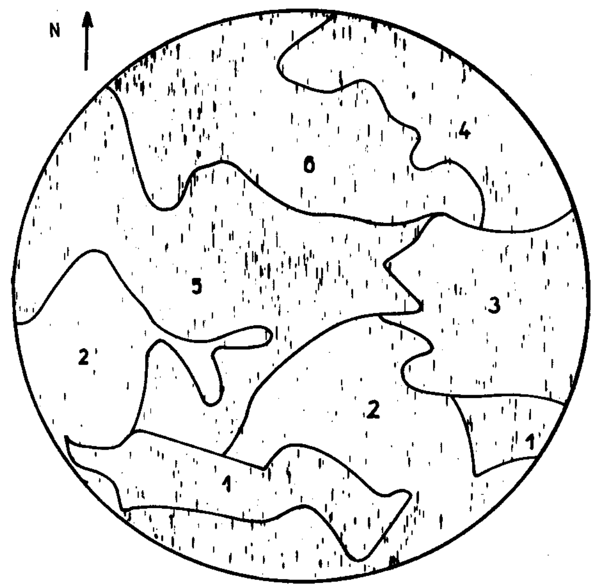


Figure 3.

Distance modulus - E_{B-V} colour excess diagrams have been drawn for each part separately. This has been done using the BO-F8 stars and assuming that all of these belong to the main sequence (Fig. 4). Absolute magnitudes and intrinsic colours of the spectral types were taken from *Allen* (1973). There is a strong reddening everywhere except in region 5 which contains the cluster IC 1396. In the region of the cluster the dispersions of the colour excesses are large; these dispersions are caused by a large number of small dark clouds having different absorptions (*Shajn* and *Gaze*, 1951).

An interesting part of the field is region 3, situated east of the cluster. In this region the reddening is about $0^{m}.8$, as in the almost starless region 2, but the surface stellar density is nearly as high as in the region of the cluster.

In the literature there are different values of the total to selective absorption for this region. *Johnson* (1965) found R=5.4 by infrared photometry of the μ Cephei; in addition, he obtained R=4.8 by applying the variable extinction method for the neigh-

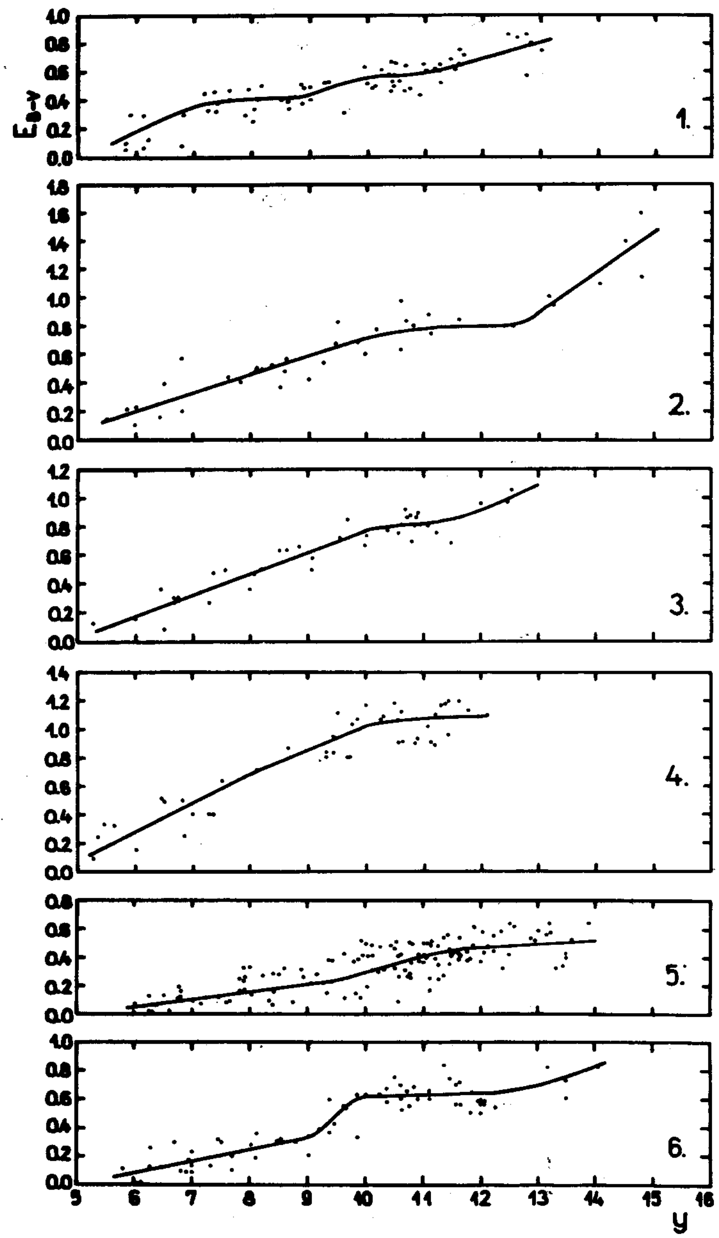


Figure 4.

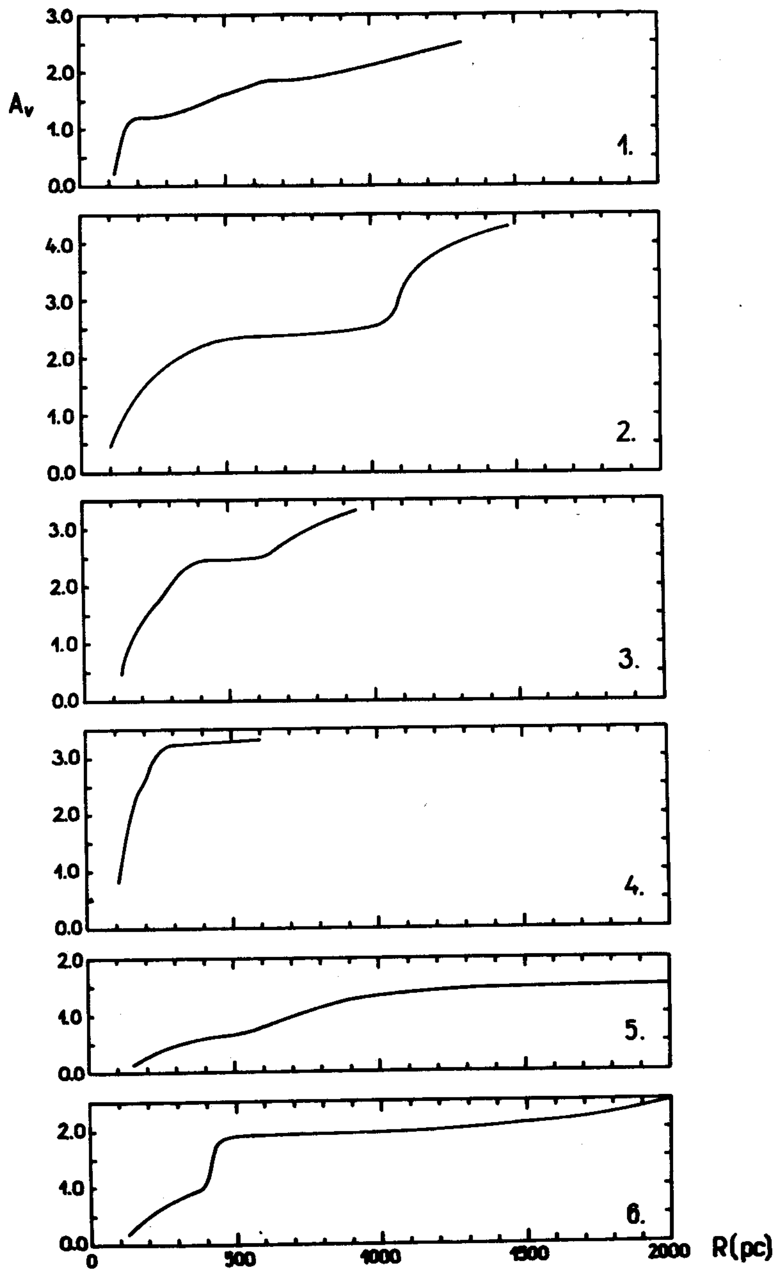


Figure 5.

bouring association Cep OB3. *Simonson* (1968) showed that neither of these methods is suitable for determining R in this region; he also suggested that there is no reason to assume an abnormally high value of R. The value R=3.0 has been adopted in this work.

Figure 5 shows the total absorption, a_V as a function of the distance assuming R=3.0 for each region separately. Except for region 5, there is a strong foreground absorption everywhere, caused by clouds situated 200-400 pc from the Sun. In the region of the cluster this method gives only a very smoothed picture of the dark material. The dust clouds seem to be concentrated between 600-1100 pc and the reddening changes almost from star to star.

The strong absorption makes possible a rough division of the late type stars into different luminosity classes (*Trumpler* and *Weaver*, 1953), if they are put onto the $y-E_{B-V}$ diagrams obtained from the main sequence stars. According to this estimation 64 G type stars are dwarfs, 14 are giants; in addition, 27 K type stars are dwarfs and 93 are giants. It is not possible to give a more accurate estimation of the absolute magnitudes of these giants as the absorption does not increase beyond 1200 pc; thus, this method gives only a lower limit of their luminosities and distances.

SPACE DISTRIBUTION OF STARS

Having evaluated the interstellar absorption it becomes possible for one to solve the convolution equation

$$A(m) = \int_{-\infty}^{+\infty} D(y)\Phi(m-y)dy,$$

separately for each spectral class. Here A(m) is the number of stars in the apparent magnitude interval $(m-\delta m, m+\delta m)$; D(y) is the number of stars between distance moduli $y-\delta y$ and $y+\delta y$; and $\Phi(M=m-y)$ is the luminosity function of a given spectral and luminosity class. The apparent magnitudes m and the distance moduli y are corrected for the absorption. To solve the equation the matrix method described by *Dolan* (1974) was used. At the absolute magnitudes of B8-A1 stars the absorption difference between the different parts of the field may cause noticeable differences between the distance limits in them. So it is not possible to deal with them together. Since it is only in region 5 that there are sufficient stars for the reliable evaluation of the equation, the densities of stars later than B7 have been calculated only for this part of the field. In the case of stars later than A1 the plate limit is within 500 pc even at the smallest absorption.

The space distribution of the three spectral groups earlier than A2 are shown in Fig. 6, 7 , 8. Straight lines show the field star densities assuming that these are functions solely of the

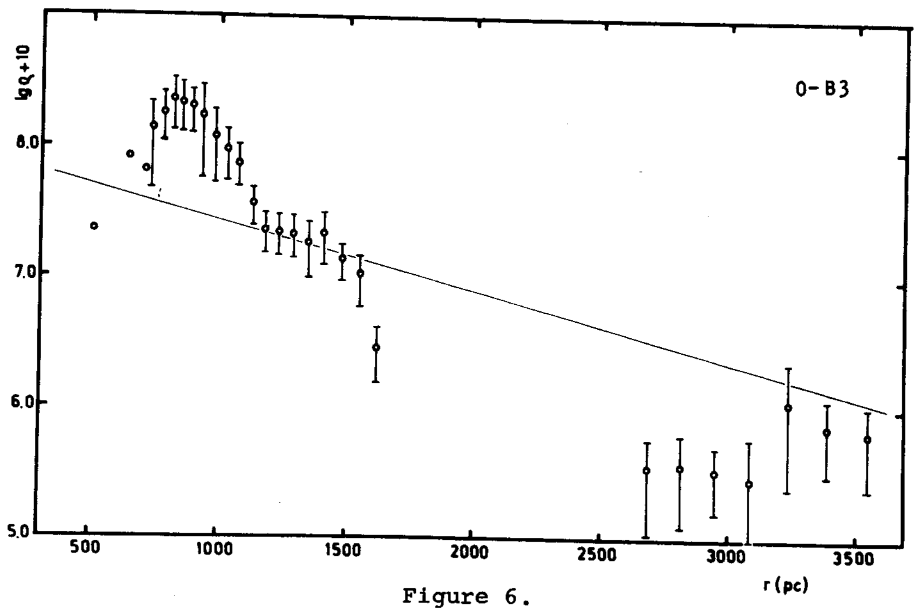


Figure 6.

distance from the galactic plane (*Allen*,1973) . Absolute values of the field star densities have been estimated in the case of stars earlier than B3 and B3-B7 from the shape of the density curve, and from *van Rhijn*'s (1955)data in the case of B8- A1 stars. Density of stars earlier than B3 shows a maximum between 2500 and 3500 pc; it may well be that these stars form the upper edge of the Perseus spiral arm. The line of sight goes 300 pc above the galactic plane at this distance. Stars of the association are concentrated between 600 and 1100 pc. B3-B7 stars also show a concentration between the same distance limits. It is more difficult to decide whether or not there is a concentration of B8-A1 stars because the plate limit is about 1150 pc. With the assumption that the space density of the field A0 stars is nearly constant at a given galactic longitude and distance from the galactic equator an extrapolation has been made for its value from *van Rhijn*'s (1955) data obtained at $l=100^{\circ}$, $b=+7^{\circ}$. The gradient of the curve indicates that there is a concentration within 1100 pc.

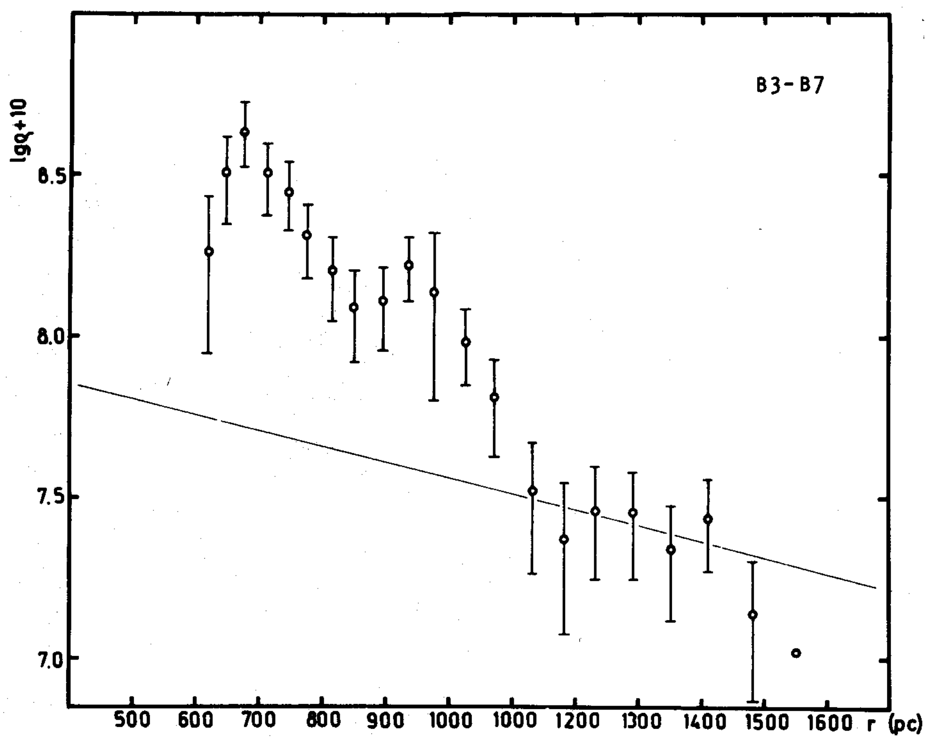


Figure 7. Space distribution of B3-B7 stars

Space density units are given as stars/10^3 pc^3. Error bars have been calculated on the assumption that the star number in every field segment has the statistical error $N^{1/2}$ (*Dolan*, 1974)

Figures 9a, b, and c show respectively the densities of A2-A6, A7-F1 as well as F2-F8 stars. The density of A2-A6 stars is nearly constant within the plate limit in this direction, whereas the densities of the A7-F1 as well as the F2-F8 stars decrease in accordance with other observations (*McCuskey*, 1956).

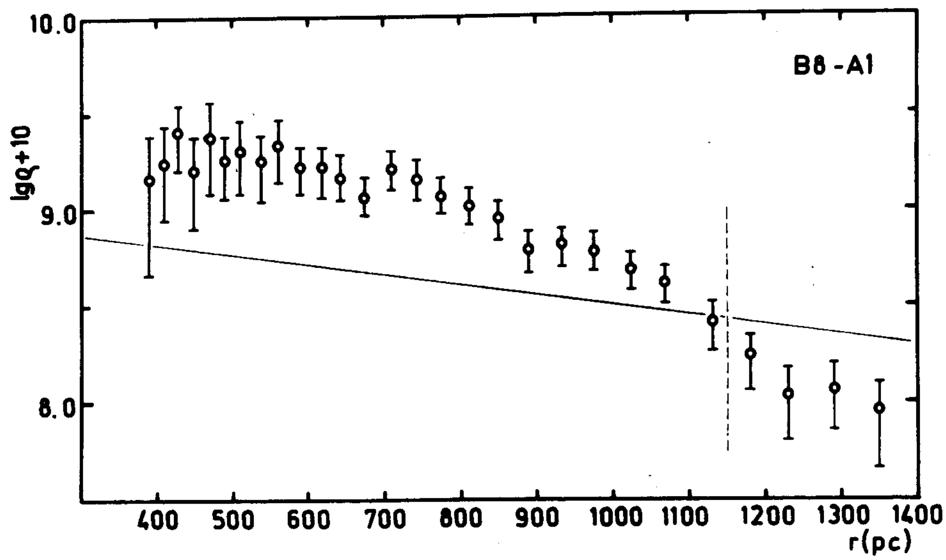
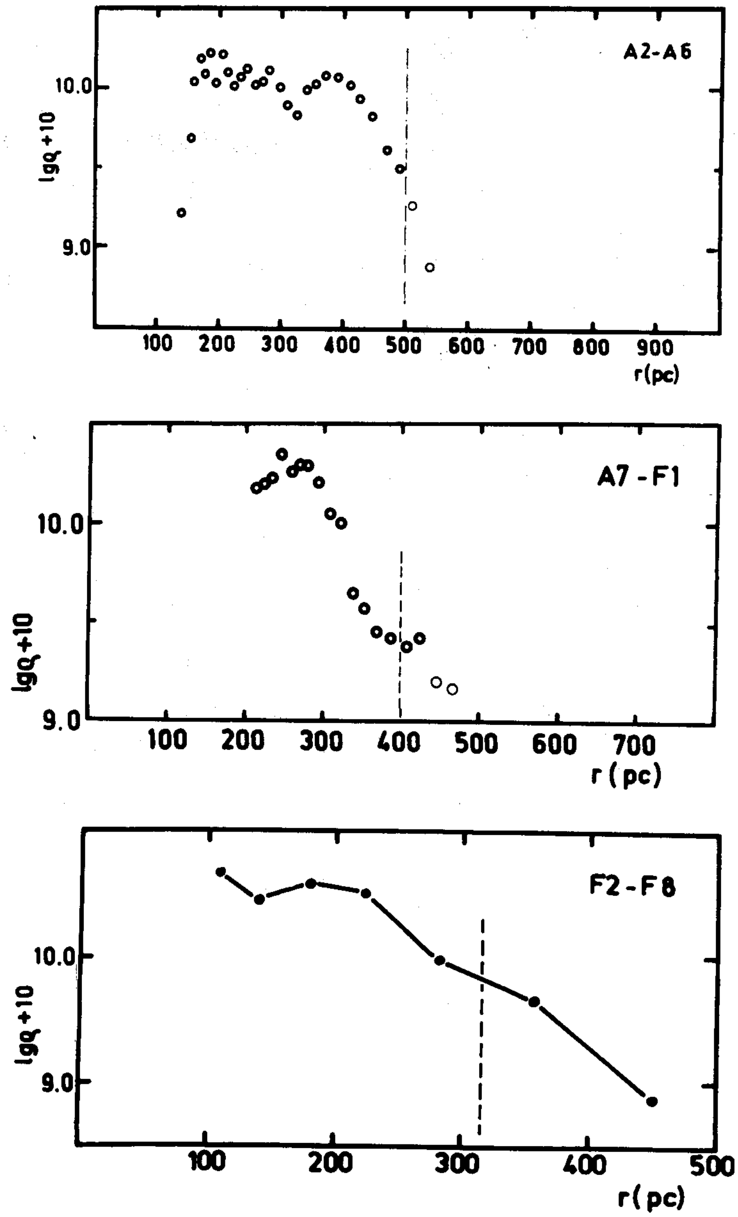


Figure 8. Space distribution of B8-A1 stars. The dashed line indicates the plate limit.

There are two possibilities for estimating the distance of K giants assuming that all they belong to the same luminosity class. On the basis of the available data, including the literature, it is not possible to decide whether this assumption is true or not.

The first possibility is a statistical parallax calculation utilizing the available proper motion data. The results obtained in this way are independent of the photometry. The SAO Catalogue contains the proper motions of 36 K type giants of our field. Their apparent magnitudes are between $8\overset{m}{.}0$ and $9\overset{m}{.}5$. From these data r=724 pc has been found to be the average distance. It implies an absolute magnitude $M_V=-2\overset{m}{.}3$, so these stars are bright giants and they lie almost at the distance of the association.

The other method of distance estimation is based on the assumption that these stars are of the third luminosity class, like the largest percentage of the late type giants of the galactic field. Then their absolute magnitudes are about $+1\overset{m}{.}0$. In this



Figures 9a, b, c. Space distribution of A2-A6, A7-F1 and F2-F8 stars. Dashed lines indicate the plate limit.

case all these stars are nearer than 500 pc. Their two-colour diagram (Fig. 10) confirms this assumption as being the average colour excess in B-V about $0^m_{\cdot}2$, whereas at a distance 724 pc it ought to be at least $0^m_{\cdot}5$.

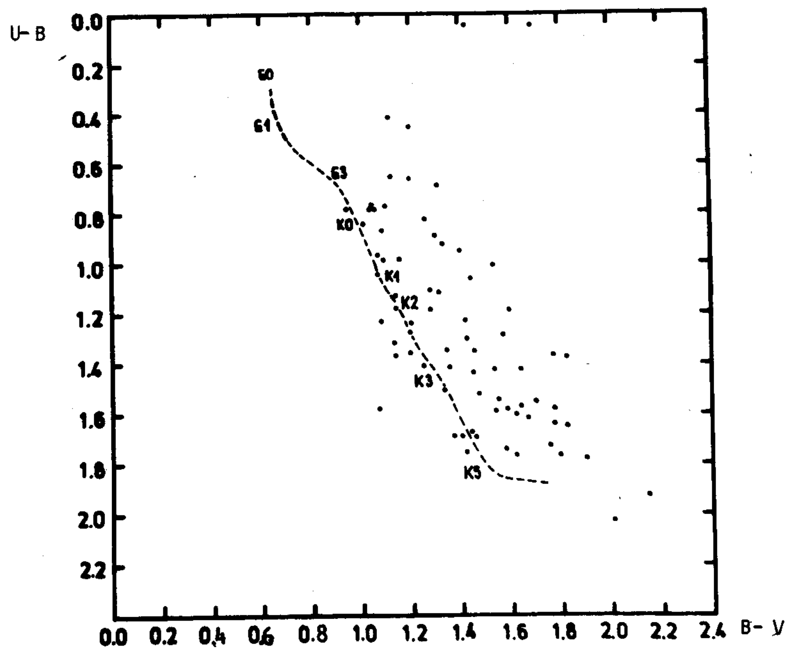


Figure 10. Two-colour diagram of K giants. The dashed line indicates the unreddened diagram of the third luminosity class taken from *Golay* (1974).

These two contradictory results indicate that either the kinematic or photometric data contain some systematic error, or one of our preliminary assumptions is not true (in particular, that they do not belong to the same luminosity class). So neither of the above estimations can be accepted without exact spectroscopic determination of the luminosity classes.

CONCLUSIONS

The distribution of stars in space shows that not only are OB stars concentrated at the distance of the association, but later B stars as well. There are, however, some signs of concentration of B8-A1 stars too, even though this is not really significant. In particular, the slope of the density curve shows that concentration does exist within 1100 pc. In the distribution of stars later than A1 the association cannot be traced because of the high foreground absorption and the limiting magnitude of the spectral classification. Due to the high interstellar absorption the study of B8-A1 stars has been restricted to an area of 5.8 square degrees including the cluster whose angular diameter is about one degree (*Trumpler*, 1930; *Collinder*, 1931; *Markarian*, 1951). Investigations of space distribution of stars in galactic clusters indicate the existence of extended coronae, whose diameters are 2.5-10 times larger than those of the clusters (*Kholopov*,1968). The central part of a cluster contains the brightest cluster members, whereas the corona mainly consists of fainter stars. So it is possible that A0 or the later association members - if they exist - form a gravitationally bound system as the corona of the IC 1396. *Reddish* (1967) has found this feature to be true for the association Cyg OB2; *Kholopov* (1974) also claims that the expansion is the property of only the earliest type stars. The surface density of B8-A1 stars in region 5 is nearly constant; their distribution makes it difficult to recognize the core of the cluster (Fig.11). This figure shows as well that the

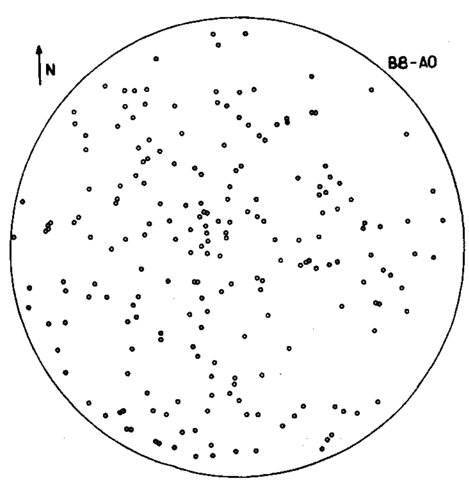


Figure 11.

surface density of B8-A1 stars in region 3 is nearly the same as in the region of the cluster. A0 stars in part 3 have a reddening of about $0\overset{m}{.}9$, they all are behind a dust cloud. The constant surface density indicates that the high concentration of the stars continues in this direction with a dark foreground cloud in front of it. Nearly in the direction of the axis of this elongated concentration are the NGC 7160, μ Cephei and numerous bright stars. The whole association seems to have an elongated shape whose axis inclines to the galactic plane at 20°.

ACKNOWLEDGEMENTS

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TABLE

Spectra and UBV data of the survey stars

No.	Sp.	V	B-V	U-B	remarks
1	A7	10.49	1.05	0.13	
2	B8	9.96	0.62	0.12	BD $+54^{o}2560$
3	FO	10.33	0.73	0.02	
4	BO	8.89	0.52	-0.68	BD $+54^{o}2575$
5	GO	11.50	0.71	-0.03	
6	K2	9.14	1.28	1.19	BD $+54^{o}2579$
7	A5	8.12	0.55	-0.33	BD $+54^{o}2581$
8	K2	8.37	1.62	1.60	BD $+54^{o}2585$
9	B5	9.27	0.42	-0.22	BD $+54^{o}2587$
10	AO	10.14	0.67	0.27	BD $+54^{o}2589$
11	AO	9.60	0.08	0.26	BD $+54^{o}2598$
12	B2	9.04	0.52	-0.44	BD $+54^{o}2611$
13	AO	11.51	0.80	0.63	
14	AO	11.29	0.63	0.54	
15	BO	8.27	0.74	-0.44	BD $+54^{o}2607$
16	A7	11.42	0.60	0.07	blend
17	AO	11.82	0.74	0.53	
18	F6	9.87	0.66	-0.10	BD $+54^{o}2601$
19	A5	8.93	0.57	-0.26	BD $+54^{o}2593$
20	B8	11.08	0.66	0.28	
21	AO	11.28	0.99	0.22	blend
22	AO	10.22	1.93	1.66	
23	FO	10.04	1.39	0.58	
24	A3	8.95	0.43	-0.05	BD $+54^{o}2573$
25	FO	10.73	0.63	0.12	BD $+54^{o}2569$
26	F8	9.62	1.55	0.97	
27	B3	11.93	0.65	-0.12:	
28	B8	10.96	0.61	0.20	
29	AO	10.56	0.69	-0.05	BD $+54^{o}2556$
30	F2	9.48	1.80	1.40	BD $+54^{o}2554$
31	F5	10.30	0.95	-0.02:	BD $+54^{o}2564$
32	K5	9.05	2.16	2.28	BD $+54^{o}2557$
33	G8	10.11	0.93	0.16	
34	A2	8.93	0.45	-0.25:	BD $+54^{o}2567$
35	F8	10.70	0.72	0.03	
36	B8	10.46	0.58	-0.17	BD $+54^{o}2573$
37	A4	10.78	0.46	0.25:	
38	B8	10.86	0.78	0.12	
39	A2	10.53	0.68	0.18	
40	A7	10.67	0.72	0.38	
41	KO	7.54	1.16	0.43	BD $+54^{o}2590$
42	KO	7.85	1.20	0.45:	BD $+54^{o}2597$
43	AO	10.69	0.60	0.18	BD $+54^{o}2600$
44	A5	10.38	0.62	0.46	
45	F2	10.64	0.31	0.16	BD $+54^{o}2605$
46	AO	11.04	0.31	-0.07	
47	AO	11.81	0.18	0.15	
48	AO	10.68	0.44	0.16	
49	AO	10.50	0.47	0.18	
50	AO	11.54	0.57	0.16	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
51	B5	9.33	0.49	-0.52	BD $+54^{o}2610$
52	AO	10.89	0.58	0.43	
53	A2	10.15	0.70	-0.01	BD $+54^{o}2608$
54	B9	8.14	0.44	0.12	BD $+54^{o}2606$
55	G6	10.64	0.65	0.02	
56	G4	9.73	0.75	0.02	BD $+54^{o}2594$
57	BO	10.74	0.64	-0.46	BD $+54^{o}2592$
58	AO	11.24	0.53	0.09	
59	FO	11.36	0.66	0.16	
60	B2	10.26	0.62	-0.30	BD $+54^{o}2588$
61	B8	11.72	0.88	-0.25	
62	B8	11.70	0.60	-0.43	
63	B7	10.21	0.49	-0.04	BD $+54^{o}2578$
64	A2	10.73	0.52	0.12	
65	B5	10.44	0.37	-0.21	
66	FO	11.05	0.91	0.42	
67	AO	11.62	0.86	0.24	
68	AO	11.38	0.98	-0.11	
69	FO	10.60	0.65	0.11	
70	KO	7.58	1.21	0.66	BD $+54^{o}2555$
71	AO	11.41	0.83	0.30	
72	A7	11.16	0.73	0.23	
73	A2	10.54	0.46	0.27	BD $+54^{o}2552$
74	A7	10.68	0.74	-0.06	BD $+54^{o}2548$
75	AO	10.30	0.82	-0.02	BD $+54^{o}2546$
76	F8	10.57	0.88	-0.07	BD $+54^{o}2549$
77	F2	10.55	0.70	-0.01	BD $+54^{o}2550$
78	B9	6.31	0.14	--	BD $+54^{o}2544$
79	AO	10.42	0.80	-0.13	BD $+54^{o}2539$
80	F4	10.86	0.84	-0.20	
81	K5	8.88	1.70	0.04	BD $+55^{o}2585$
82	KO	7.99	1.53	1.05	BD $+54^{o}2538$
83	F4	10.46	0.89	-0.06	BD $+55^{o}2590$
84	K2	10.03	1.47	0.31	BD $+54^{o}2571$
85	FO	12.11	0.55	0.05	blend
86	B5	11.36	0.45	-0.23	
87	K	8.84	1.36	1.41	BD $+54^{o}2582$
88	FO	10.39	0.54	0.03	BD $+54^{o}2584$
89	K	10.03	1.48	1.51	
90	AO	11.12	0.44	0.40	
91	F7	11.14	0.90	-0.20	
92	GO	9.53	0.76	0.16	BD $+54^{o}2609$
93	AO	11.36	0.22	0.31	blend
94	AO	9.81	0.47	0.35	BD $+55^{o}2622$
95	A2	11.00	0.50	0.33	
96	FO	9.47	0.36	-0.08	
97	G	10.86	0.79	0.32	
98	G8	10.74	0.79	0.14	blend
99	G2	9.80	0.66	0.05	BD $+54^{o}2612$
100	AO	11.90	0.38	0.01	
101	B5	7.89	0.38	-0.52	BD $+54^{o}2589$

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
102	F2	10.70	0.52	0.22	blend
103	A0	9.25	0.27	-0.01	BD $+55^{\circ}$2610
104	A5	8.95	0.57	-0.09	blend
105	A4	9.90	0.26	0.02	BD $+55^{\circ}$2602
106	F0	11.02	0.84	-0.18	
107	F2	11.20	0.87	-0.30	
108	K	9.74	2.07	2.09	
109	K5	9.08	2.17	1.92:	BD $+55^{\circ}$2581
110	K0	9.43	1.31	0.69	BD $+55^{\circ}$2589
111	G8	10.74	0.83	0.54	
112	K0	7.72	1.42	1.22	BD $+55^{\circ}$2597
113	K2	8.86	1.57	1.54	BD $+55^{\circ}$2598
114	A2	10.71	0.90	0.43	
115	K2	9.28	1.64	1.62	BD $+55^{\circ}$2601
116	B8	11.13	0.60	-0.44	
117	B5	10.24	0.35	-0.11	blend
118	B7	10.76	0.48	-0.19	BD $+55^{\circ}$2606, blend
119	G2	9.47	0.70	-0.03	BD $+55^{\circ}$2608
120	A0	11.75	0.62	0.53	
121	F2	10.80	0.79	0.13	
122	G2	10.89	0.63	0.15	
123	F0	9.92	0.54	0.15	BD $+55^{\circ}$2621
124	K0	8.45	1.20	0.74	BD $+55^{\circ}$2624
125	B6	10.20	0.36	-0.02	BD $+55^{\circ}$2625
126	A0	11.18	0.48	0.40	
127	A2	9.54	0.41	0.33	BD $+55^{\circ}$2628
128	F5	9.70	0.64	0.00	BD $+55^{\circ}$2632
129	A0	11.00	0.91	0.42	
130	K7	9.25	1.70	1.55	BD $+55^{\circ}$2635
131	F0	11.35	0.61	0.45	
132	A5	10.81	0.47	0.34	BD $+55^{\circ}$2618
133	F0	10.37	0.66	0.12	
134	A0	11.84	0.90	0.50	
135	A0	10.27	1.60	1.31	blend
136	F8	10.74	0.68	0.11	
137	F5	11.36	0.73	0.12	
138	K0	10.43	0.91	--	blend
139	B8	11.41	0.72	0.25	blend
140	G0	11.35	0.91	--	blend
141	G	11.46	2.19	--	
142	F8	9.31	0.63	-0.13	BD $+55^{\circ}$2596
143	F0	11.31	0.74	0.39	
144	F0	10.75	0.79	-0.09	
145	K2	9.27	1.43	0.04	BD $+55^{\circ}$2583
146	F0	10.03	0.72	0.08	BD $+55^{\circ}$2579
147	F0	10.06	0.60	-0.08	BD $+55^{\circ}$2578
148	A0	7.86	0.59	--	BD $+55^{\circ}$2576
149	G	11.66	1.01	0.03	
150	G	10.46	1.04	0.08	
151	F8	9.97	0.62	-0.27	BD $+55^{\circ}$2574
152	G0	9.01	0.85	0.20	BD $+55^{\circ}$2577

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
153	F8	10.10	0.75	-0.06	BD +55°2582
154	A3	9.52	0.42	0.15	BD +55°2586
155	B8	9.50	0.39	0.14	BD +55°2591
156	A0	10.57	0.68	0.08	
157	B2	8.97	0.71	-0.38	BD +55°2592
158	K0	10.78	1.08	0.36	
159	G0	11.35	0.98	-0.12	
160	G0	10.56	0.72	0.14	
161	K0	9.82	1.04	0.79	BD +55°2605
162	F8	10.85	0.98	0.16	
163	A0	10.74	0.73	0.54	BD +55°2607
164	A0	12.36	0.49	-0.03	
165	F2	10.45	0.53	0.15	BD +55°2616
166	F8	10.43	0.57	-0.01	
167	A2	10.34	0.44	0.50	
168	F2	10.70	0.58	0.19	BD +55°2619, blend
169	A0	11.02	0.43	0.44	
170	F8	11.56	0.76	0.30	
171	B8	11.31	0.87	0.20	
172	F0	10.28	0.69	0.54	
173	F5	10.19	0.65	-0.20	
174	F8	10.33	0.95	0.25	blend
175	K0	9.12	1.60	1.19	BD +55°2634
176	F2	11.26	0.82	0.41	
177	B5	10.31	0.36	0.32	BD +55°2559, edge
178	B5	10.92	0.78	0.06	edge
179	A0	11.67	0.86	0.18	
180	G	11.92	0.83	--	
181	F2	12.60	0.87	0.43	blend
182	K	10.57	1.57	1.28	
183	B3	9.23	0.59	--	BD +55°2637
184	F2	9.74	0.35	0.19	BD +55°2629
185	F5	10.70	0.58	0.25	
186	A2	11.15	0.49	0.38	blend
187	A2	11.33	0.54	0.42	
188	F8	11.51	1.30	0.29	
189	K7	8.39	1.82	1.65	BD +55°2620
190	A0	11.80	0.55	0.45	
191	F8	11.20	0.74	0.05	
192	F2	10.92	0.59	0.05	
193	A0	12.63	0.90	0.11	
194	F2	10.84	0.60	0.05	
195	F8	11.56	0.77	0.00	
196	A2	11.03	0.59	0.16	
197	F5	10.74	1.60	1.34	
198	B2	10.46	0.53	-0.30	
199	F8	11.16	0.90	0.30	
200	K0	7.62	1.44	1.06	BD +55°2595
201	F6	10.27	0.67	-0.07	BD +55°2580
202	B8	11.46	0.92	0.17	
203	B3	8.62	0.78	-0.48	BD +55°2575, blend

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
204	B3	9.12	0.69	-0.31	BD +55°2569
205	FO	9.42	0.49	-0.04	BD +55°2568
206	A2	9.07	0.42	0.07	BD +55°2560
207	AO	11.16	0.97	0.27	
208	F2	10.01	0.56	-0.01	BD +55°2584
209	KO	7.77	1.42	1.76	BD +55°2587
210	AO	11.36	0.90	0.43	
211	AO	9.82	0.94	0.85	BD +55°2588
212	FO	11.63	0.86	0.22	
213	F5	10.04	0.48	0.03	
214	AO	11.79	0.70	0.22	
215	FO	11.52	0.63	0.29	
216	F2	11.43	0.71	-0.01	
217	A5	11.55	0.95	0.35	
218	K5	8.94	2.13	2.64	BD +55°2600
219	G5	9.47	1.12	0.42	BD +55°2604
220	AO	11.47	0.21	--	blend
221	A2	10.46	0.59	0.20	BD +55°2609
222	A7	11.63	0.57	0.56	
223	AO	8.93	0.35	-0.04	BD +55°2613
224	F2	10.16	0.52	0.09	BD +55°2615
225	B8	11.04	0.59	0.03	BD +55°2626
226	FO	10.67	0.48	0.31	
227	A2	11.37	0.57	0.49	
228	F2	11.06	0.60	0.14	
229	G2	10.48	0.64	0.21	
230	AO	11.96	0.34	0.19	
231	A2	11.72	0.37	0.04	blend
232	K5	10.71	1.80	1.77	blend
233	AO	12.42	0.11	--	blend
234	A7	10.66	0.40	0.17	
235	G2	11.00	0.69	-0.04	
236	G5	10.97	0.63	0.16	
237	K5	9.22	1.33	0.92	BD +55°2633
238	AO	11.53	0.79	0.18	
239	AO	11.51	0.57	0.78	
240	AO	10.87	1.17	0.84	
241	AO	11.04	0.74	0.41	
242	AO	11.22	0.65	0.37	
243	A7	11.06	0.59	0.40	
244	K	10.87	1.30	1.11	
245	A2	10.95	0.58	0.48	
246	AO	11.08	0.34	0.15	
247	AO	11.21	0.26	0.01	
248	B2	10.40	0.72	-0.31	
249	AO	11.01	0.44	0.35	
250	G5	10.70	0.82	0.39	
251	F6	10.73	0.78	0.30	
252	K2	9.87	1.47	--	BD + 56°2603
253	F4	10.94	1.04	0.13	
254	AO	11.51	0.61	-0.22	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
255	A2	10.45	0.68	0.44	BD +56°2587
256	F8	11.43	0.73	-0.12	
257	A2	10.20	0.71	0.25	BD +56°2583
258	KO	8.19	1.30	0.89	BD +56°2580
259	AO	11.67	0.87	0.58	blend
260	G2	10.95	0.93	0.37	
261	F5	10.25	0.67	0.10	
262	KO	8.05	1.26	--	BD +56°2565
263	A7	10.63	0.81	0.36	
264	AO	11.49	0.88	0.55	
265	AO	11.34	0.91	-0.05	
266	A2	10.67	0.74	0.43	
267	A4	11.52	0.82	0.35	
268	F6	11.48	0.78	-0.09	
269	F2	10.43	0.57	0.00	
270	AO	11.81	0.72	0.04	
271	AO	11.15	0.66	-0.01	
272	AO	9.42	0.09	-0.02	BD +56°2608
273	F5	10.08	0.41	-0.15	BD +56°2611
274	AO	10.86	0.31	-0.11	
275	KO	11.06	0.85	0.62	
276	B2	11.48	0.56	-0.27	
277	B6	10.11	0.34	-0.05	
278	AO	11.23	0.53	0.38	
279	G	11.48	0.92	0.44	
280	FO	9.72	0.29	0.08	BD +56°2633
281	B2	9.25	0.70	-0.35	BD +56°2640
282	AO	11.53	0.96	0.29	
283	A2	11.35	0.96	0.52	
284	F8	11.35	0.80	0.45:	
285	AO	11.58	0.85	0.49	
286	F2	11.64	0.96	0.68:	
287	AO	12.25	0.57	0.38	
288	B5	10.73	0.44	-0.26	
289	K2	10.15	1.54	1.42	
290	F8	10.40	0.85	0.74	BD +56°2639
291	K5	9.50	1.68	2.27	BD +56°2637
292	AO	11.15	0.48	0.27	
293	B3	8.92	0.29	-0.62	BD +56°2632
294	B3	9.49	0.21	-0.70	BD +56°2631
295	F8	11.27	0.43	0.25	
296	AO	11.79	0.40	0.17	
297	B7	11.05	0.25	-0.26	
298	GO	11.29	0.65	0.29	
299	B7	11.69	0.50	-0.07	
300	K	11.08	1.05	0.00	
301	K	8.61	0.94	0.79	BD +56°2624
302	AO	12.25	0.80	0.44	
303	AO	11.10	1.23	0.84	blend
304	A7	12.10	0.50	0.56	
305	F2	10.11	2.05	0.29	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
306	B2	9.21	0.23	-0.64	BD +56°2618
307	BO	7.40	0.14	-0.79	BD +56°2614
308	GO	9.80	0.51	--	BD +56°2609
309	G8	10.00	0.82	0.52	BD +56°2597
310	A4	10.98	0.73	0.43	
311	AO	11.27	0.84	0.25	
312	A2	9.51	0.59	0.11	BD +56°2591
313	B8	11.00	0.65	0.24	
314	AO	11.35	0.81	0.65	blend
315	AO	9.22	0.30	-0.02	BD +56°2585
316	AO	11.27	0.76	0.29	
317	AO	11.81	0.80	0.12:	
318	A7	10.98	0.79	0.50	
319	K	10.46	1.76	1.73	
320	A4	10.07	0.74	0.80	
321	G2	10.69	0.83	0.04	
322	B8	10.68	0.67	0.00	
323	K	9.62	1.77	1.37	BD +56°2572
324	A5	11.30	0.91	0.55	
325	A7	11.46	0.88	0.29	
326	G5	9.79	0.82	0.19	BD +56°2568
327	A7	11.37	1.71	1.27	
328	AO	11.08	0.78	0.23	
329	A5	10.22	0.60	0.09	BD +56°2566
330	B5	10.27	0.89	-0.06	
331	B8	10.89	0.94	0.03	
332	A6	10.77	1.06	0.62	blend
333	BO	11.54	0.98	0.15	edge
334	A2	11.68	0.95	0.14	blend
335	FO	11.56	0.77	0.46	
336	A2	10.83	0.67	0.40:	
337	FO	10.62	0.64	0.18	
338	FO	10.39	0.78	-0.05	
339	GO	10.02	0.56	0.18	BD +56°2579
340	F4	8.27	0.35	-0.23	BD +56°2581
341	B1	8.68	0.33	-0.83	BD +56°2584
342	F4	11.22	0.69	-0.08	
343	F2	11.15	0.47	0.10	
344	G2	10.37	0.68	0.05	
345	K	10.12	1.20	1.22	
346	F2	10.31	0.47	0.02	
347	B8	10.63	0.12	-0.09	BD +56°2612
348	G2	10.82	0.48	0.38	
349	K2	9.28	1.69	2.29	BD +56°2624
350	B8	9.98	1.07	0.97	
351	K	11.06	1.31	1.12	
352	FO	10.51	0.64	0.53	BD +56°2635
353	FO	10.58	0.57	0.51	BD +56°2638
354	F8	9.97	0.47	0.08	BD +56°2646
355	A5	10.59	0.64	0.03	BD +56°2647
356	F8	10.78	0.52	0.23	BD +56°2650

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
357	B5	10.60	0.57	-0.06	
358	F8	11.50	0.62	0.05	
359	K	10.34	1.77	1.58	
360	G8	10.05	0.64	0.53	
361	K5	9.42	1.44	2.36	BD +56°2666
362	KO	10.79	1.79	1.18	
363	F2	11.30	0.47	0.35	
364	B7	10.43	0.35	0.09	edge
365	F2	11.97	0.53	0.46	
366	G8	11.59	0.47	0.44	
367	F5	10;31	0.68	0.07	BD +56°2648
368	KO	9.85	1.14	1.13	BD +56°2644
369	AO	9.84	0.26	0.10:	BD +56°2642
370	F5	12.03	0.63	0.22	
371	A5	11.19	0.63	0.58	
372	A2	11.36	0.45	0.16	
373	B8	11.06	0.21	-0.31	
374	FO	11.65	0.55	--	
375	AO	11.48	0.36	0.43	
376·	B5	9.24	0.87	0.35	BD +56°2621
377·	A7	9.42	0.35	0.14	BD +56°2606
378·	KO	9.09	1.07	0.97	BD +56°2619
379·	B8	10.57	0.34	-0.04	
380·	A2	10.71	0.58	0.37	
381·	FO	10.57	0.40	0.06	
382·	K	10.89	1.54	1.59	
383·	FO	11.70	0.69	0.41	
384·	BO	6.90	0.19	-0.72	BD +57°2374
385·	F2	9.20	0.43	0.03	BD +56°2600
386·	F2	9.65	0.41	-0.02	BD +56°2600
387·	A2	10.10	0.45	2.04	
388·	O6	5.86	0.19	-0.60	BD +56°2717
389·	BO	8.04	0.27	-0.77	BD +56°2717
390·	BO	8.03	0.14	-0.68	BD +56°2717
391·	F4	7.44	0.46	0.04	BD +56°2623
392·	F4	8.76	0.62	0.08	BD +56°2623
393·	BO.5	10.47	0.65	-0.35	
394·	B2	8.65	0.25	-0.57	BD +56°2610
395	AO	11.80	0.16	0.03	
396	AO	11.42	0.26	0.38	
397	F6	10.25	0.46	0.04	
398	MO	9.15	1.76	2.45	BD +56°2616
399	K5	9.10	1.02	0.19	BD +56°2613
400	B1	9.16	0.36	-0.50	BD +56°2615
401	AO	11.45	0.28	0.08	
402	B5	12.10	0.56	-0.18	
403	KO	10.18	1.35	1.17	
404	B3	10.32	0.37	-0.33	BD +56°2602
405	F6	10.15	0.57	-0.01	BD +56°2599
406	B5	10.81	0.52	-0.18	
407	KO	10.30	1.29	0.25	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
408	A2	11.53	0.58	-0.29	
409	B9	9.45	0.24	-0.19	BD $+56^{o}2594$
410	B5	12.51	0.70	0.19	
411	AO	12.57	1.06	0.17	
412	FO	10.35	0.37	-0.04	BD $+56^{o}2568$, blend
413	AO	11.04	0.36	0.15	
414	K2	10.33	1.10	0.78	
415	M	9.91	1.90	1.78	
416	G8	8.13	0.87	-0.01	BD $+56^{o}2578$
417	G8	10.69	0.95	0.22	
418	B5	9.94	0.82	0.00	BD $+56^{o}2577$
419	M	10.94	2.24	1.21	
420	K5	10.18	1.44	1.43	BD $+56^{o}2576$
421	AO	11.81	0.81	0.64	
422	KO	8.08	1.26	0.83	BD $+56^{o}2574$
423	AO	11.86	0.88	0.16	
424	F8	10.29	0.88	0.05	
425	GO	10.22	1.00	0.28	
426	AO	11.96	1.07	0.45	
427	F8	10.49	0.97	0.15	BD $+56^{o}2563$
428	KO	7.68	1.77	1.67	BD $+56^{o}2561$
429	B8	10.74	1.01	0.05	
430	F8	10.81	0.96	0.14	edge
431	KO	9.48	1.35	-0.01:	
432	A2	11.56	1.27	0.68	
433	A5	11.43	0.83	0.57	
434	KO	8.00	1.64	1.54	BD $+56^{o}2569$
435	G8	11.72	0.96	0.12	
436	K2	9.45	1.42	1.30	BD $+56^{o}2575$
437	AO	11.73	0.92	0.39	
438	K	8.70	1.59	1.59	BD $+56^{o}2582$
439	F8	11.65	0.71	0.21	
440	F5	10.59	0.51	0.13	
441	G2	11.29	0.73	0.10	
442	A3	10.01	0.24	0.06	BD $+56^{o}2593$
443	A2	10.38	0.16	0.48	
444	B5	11.30	0.45	-0.12	
445	AO	9.39	0.05	-0.05	BD $+56^{o}2595$
446	B3	10.11	0.25	-0.42	
447	B3	8.38	0.41	-0.72	BD $+56^{o}2598$
448	B3	9.46	0.14	-0.39	BD $+56^{o}2604$
449	AO	12.14	0.46	0.16	
450	BO	8.39	0.39	-0.79	BD $+56^{o}2620$
451	B5	10.20	0.23	-0.52	BD $+56^{o}2622$, blend
452	G2	11.14	0.40	0.53	blend
453	F8	12.62	0.92	0.36	
454	K	11.96	1.41	0.08	
455	F2	10.72	0.42	0.38	
456	B8	10.74	0.48	0.22	
457	K5	8.46	1.08	1.23	BD $+56^{o}2634$
458	A5	11.68	0.70	0.72	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
459	KO	11.59	0.85	0.53	blend
460	AO	12.37	0.38	0.66	
461	F5	11.71	0.65	0.54	
462	FO	10.39	0.59	0.46	BD $+56^{\circ}2645$
463	B8	11.54	0.53	0.22	
464	AO	11.96	0.31	0.15	edge
465	KO	10.90	0.69	0.66	
466	AO	12.01	0.63	0.64	
467	AO	11.21	0.32	0.42	
468	AO	11.18	0.32	0.35	
469	AO	8.72	0.04	-0.06	BD $+56^{\circ}2652$
470	AO	12.39	0.71	0.23	
471	A2	11.64	0.37	0.52	
472	F8	10.49	0.45	0.10	
473	A2	11.21	0.44	0.69	
474	FO	10.93	0.68	0.42	
475	G5	9.70	0.53	0.29	
476	F2	10.71	0.79	0.29	
477	K2	8.52	1.48	1.75	BD $+56^{\circ}2636$
478	F6	11.79	0.81	0.43	
479	AO	12.36	0.45	0.48	
480	K4	10.67	1.17	0.90	
481	B8	11.25	0.12	-0.11	
482	GO	10.67	0.67	0.50	
483	A7	11.93	0.48	0.49	
484	F2	11.50	0.71	0.46	
485	B2	9.81	0.04	-0.65	
486	A2	9.48	0.22	-0.12	
487	B8	11.04	0.02	-0.16	
488	AO	11.94	0.35	0.61	
489	B8	10.70	0.25	-0.10	
490	AO	11.94	0.49	0.10	
491	BO	8.63	0.33	-0.79	BD $+56^{\circ}2605$
492	B3	11.02	0.54	-0.20	edge
493	B5	10.86	0.82	0.11	blend
494	AO	11.19	0.85	0.38	
495	KO	10.69	0.71	0.40	
496	AO	11.96	0.90	-0.26	blend
497	F8	11.05	0.75	0.13	
498	G8	10.02	0.74	0.17	BD $+57^{\circ}2347$
499	B5	10.95	0.71	-0.13	
500	KO	8.08	1.09	0.87	BD $+56^{\circ}2590$
501	G8	11.72	0.72	0.35	
502·	BO	7.45	0.57	-0.45	BD $+56^{\circ}2589$
503	AO	11.39	1.02	0.70	
504	AO	11.31	0.90	1.01:	blend
505	A2	11.28	0.85	0.56	
506	A5	9.34	0.49	0.31	BD $+56^{\circ}2571$
507	F8	9.44	0.86	0.41	BD $+56^{\circ}2570$
508	F5	9.63	0.70	0.13	BD $+56^{\circ}2564$
509	F8	7.82	0.82	-0.05	BD $+56^{\circ}2562$

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
510	F8	10.44	0.75	0.03	edge
511	AO	11.25	1.19	0.24	blend
512	F6	9.41	0.75	0.22	BD +57°2316
513	F2	8.44	0.77	-0.22	BD +57°2317
514	AO	11.69	1.06	0.79	
515	F8	11.73	1.02	0.70	
516	F8	11.18	0.76	0.20	
517	F6	11.57	0.99	0.40	
518	AO	12.27	1.07	0.70	
519	B8	10.72	0.50	0.14	BD +57°2336
520	A7	11.29	0.67	0.76:	
521	F8	10.42	0.50	0.05	BD +57°2345
522	B3	9.92	0.29	-0.44	BD +57°2350
523	A2	10.71	0.71	0.45	
524	K2	9.81	1.06	1.05	BD +57°2353
525	B8	10.34	0.58	0.10	
526	M	10.65	1.83	1.37	
527	F8	11.39	0.70	-0.13	
528	K2	10.52	1.40	0.95	
529	G5	11.04	0.82	0.16	
530	AO	12.00	0.53	0.09	
531	FO	11.04	0.79	-0.05	
532	A5	11.58	0.65	0.46	
533	A2	9.48	0.56	0.36	BD +57°2356
534	AO	11.31	0.42	0.03	
535	A7	11.67	0.53	0.33	
536	A4	10.84	0.47	0.41	
537	AO	11.43	0.35	0.10	
538	AO	12.45	0.38	0.20	
539	A4	11.63	0.59	0.43	blend
540	B6	11.24	0.27	-0.25	
541	A7	12.05	0.62	0.50	
542	A5	11.26	0.32	0.41	
543	AO	12.19	0.41	0.42	
544	B2	9.95	0.06	-0.55	BD +57°2369
545	B7	10.58	0.13	-0.23	
546	F	10.36	1.32	1.47	
547	A2	12.01	0.29	0.35	
548	K4	9.83	1.33	1.51	BD +56°2630
549	K	9.98	1.91	2.35	BD +56°2627
550	B8	9.04	0.37	0.09	BD +57°2386
551	FO	11.59	0.75	0.56	
552	F	11.51	0.73	0.44	
553	F	11.51	0.75	0.30	
554	B8	11.39	0.43	0.11	
555	F8	10.87	0.59	0.38	
556	G5	11.01	0.58	0.43	
557	KO	8.95	1.05	0.79	edge
558	A2	8.35	0.14	-0.07	BD +57°2402
559	FO	12.15	0.73	0.67	
560	M	9.35	1.94	1.69	BD +57°2398

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
561	AO	9.95	0.12	0.38	BD +57°2395, blend
562	B3	9.48	0.49	-0.23	BD +57°2395, blend
563	AO	11.61	0.71	0.73	
564	FO	11.58	0.72	0.59	
565	B5	9.73	0.41	--	BD +57°2383
566	FO	12.02	0.43	0.37	
567	AO	11.59	0.92	0.93	
568	B5	10.01	0.12	-0.12	BD +57°2375
569	A6	10.68	0.46	-0.27	
570	KO	8.38	1.20	1.28	BD +57°2371
571	A7	12.49	0.63	0.30	blend
572	G8	11.40	0.76	0.27	
573	KO	7.90	1.05	0.79	BD +57°2359
574	F8	10.46	0.60	0.19	
575	AO	11.77	0.42	0.17	
576	KO	11.25	0.84	0.48	
577	G8	10.79	0.80	0.31	
578	F4	10.77	0.76	0.35	
579	F6	12.69	0.76	0.51	
580	B8	11.95	0.91	0.57	
581	B2	9.53	0.23	-0.51	BD +57°2343
582	B7	10.15	0.32	-0.16	BD +57°2335
583	AO	11.18	0.42	-0.03	
584	B3	9.39	0.29	-0.44	BD +57°2334
585	AO	11.57	0.90	0.82	blend
586	AO	11.37	0.91	0.36	
587	B3	10.45	0.58	-0.21	BD +57°2327
588	K2	9.08	1.34	1.35	BD +57°2319
589	GO	11.47	0.84	0.13	
590	A2	11.46	1.21	0.54	edge
591	KO	7.49	1.31	1.09	BD +57°2318
592	G2	10.39	0.79	0.05	
593	G5	7.09	0.77	-0.23:	BD +57°2322
594	F8	10.37	0.69	--	BD +57°2324
595	A7	9.61	0.34	0.15	BD +57°2332
596	B8	10.12	0.55	0.35	BD +57°2333
597	G	11.84	1.00	0.21	
598	B5	9.92	0.38	-0.08	BD +57°2339
599	G2	11.67	0.85	0.51	
600	K2	9.21	1.20	1.36	BD +57°2351
601	A2	11.77	0.74	0.85	
602	B8	12.82	0.86	0.48	
603	B8	10.39	0.34	0.10	
604	G8	10.86	0.86	0.37	
605	A2	11.33	0.65	0.78	
606	A5	11.18	0.77	0.68	
607	A5	10.89	0.81	0.70	
608	B7	9.67	0.35	-0.31	BD +57°2363
609	F2	11.15	0.57	0.13	blend
610	F8	10.24	0.61	0.11	BD +57°2373
611	K4	9.36	1.60	2.24	BD +57°2381

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
612	B8	10.60	0.30	0.12	BD +57°2382
613	F2	11.79	0.71	0.24	
614	AO	12.21	0.57	0.61	
615	GO	10.80	0.91	0.51	
616	A7	10.94	0.78	0.64	BD +57°2397
617	KO	10.33	1.45	1.25	BD +57°2400
618	A5	10.39	0.47	0.55	
619	AO	10.42	0.46	0.43	
620	A2	8.28	0.20	-0.05	BD +57°2403
621	A7	10.39	0.51	0.46	BD +57°2400
622	A4	11.35	0.48	0.52	
623	G4	12.38	0.53	0.69	
624	KO	11.75	0.71	0.15:	edge
625	AO	12.05	0.26	0.21:	edge
626	BO	11.17	0.34	-0.67	
627	G5	10.71	0.72	0.48	
628	G8	11.27	0.77	0.64	
629	G5	8.40	0.73	0.08	BD +57°2399
630	K	11.98	1.31	1.14	
631	A2	12.57	0.48	0.51	
632	A2	11.46	0.44	0.49	
633	M	7.23	2.03	2.36	BD +57°2396
634	A2	11.74	0.40	0.42	
635	AO	9.30	0.40	0.29	BD +57°2391
636	KO	6.79	1.12	0.66	BD +57°2392
637	F8	11.71	0.71	0.22	
638	KO	9.11	1.12	0.35	BD +57°2388
639	A4	11.35	0.49	0.49	
640	GO	10.73	0.73	0.47	
641	AO	10.74	0.49	0.52	
642	B2	8.92	0.29	-0.62	BD +57°2380
643	AO	10.77	0.41	0.42	
644	F8	11.36	0.59	0.15	
645	B2	9.72	0.37	0.47	BD +57°2376
646	A2	10.15	0.36	0.56	
647	AO	11.68	0.70	0.26	
648	K2	9.32	1.25	1.41	BD +57°2367
649	A6	11.75	0.68	0.62	
650	B6	9.97	0.42	-0.09	BD +57 2366
651	AO	11.63	0.60	0.55	
652	B2	8.83	0.35	-0.29:	BD +57°2360
653	AO	12.08	0.50	0.54	
654	B2	8.51	0.58	0.60	BD +57°2354
655	B7	10.66	0.65	0.13	BD +57°2352
656	A2	7.97	0.30	-0.10	BD +57°2349
657	F2	8.80	0.49	0.06	BD +57°2342
658	A2	8.88	0.31	0.11	BD +57°2338
659	A2	9.05	0.37	0.19	BD +57°2337
660	G	11.68	0.84	0.41	
661	F8	11.45	0.69	0.22	
662	A4	10.10	0.82	0.48:	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
663	K5	7.98	1.45	1.44:	BD +57°2323
664	A2	9.10	0.36	0.18	BD +57°2320
665	B8	10.78	1.04	0.46	edge
666	G8	11.69	1.61	1.30	blend
667	GO	9.29	0.73	0.15	BD +57°2321, edge
668	F8	11.86	1.00	0.48	
669	K2	8.76	1.14	1.32	BD +57°2330
670	A3	10.12	0.46	0.37	BD +57°2330
671	A7	12.15	0.41	-0.03	blend
672	K4	10.08	1.62	1.77	
673	G8	10.84	0.70	0.41	
674	B8	11.10	0.65	0.27	
675	AO	12.07	0.67	0.43	
676	AO	12.32	0.54	0.46	
677	KO	10.15	1.01	0.85	BD +57°2365
678	K4	9.29	2.03	2.92:	BD +57°2368
679	K2	11.40	0.94	0.57	
680	B8	11.69	0.44	-0.01	
681	B5	11.41	0.32	-0.18	
682	AO	11.62	0.52	-0.07	
683	FO	11.65	0.73	0.15	
684	F8	11.41	0.65	0.11	
685	K4	10.46	1.40	1.69	
686	F2	11.93	0.52	0.46	
687	B7	9.97	0.15	-0.15	BD +57°2366
688	AO	11.45	0.44	-0.07	
689	B2	10.56	0.37	-0.53:	
690	FO	11.60	0.60	0.59	
691	F8	10.22	0.67	0.44	
692	F5	10.65	0.51	0.26	
693	F5	9.81	0.50	0.21	
694	F2	11.33	0.54	0.30	
695	KO	11.82	0.62	0.95:	edge
696	F2	11.67	0.52	0.50	
697	AO	11.41	0.31	0.29	
698	A2	10.47	1.14	1.37	
699	K2	10.47	1.23	0.47	
700	F8	11.52	0.58	0.19	
701	FO	10.47	0.36	0.17	BD +57°2394
702	AO	11.30	0.34	0.22	
703	F6	9.66	0.72	0.20	BD +57°2398
704	B7	9.62	0.53	0.18	BD +57°2387
705	FO	11.21	0.72	0.36	blend
706	G2	10.81	0.55	0.64	BD +57°2387
707	F8	11.07	0.75	0.30	
708	AO	11.61	0.84	0.23	
709	M	9.77	1.86	2.32	BD +57°2379
710	G5	10.74	0.63	0.32	
711	A4	11.71	0.61	0.16	
712	B3	8.49	0.41	-0.56	BD +57°2372
713	G8	11.19	0.65	0.26	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
714	AO	11.73	0.62	0.52	
715	A4	11.20	0.49	0.71	
716	A2	11.07	0.48	0.52	
717	B8	11.26	0.51	-0.08	
718	AO	11.51	0.68	-0.01	
719	K2	10.64	1.64	1.62	
720	AO	11.37	0.52	0.35	
721	A4	11.37	0.70	0.61	
722	B1	9.28	0.42	-0.35	BD +57°2343
723	AO	12.04	0.84	0.77	
724	AO	12.20	0.74	0.38	
725	FO	8.13	0.45	0.02	BD +57°2344
726	F4	10.92	0.68	0.19	
727	B8	10.89	0.53	0.24	
728	AO	11.84	0.60	1.02	
729	A2	10.56	0.39	0.19	BD +57°2329
730	G5	9.94	0.97	0.15	BD +57°2328
731	K2	8.01	1.28	1.11:	BD +58°2263
732	AO	10.54	1.07	0.19	
733	F8	10.31	0.71	0.01	BD +58°2269
734	BO	7.90	0.92	-0.26	BD +58°2272
735	G2	11.04	0.76	0.05:	
736	A4	10.48	0.40	0.36:	BD +58°2278
737	F8	10.26	0.58	0.11	BD +58°2286
738	K2	10.48	1.47	1.69	BD +58°2280
739	B1	8.61	0.20	-0.58	BD +58°2283
740	F8	10.98	0.73	0.14	
741	A2	10.37	0.27	0.34	BD +57°2348
742	A2	11.23	0.61	0.52	
743	B3	9.88	0.48	-0.26	BD +58°2292
744	B3	10.01	0.16	-0.31:	
745	KO	7.93	1.16	0.99:	BD +58°2295
746	B8	11.14	0.55	-0.05	
747	B2	10.67	0.70	0.24	BD +58°2297
748	G2	11.54	0.74	0.31	
749	B8	7.76	0.27	-0.17	BD +58°2300
750	G8	11.01	0.75	0.55	
751	AO	11.21	0.65	0.18	
752	G2	11.42	0.67	0.41	
753	B5	11.32	0.43	-0.03	
754	B5	11.98	0.53	-0.03	blend
755	F5	10.86	0.56	0.24	
756	A7	10.04	0.44	0.40	BD +57°2377
757	F6	10.23	0.38	--	BD +57°2389
758	B8	10.28	0.28	0.23	BD +57°2389
759	A4	11.37	0.49	0.76	blend
760	A4	11.17	0.44	0.60	
761	AO	11.70	0.37	0.20	
762	K5	8.57	1.17	2.87:	edge
763	AO	12.01	0.33	0.35:	
764	F8	11.17	0.55	0.34:	

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
765	AO	12.76	0.59	0.23	blend
766	G8	11.66	0.43	0.49	
767	AO	9.77	0.46	-0.29	BD +58^{o}2315
768	FO	9.04	0.46	0.03	BD +58^{o}2313
769	GO	9.90	0.53	0.00	BD +58^{o}2312
770	F8	10.75	0.56	0.30	
771	FO	11.67	0.67	0.49	
772	G	12.04	0.85	0.29	
773	AO	11.79	0.81	0.10	
774	AO	11.06	0.68	0.33	
775	A2	11.85	0.68	0.13	
776	A2	11.42	0.68	0.01	
777	F8	11.35	0.68	0.16:	
778	AO	11.64	0.72	0.64:	
779	A2	11.20	0.91	0.53:	
780	A4	10.02	0.37	0.55	BD +58^{o}2287, blend
781	F5	10.20	0.68	0.45	BD +58^{o}2286
782	F6	10.21	0.50	0.15:	BD +58^{o}2284
783	F2	9.79	0.99	0.34	BD +58^{o}2288
784	B5	9.87	0.90	0.10	
785	FO	10.80	0.48	0.16:	
786	KO	10.23	1.14	1.18:	blend
787	A2	10.20	0.35	0.42:	BD +58^{o}2271
788	F2	11.56	0.84	0.42:	
789	A4	11.77	1.13	0.70	
790	FO	11.03	0.51	0.18	
791	A2	10.68	0.97	0.73:	
792	F3	10.98	0.62	0.30	
793	A2	11.24	0.59	0.41:	
794	F2	10.11	0.41	0.20:	BD +58^{o}2291
795	B5	8.38	0.15	-0.23	BD +58^{o}2290
796	FO	10.43	0.39	0.29	blend
797	B5	10.40	0.68	0.11	
798	F8	10.62	0.60	0.22	BD +58^{o}2298
799	F8	9.73	0.43	0.50	BD +58^{o}2285, blend
800	A7	10.76	0.48	0.50	
801	GO	10.89	0.58	0.30	
802	A7	10.39	0.42	0.25	
803	F8	11.15	1.21	0.54	blend
804	F6	11.22	0.79	0.52	
805	AO	11.37	0.57	0.21	
806	F8	10.76	0.66	0.03	
807	A2	9.21	0.40	0.03	BD +58^{o}2318
808	B5	10.14	0.46	0.32	
809	B2	9.21	0.30	-0.54	BD +58^{o}2320
810	AO	10.72	0.42	0.25:	
811	F2	9.50	0.45	0.28	BD +58^{o}2322
812	A2	11.40	0.39	0.55	
813	AO	11.78	0.69	0.19	
814	A2	11.04	0.32	0.45	
815	A2	11.89	0.25	0.60:	edge

TABLE

(Continued)

No.	Sp.	V	B-V	U-B	remarks
816	A7	11.19	0.41	0.37	
817	F2	11.57	0.51	0.24	
818	K	6.21	1.07	1.58	BD +58°2314
819	F2	10.56	0.52	0.29:	BD +58°2310
820	G5	10.40	0.72	0.35	BD +58°2308
821	F8	10.81	0.92	0.62	
822	B3	9.46	0.74	0.13	BD +58°2303
823	F8	11.19	0.73	0.41	blend
824	A4	11.73	0.90	0.18	
825	F2	10.63	1.22	0.64:	
826	KO	8.33	1.45	1.78:	BD +58°2277
827	A2	11.30	0.90	0.73:	
828	B8	10.64	0.66	0.07:	BD +58°2293
829	B8	10.33	0.69	0.44:	
830	AO	9.09	0.28	0.28:	BD +58°2301
831	GO	9.59	0.58	0.25:	BD +58°2304
832	F4	10.34	0.51	0.39	
833	F6	12.32	0.54	0.48	
834	AO	11.45	0.51	0.35	
835	G2	11.51	0.41	0.41	
836	A2	10.76	0.39	0.60	
837	AO	12.45	0.44	0.32	
838	A2	11.65	0.21	0.34	
839	AO	7.73	0.25	-0.22	BD +57°2326
840	F5	12.14	0.81	0.84	
841	FO	8.08	0.77	-0.01	blend
842	FO	8.81	0.57	0.25	blend

NOTES TO THE TABLE

A point at the right upper side of the running number denotes photoelectrically measured magnitudes.

Blend is remarked if the photographic image of the measured star is distorted by a neighbouring star.

A colon beside the U-B colour denotes that the ultraviolet magnitude of the star is uncertain because of the field error of the ultraviolet filter.

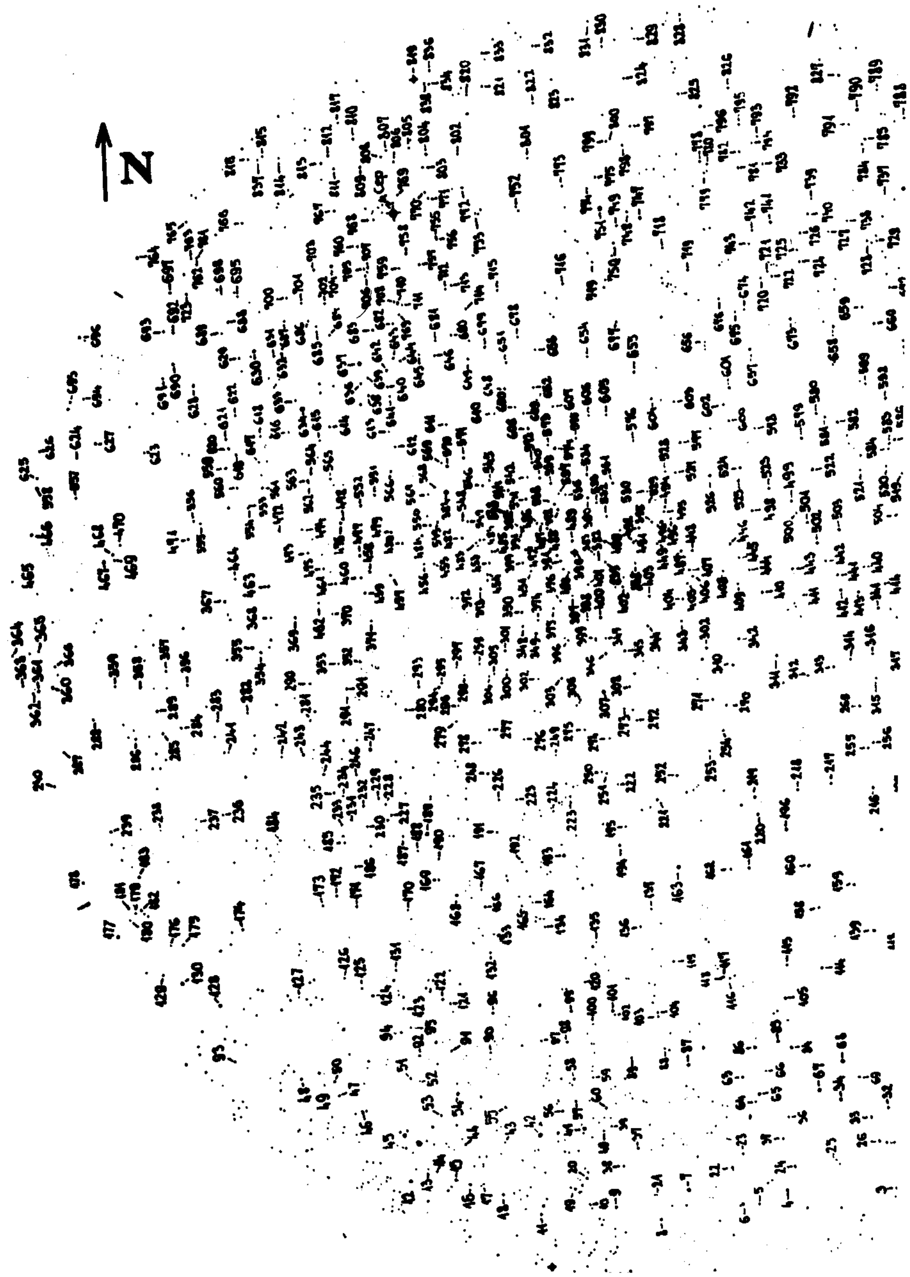
Edge is remarked if the star is near the edge of the plate.

Photoelectric magnitudes and colours of stars were taken from the following sources:

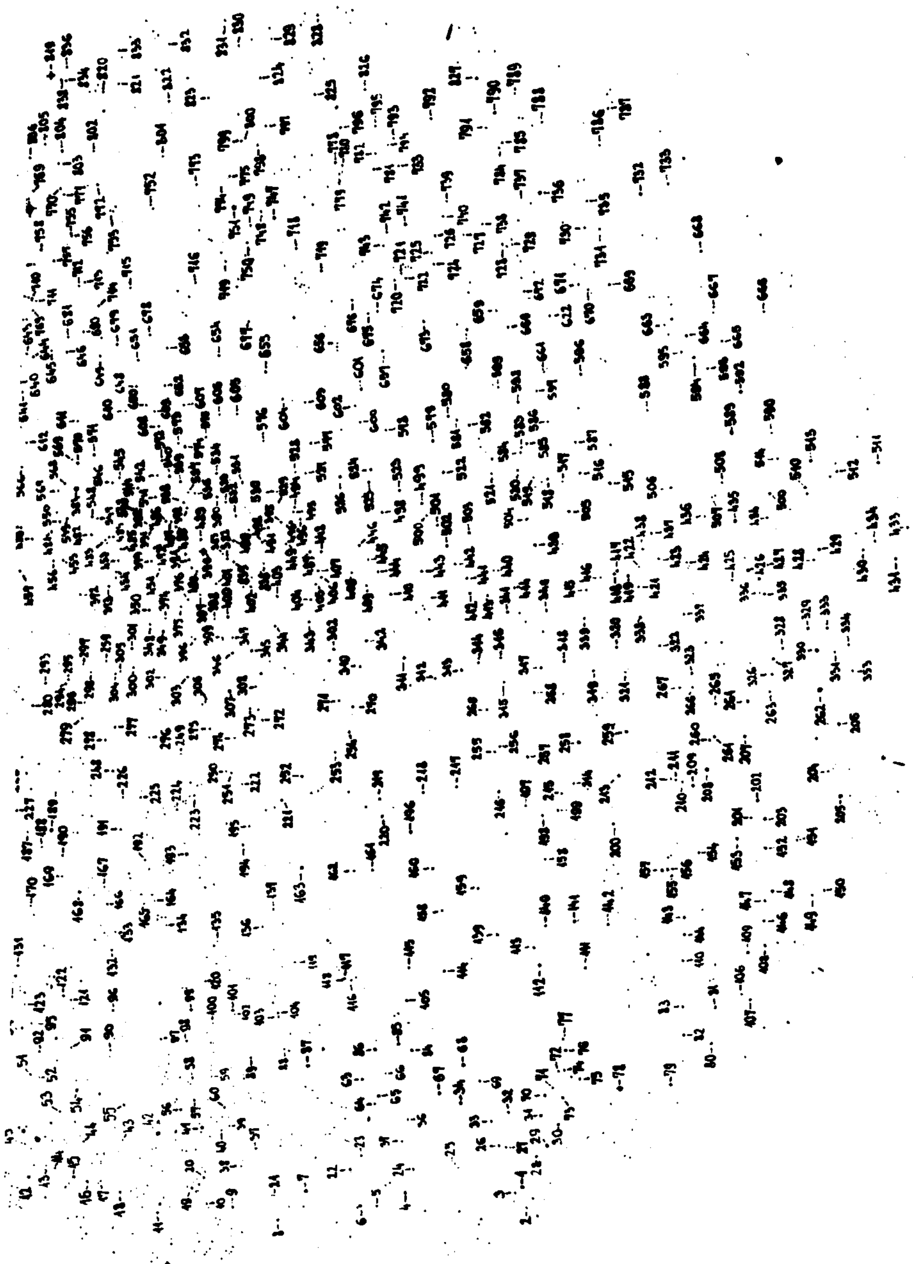
Balázs, B. A.,private communication (376, 377, 378, 379, 380, 381, 382, 383, 387).

Eggen, O. J. 1966. Roy. Obs. Bull. No. 120.(385, 386, 391, 392).

Deutschman, W. A., Davis, R. J., Schild, R. E. 1976. ApJ. Suppl. 30. 97. (293, 642).
Hiltner, W. A. 1956. ApJ. Suppl. 2. 389. (281, 307, 384, 502).
Simonson, S. C. 1968. ApJ. 154. 923. (388, 389, 390, 394).



Finding chart of the survey stars I..



Finding chart of the survey stars II.

A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

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RED GIANT STARS OF M3

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RED GIANT STARS OF M3

ABSTRACT

Photographic observations of seven red giant stars of M3 ($CI \geq 1\overset{m}{.}3$) are presented. The star v.Z.1397 was found to be variable with the period of 31.395 or 215.8 days. Two other stars, v.Z.238 and 837 previously known as variables, show constant light within the observational error. It seems that only the two reddest stars in M3, i.e. v.Z.1397, $CI=1\overset{m}{.}58$ and v.Z.318 = V95, $CI=1\overset{m}{.}60$, are variable.

INTRODUCTION

The investigation of red giant variable stars in globular clusters is of great importance especially from the theoretical point of view. These stars lie at the tip of the red giant branch in the HRD and are at an interesting stage of their evolution. It can be supposed that from a given colour index all the redder giant stars show light variation (see e.g. *Osborn* and *Fuenmayor*, 1977). For this reason much work has been done on the red giants of various clusters.

In addition, a number of studies have already been published on some red giants of M3 (see for example *Walker*, 1955; *Russev*, 1971). Here we present a photographic study of red giant stars of M3 covering the time interval 1938-1962.

OBSERVATIONS

The red giant stars of M3 redder than $CI=1\overset{m}{.}3$ (see *Sandage*, 1953) were selected in order to investigate their possible light variations. Recent photoelectric B-V observations (*Cohen* et al., 1978) show no substantial difference from the values observed by *Sandage* for the three stars v.Z.238, 1392 and 1397, but for v.Z. 205 the B-V colour index measured by *Cohen* et al. is about $0\overset{m}{.}1$ redder than *Sandage*'s value (detailed remarks on this star are included).

From the selected ten stars the following six have been measured: v.Z.238, 297, 837, 1392, 1397 and I-I-109 (designation after *Sandage*, 1953) whereas v.Z.490, 612, 752 and 1053 proved to be unmeasurable in our photographic plates because of their position near the centre of the cluster. As comparisons, v.Z.216, 237, 334 740 and 1402 were used (selected from *Sandage*'s paper).

The detailed description of the observational material can be found in *Szeidl*'s paper (*Szeidl*, 1965).

The measurements were carried out with both the Becker and the Cuffey iris photometer of the Konkoly Observatory. Every plate was measured twice using the two photometers. No difference were found between the observational errors of the two sets of measurements. The mean values of the two measured magnitudes are given in Table 2.

The mean error of one single measurement is $\pm 0\overset{m}{.}061$, nevertheless, the standard deviations of the measurements of different stars vary depending on their positions. In Table 1 the mean of all magnitudes, the standard deviations and the numbers of observations are given for each measured star.

Table 1

star	$\overline{m}_{pg}$	standard deviation	number of observations
v.Z. 205	14.094	0.059	200
238	14.235	0.061	205
297	14.287	0.058	204
837	14.171	0.071	201
1392	14.373	0.053	189
1397	14.295	0.094	195
I-I-109	14.029	0.104	165

REMARKS ON INDIVIDUAL STARS

v.Z.205 = I-III-28

This star was originally chosen as a comparison, but has never fitted the calibration curve. Therefore, the star was added to the other variable candidates.

The mean of the observed magnitudes ($14\overset{m}{.}09$) was found to be $0\overset{m}{.}1$ fainter than *Sandage*'s result ($13\overset{m}{.}99$). According to *Cohen* et al.'s observations the star seems to be about $0\overset{m}{.}1$ redder than previously thought.

As 68% of the measured values are within a $\pm 0\overset{m}{.}06$ interval around the mean, we can say that the star does not vary at least with an amplitude larger than $0\overset{m}{.}12$ (Figure 1).

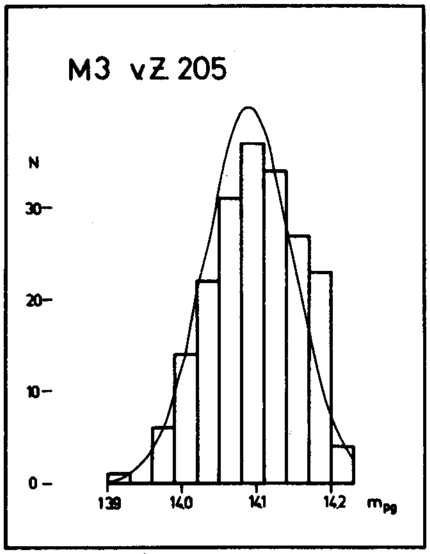

Figure 1: Histogram of the measured magnitudes of v.Z.205 with $0^m.03$ wide intervals. The normal distribution curve was calculated with the estimated mean: 14.094 and standard deviation: 0.059

v.Z.238 = AA

v.Z.238 was supposed by *Russev* (*Russev*, 1971) to be variable with $80^d.98$ period and $0^m.24$ amplitude. The mean brightness of the star given by him differs from our result by only $0^m.02$ ($14^m.26$ and $14^m.24$ respectively) but the scatter of *Russev*'s values is much wider than ours.

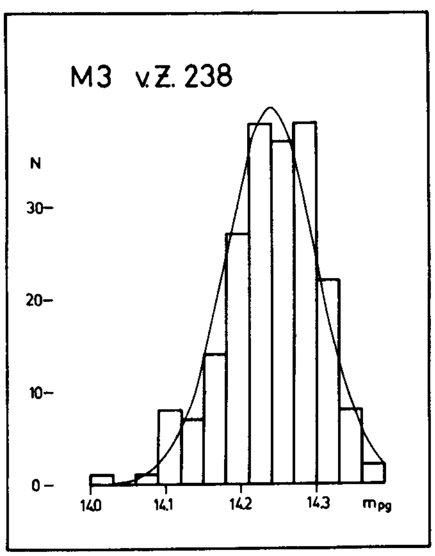

Figure 2: Histogram of the measured magnitudes of v.Z.238 with $0^m.03$ wide intervals. The normal distribution curve was calculated with the estimated mean: 14.235 and standard deviation : 0.061

Concerning our observations, no light variation was found for this star, 73% of the measured magnitudes are within a range of $\pm 0^{m}.06$ around the mean (Figure 2).

<u>v.Z.297</u>

According to our measurements, this star does not show any light variation. 76% of the obtained magnitudes lie in the region $14^{m}.29 \pm 0^{m}.06$ (Figure 3).

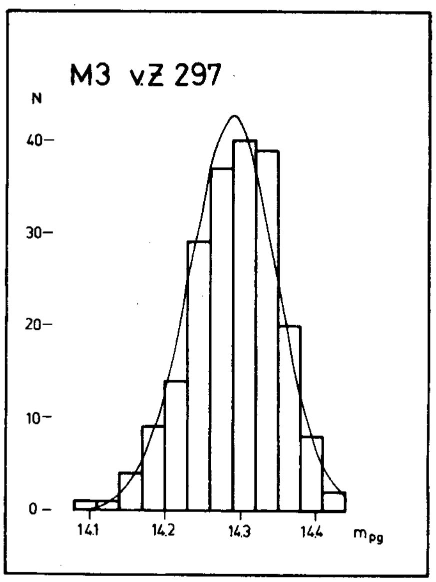

Figure 3: Histogram of the measured magnitudes of v.Z.297 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.287 and standard deviation: 0.058.

<u>v.Z.837 = I-II-46</u>

For this star, *Russev* found light variation with a period of $89^{d}.59$ and an amplitude of $0^{m}.33$. There is no great difference between the mean brightness given by him ($14^{m}.11$) and our result ($14^{m}.17$) but as with v.Z.238, the scatter of his magnitudes is considerably wider.

The distribution of the measured values is close to the normal one (Figure 4) and from all the data 74% take place within $\pm 0^{m}.07$ around the mean. Therefore we can claim that this star also does not vary with an amplitude greater than $0^{m}.14$.

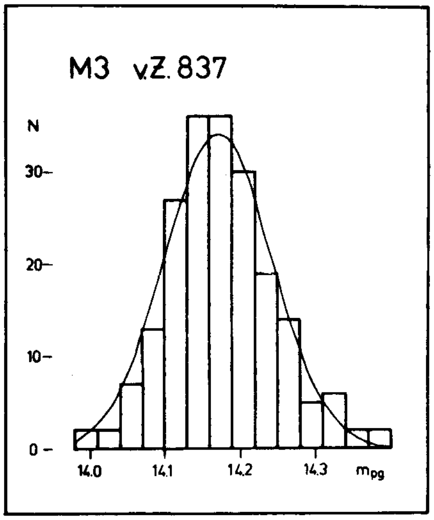

Figure 4: Histogram of the measured magnitudes of v.Z.837 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.171 and standard deviation: 0.071

v.Z.1392 = I-I-21

This star does not show light variation; 78% of the measured values fall within the range of $0\overset{m}{.}06$ around the mean (Figure 5).

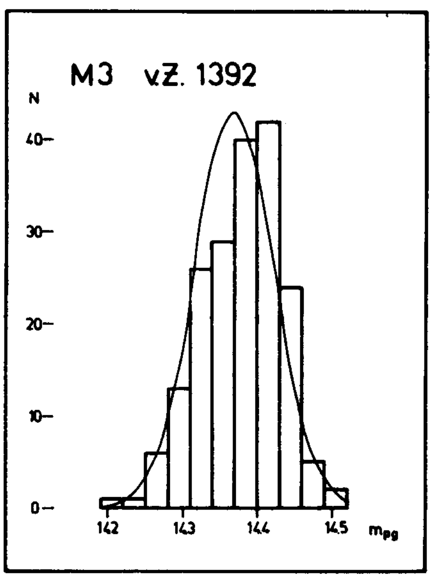

Figure 5: Histogram of the measured magnitudes of v.Z.1392 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.373 and standard deviation: 0.053

v.Z.1397

The distribution of the measured magnitudes of this star does not follow a normal distribution (Figure 6). Two peaks are visible in the histogram which is characteristic of the histograms of variable stars. The standard deviation of the values obtained is definitely larger ($\pm 0\overset{m}{.}094$) than the average standard deviation of the other non-variable stars. As well as the others, this star lies in a very good measurable place far from the centre.

A modified *Lafler-Kinman* method was used to search for period with trial periods from 30 to 350 days. As a result, two almost equally well acceptable periods were received: $31\overset{d}{.}395$ (Figure 7) and $215\overset{d}{.}8$ (Figure 8).

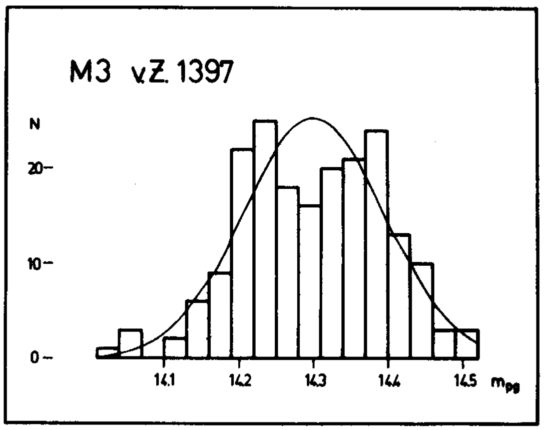

Figure 6: Histogram of the measured magnitudes of v.Z.1397 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.295 and standard deviation: 0.094

I-I-109

The scatter of the measurements of this star is relatively wide, because of its close companion and dense surroundings. The histogram of the measured values does not follow a normal distribution but the shape of it is not similar to a variable star's histogram (Figure 9).

In this case the search for period was unsuccessful, no suitable period has been found. The wide scatter is very probably due to the above mentioned effects.

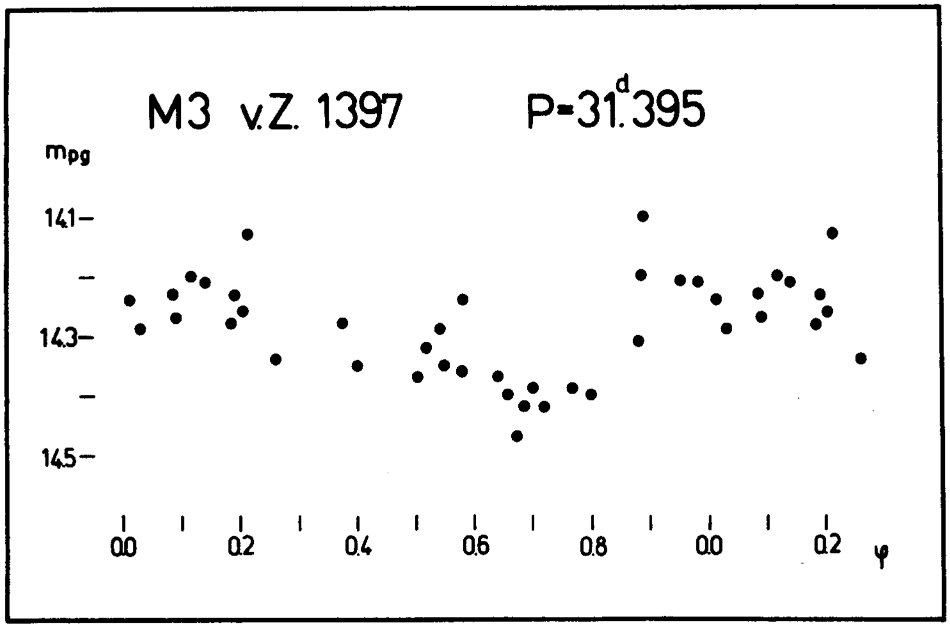

Figure 7: Light curve of v.Z.1397 with the period of 31.395 days

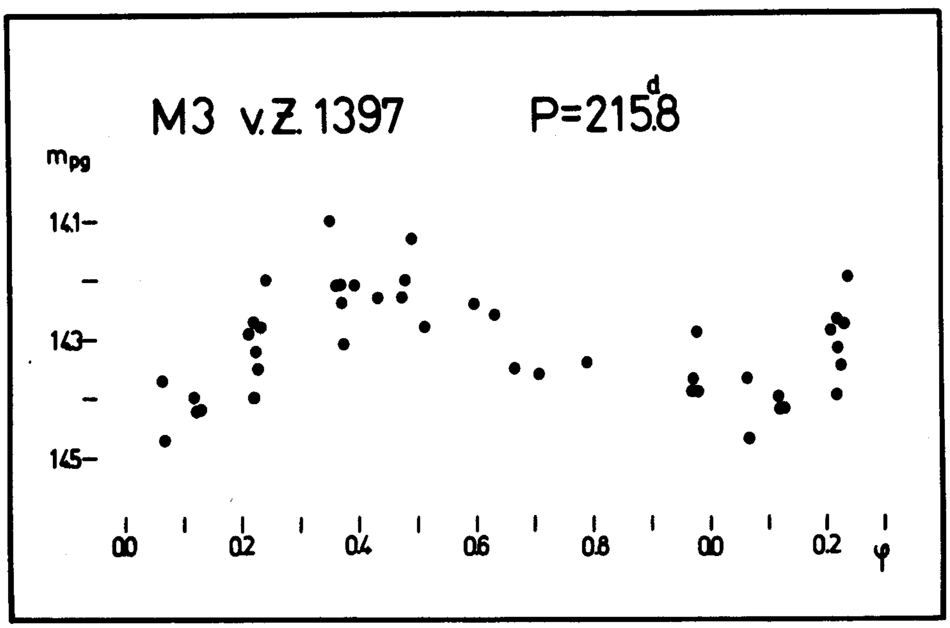

Figure 8: Light curve of v.Z.1397 with the period of 215.8 days

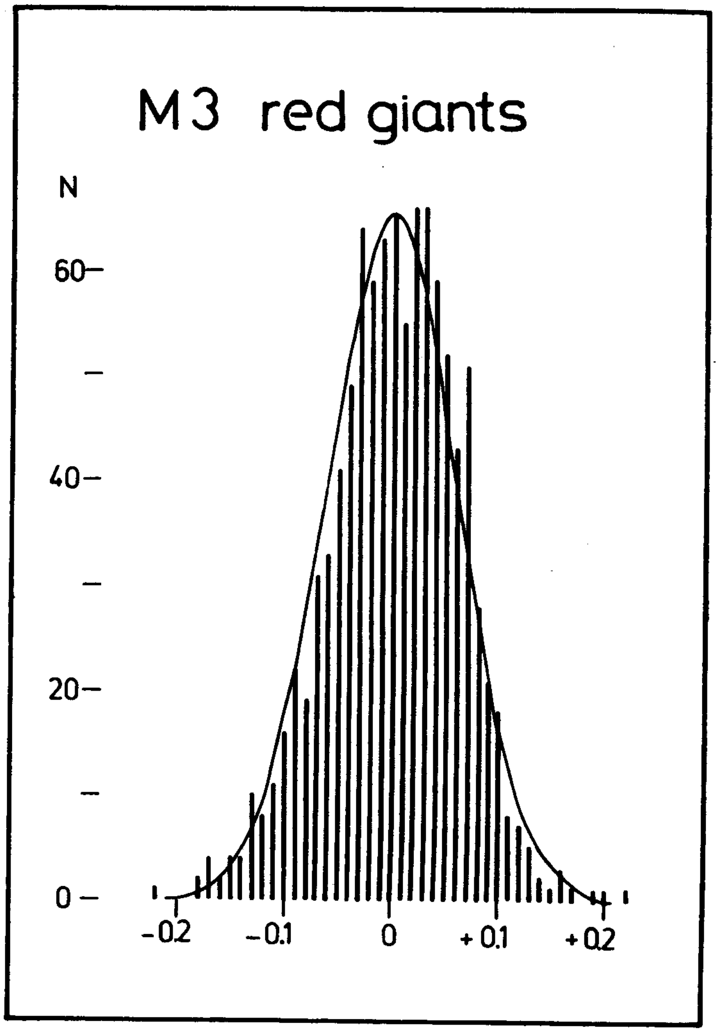

Figure 10: Composite distribution of all measured magnitudes of v.Z.205, 238, 297, 837 and 1392. The means were placed at the 0 point. The estimated standard deviation of the normal distribution curve is 0.061.

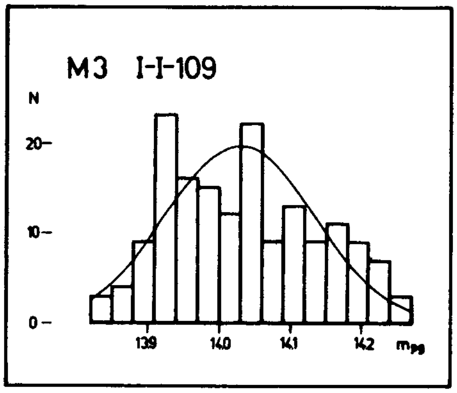

Figure 9: Histogram of the measured magnitudes of I-I-109 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.029 and standard deviation: 0.104

CONCLUSION

The results of the present investigation seem to confirm the idea that from a given colour index all redder giant stars are variable in globular clusters.

v.Z.1397 is the reddest star (CI=$1^{m}.58$) in our sample and shows small amplitude light variation. There exists one redder giant star in M3, namely v.Z.318 = V95 (CI=$1^{m}.60$), the only known red variable of the cluster with large amplitude.

Our photographic observations do not preclude the possibility of the very small amplitude (less than $0^{m}.15$) light variations among the red giant stars measured. Precise photoelectric observations are necessary for making the final decision on the variability of these stars.

I gratefully acknowledge the many helpful discussions with Dr. B. Szeidl and thank him for his continuous encouragement. Mr. B. Kálmán Jr. is thanked for his valuable assistance with the instruments.

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Table 2

Photographic observations

(m-10)

J.D.	205	238	297	837	1392	1397	I-I-109
2428963.487	4.17	4.21	4.27	4.28	4.25	-	3.98
28991.403	4.20	4.28	4.32	4.33	4.36	4.24	4.06
.416	4.12	4.20	-	4.23	4.33	4.23	4.01
.430	4.13	4.21	4.19	4.37	4.35	4.20	4.03
.522	4.12	4.28	4.35	4.32	4.31	4.29	4.04
.542	4.18	4.27	4.34	4.29	4.31	4.22	4.02
29346.376	4.09	4.24	4.14	4.26	4.30	4.18	4.03
.392	4.10	4.21	4.12	4.18	4.23	4.22	3.94
29719.549	4.20	4.32	4.25	4.09	4.44	4.36	4.02
.560	4.12	4.28	4.29	4.19	4.36	4.42	3.93
29720.546	-	4.28	4.32	4.33	-	-	3.95
.558	-	4.31	4.34	4.30	-	-	4.01
29774.405	4.08	4.21	4.25	-	-	4.27	3.97
.417	4.16	-	4.27	4.25	-	4.37	3.92
29775.403	4.10	4.27	4.35	4.16	4.41	4.37	4.05
.415	4.18	4.31	4.27	4.11	4.40	4.30	3.94
.426	4.19	4.23	4.29	4.20	-	4.35	3.97
.437	4.21	4.27	4.30	4.21	-	4.37	4.04
.447	-	4.34	4.28	4.24	-	4.36	4.09
30052.462	4.02	4.31	4.34	4.10	4.30	4.28	3.92
.474	3.99	4.36	4.28	-	4.26	4.19	3.94
.489	4.09	-	4.30	4.24	4.47	4.31	-
.501	3.96	4.24	4.30	4.05	4.34	4.32	3.96
30078.418	3.98	4.17	4.34	4.12	4.37	4.33	3.92
.434	3.99	4.25	4.42	4.13	4.28	4.21	-
.470	3.92	4.26	4.30	4.04	4.30	4.35	-
.483	4.02	4.24	4.28	4.20	4.39	4.20	3.85
.498	4.08	4.30	4.41	4.12	4.33	4.29	3.95
.509	4.02	4.19	4.38	4.16	4.29	4.20	3.82
.521	4.06	4.30	4.33	4.16	4.33	4.24	3.93
.536	4.03	4.24	4.32	4.14	4.33	4.23	3.84
.548	4.07	4.16	4.39	4.07	4.37	4.29	3.91
33390.497	4.11	4.26	4.28	4.24	4.31	4.43	4.24
.534	4.15	4.24	4.28	4.27	4.44	4.43	-
.545	4.14	4.21	4.29	4.18	-	4.37	4.19
.558	4.13	4.23	4.33	4.25	4.44	4.42	4.17
.570	4.15	4.20	4.30	4.20	4.38	4.34	4.21
.586	4.08	4.21	4.25	4.26	4.32	4.36	4.18
33420.424	4.10	4.20	4.18	4.16	4.44	4.38	4.15
.438	4.06	4.15	4.15	4.17	4.41	4.45	4.10
.450	4.13	4.18	4.25	4.12	4.41	4.38	4.13
.476	4.10	4.27	4.24	4.16	4.43	4.40	4.13
.487	4.08	4.22	4.14	4.16	4.35	4.40	4.07
.498	4.12	4.23	4.26	4.12	4.47	4.40	4.14
.510	4.14	4.27	4.23	4.14	4.44	4.43	4.08
.523	4.11	4.29	4.20	4.12	4.30	4.33	4.09
33421.385	4.18	4.34	4.33	4.13	4.44	4.49	4.07
.442	4.10	4.20	4.26	4.08	4.35	4.37	4.05
.454	4.11	4.26	4.27	4.04	4.37	4.42	4.04
.465	4.08	4.24	4.28	4.08	4.37	4.39	3.97
.475	4.10	4.27	4.33	4.06	4.38	4.45	4.05

Table 2 (continued)

J.D.	205	238	297	837	1392	1397	I-I-109
2433421.486	4.08	4.19	4.25	4.01	4.35	4.38	3.98
.497	4.13	4.27	4.39	-	4.32	4.46	4.00
.535	4.17	4.24	4.30	4.07	4.38	4.40	4.05
.548	4.12	4.24	4.26	4.00	4.30	4.41	4.03
33422.398	4.18	4.28	4.21	4.21	4.44	4.40	4.18
.431	4.11	4.19	4.17	4.20	4.50	4.51	4.14
.442	4.04	4.24	-	4.14	4.41	4.38	4.16
.452	4.10	4.23	4.17	4.20	4.48	-	-
.472	4.17	4.23	4.24	4.14	4.34	4.38	4.11
.483	4.15	4.29	4.27	4.24	-	4.46	4.16
.493	4.14	4.29	4.21	4.16	4.44	4.42	4.06
.508	4.08	-	4.19	-	4.40	4.36	4.04
.520	4.06	4.20	4.22	4.15	4.41	4.43	4.14
33763.406	4.12	4.25	4.32	4.12	4.37	4.39	4.12
.420	4.06	4.24	4.25	4.08	4.33	4.34	4.12
.442	4.18	4.31	4.33	4.20	4.38	4.38	4.18
.455	4.12	4.21	4.31	4.13	4.44	4.37	-
.464	4.08	4.24	4.26	4.10	4.40	4.34	4.20
.483	4.16	4.29	4.22	4.18	4.43	4.43	4.20
.494	4.18	4.31	4.24	4.17	4.40	4.36	4.15
.504	4.07	4.30	4.30	4.18	4.42	4.34	4.16
.514	4.09	4.21	4.29	4.12	4.39	4.33	4.16
.525	4.06	4.20	4.30	4.08	-	4.31	4.14
34118.355	-	4.28	4.35	-	-	-	-
.372	-	4.21	4.36	4.19	4.36	4.12	4.09
.428	-	4.10	4.34	4.02	-	-	3.84
.443	4.02	4.02	4.21	3.99	4.25	4.05	3.92
.470	-	4.21	4.33	4.24	-	4.17	-
.485	4.03	4.11	4.38	4.05	-	4.04	3.95
.499	4.13	4.22	4.30	4.14	4.35	4.12	3.98
.513	4.08	4.07	4.29	4.04	-	4.02	3.96
.540	4.05	4.15	4.37	-	4.20	4.15	-
34120.471	4.07	4.11	4.29	4.15	4.38	4.19	3.92
.484	4.10	4.11	4.30	4.21	4.38	4.21	3.92
.497	4.07	4.17	4.36	4.17	4.42	4.19	3.94
.510	4.09	4.21	4.26	4.19	4.41	4.24	3.93
.523	4.12	4.13	4.25	4.13	4.33	4.16	3.93
.536	4.17	4.20	4.34	4.11	4.40	4.18	3.89
.551	4.11	4.21	4.30	4.10	4.34	-	3.92
.564	4.21	4.20	4.31	4.24	4.36	4.29	4.03
.579	4.19	4.22	4.31	4.24	4.35	4.20	3.87
34121.401	4.06	4.14	4.27	4.12	4.36	4.17	4.04
.412	4.16	4.19	4.33	4.17	4.35	4.25	4.05
.422	4.13	4.23	4.28	4.21	4.40	4.22	4.05
.431	4.17	4.23	4.35	4.16	4.36	4.22	3.99
.441	4.13	4.13	4.28	4.14	4.32	-	3.91
.484	4.17	4.17	4.29	4.20	4.40	4.23	4.01
.495	4.10	4.14	4.26	4.17	4.37	4.18	3.99
.505	4.15	4.15	4.36	4.23	4.49	-	4.02
.517	4.07	4.14	4.26	4.13	4.36	4.14	-
.528	4.04	4.09	4.37	4.15	4.39	4.27	3.89
.539	4.04	4.09	4.29	4.17	4.40	4.15	4.02
.552	4.18	4.11	4.35	4.23	4.41	4.22	4.05

Table 2 (continued)

J.D.	205	238	297	837	1392	1397	I-I-109
2434121.562	4.15	4.16	4.31	4.15	4.42	4.23	4.05
.594	-	4.20	4.34	4.25	-	4.28	3.94
.605	4.16	4.20	4.28	4.21	-	4.21	-
34122.404	4.02	4.21	4.32	4.13	4.39	4.23	3.97
.416	4.07	4.17	4.36	4.18	4.35	4.29	3.93
.431	4.10	4.09	4.32	4.16	4.43	4.19	-
34126.433	4.07	4.19	4.33	4.13	4.27	4.21	4.07
34131.415	4.14	4.26	4.24	4.20	4.39	-	4.13
34487.347	4.06	4.23	4.28	4.25	4.35	-	-
.367	4.11	4.26	4.36	4.39	-	4.45	4.21
.385	4.12	4.28	4.27	4.36	4.40	4.36	-
.397	4.10	4.26	4.34	4.33	4.41	4.37	4.23
.410	4.14	4.20	4.31	4.32	4.40	4.31	4.21
.428	4.14	4.28	4.37	4.31	4.39	4.40	-
.438	4.13	4.22	4.27	4.30	4.42	4.38	4.24
.449	4.16	4.18	4.27	4.34	4.33	4.34	4.18
.460	4.13	4.30	4.32	4.27	4.43	4.46	4.24
.474	4.12	4.25	4.30	4.25	4.30	4.37	-
.483	-	4.22	4.33	4.26	4.33	4.33	4.23
.494	4.14	4.23	4.24	4.28	4.41	4.36	4.22
.508	4.08	4.29	4.31	4.26	4.38	4.37	4.16
.518	4.07	4.20	4.29	4.26	4.38	4.33	4.22
34488.530	4.09	4.26	4.25	4.24	4.42	4.45	4.19
.540	4.04	4.21	4.38	4.15	4.36	4.49	4.15
34567.388	4.02	4.29	4.25	4.11	4.39	4.23	4.09
35223.415	3.97	4.21	4.31	4.21	4.43	4.26	3.92
.428	4.07	4.28	4.27	4.14	4.42	4.26	3.86
.441	4.06	4.30	4.25	4.10	4.40	4.27	3.90
.467	4.11	4.31	4.26	4.14	4.39	4.26	3.94
.490	4.07	4.24	4.34	4.12	4.41	4.21	3.90
.503	4.05	4.27	4.33	4.15	4.40	4.21	3.95
.517	4.05	4.24	4.27	4.17	4.35	4.14	3.95
.530	3.97	4.25	4.32	4.15	4.29	4.24	3.97
.546	4.01	4.29	4.24	4.22	4.45	4.24	3.98
.573	4.05	4.27	4.21	4.15	4.37	4.22	3.94
35224.454	3.98	4.29	4.25	4.11	4.34	4.19	3.90
.472	4.07	4.28	4.25	4.18	4.42	4.24	3.91
.485	4.00	4.27	4.27	4.11	4.31	4.19	3.91
.499	4.07	4.32	4.31	4.17	4.32	4.26	3.99
.512	4.00	4.30	4.23	4.15	4.34	4.22	3.93
.524	4.07	4.34	4.32	4.19	4.37	4.19	4.01
.542	4.04	4.29	4.25	4.09	4.40	4.20	4.01
.556	3.99	4.28	4.37	4.11	4.41	4.18	3.98
.569	4.08	4.27	4.30	4.11	4.39	4.20	3.93
.583	4.01	-	-	4.07	4.28	4.14	3.93
35227.534	3.99	4.24	-	4.17	4.44	4.06	4.01
.547	4.11	4.23	4.17	4.18	4.37	4.16	4.08
.560	4.04	4.19	4.10	4.21	4.33	-	4.08
.573	4.13	4.30	4.19	4.17	4.31	4.13	4.10
.586	4.00	4.26	4.22	4.19	4.31	4.16	3.93
35598.507	4.03	4.23	4.23	4.19	4.31	4.30	4.10
.524	4.01	4.30	4.15	4.17	4.41	4.28	4.09
.537	4.14	4.34	4.25	4.20	4.39	4.28	4.19

Table 2 (continued)

J.D.	205	238	297	837	1392	1397	I-I-109
2435600.363	4.10	4.24	4.31	4.12	4.32	4.26	4.06
.378	4.10	4.33	4.20	4.23	4.39	4.27	4.11
.391	4.10	4.28	4.24	4.17	4.27	4.28	4.15
.405	4.04	4.31	4.32	4.19	4.47	4.36	4.05
.421	4.16	4.34	4.23	4.15	4.36	4.39	4.15
.434	4.15	4.32	4.22	-	4.44	4.23	4.11
.446	4.03	4.20	4.22	4.19	4.41	4.21	4.05
.501	4.10	4.22	4.18	4.17	4.25	4.24	4.07
.525	4.16	4.25	4.20	4.16	4.38	4.23	4.07
35603.369	4.13	4.31	4.35	4.22	4.38	4.27	4.03
.381	4.04	4.24	4.25	-	-	4.24	3.90
.397	4.07	4.31	4.40	4.23	4.40	4.32	3.92
.408	4.11	4.27	4.23	4.16	4.38	4.29	-
.419	4.03	4.18	4.31	4.15	4.39	4.33	3.97
.431	4.17	4.26	4.29	4.25	4.39	4.30	4.01
.446	4.06	4.18	4.31	4.25	4.30	4.26	-
.457	4.02	4.21	4.24	4.15	-	4.26	3.94
.468	4.13	4.29	4.33	4.22	4.45	4.29	4.05
.491	4.01	4.26	4.19	4.14	4.29	4.24	3.98
.507	4.11	4.31	4.26	4.20	4.35	4.33	3.92
36991.457	4.17	4.27	4.26	4.13	4.42	4.37	4.05
.470	4.16	4.26	-	4.09	4.40	4.36	-
.485	4.18	4.28	4.36	4.08	4.43	4.33	3.94
37018.470	4.18	4.37	4.34	4.22	4.43	4.25	-
.483	4.16	4.34	-	4.18	4.40	-	-
.496	4.14	4.33	4.32	4.10	-	-	-
.510	4.00	4.24	4.27	4.16	4.36	4.32	-
.523	4.04	4.22	4.28	4.10	4.44	4.43	-
.537	4.00	4.22	4.33	4.13	4.40	-	-
.550	4.14	4.29	4.35	4.19	4.32	4.33	-
.577	4.08	4.23	4.30	4.14	4.40	4.34	-
.609	4.06	4.31	4.28	4.10	4.31	4.27	-
.623	4.09	4.29	4.35	4.22	4.38	4.40	-
.637	4.01	4.26	4.27	4.15	4.32	4.35	-
37057.539	4.09	4.21	4.34	4.12	4.37	4.39	-
.552	3.97	4.16	4.33	4.08	4.37	4.38	-
.578	4.06	4.20	4.22	4.06	4.31	4.34	-
37058.529	-	4.14	4.21	4.07	4.43	4.32	-
.580	4.10	4.19	4.29	4.19	4.29	4.26	-
37757.598	4.19	4.27	4.40	4.13	4.47	4.40	-
37791.365	4.07	4.15	4.30	-	4.33	4.35	-
.380	4.13	4.17	4.33	4.18	4.35	4.37	-
.394	4.17	4.24	4.34	4.20	4.43	4.33	-
.424	4.18	4.24	4.27	4.22	4.41	4.21	-
.439	4.11	4.16	4.34	4.17	4.39	4.29	-
.454	4.04	4.13	4.29	4.14	4.39	4.27	-
.469	4.08	4.20	4.33	4.13	4.34	4.33	-
.483	4.07	4.15	4.35	4.11	4.41	4.24	3.88
.497	4.15	4.23	4.39	4.18	4.42	4.31	-
.519	4.17	4.26	4.31	4.14	4.43	4.34	3.90
.533	4.16	4.21	4.35	4.20	4.37	4.37	-
.549	4.05	4.19	4.30	4.11	4.37	4.32	3.86
.563	4.09	-	4.25	4.19	4.34	4.25	3.88

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TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

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PERIOD CHANGES OF DWARF CEPHEIDS, I
CY AQUARII, EH LIBRAE, DY PEGASI

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CY AQUARII, EH LIBRAE AND DY PEGASI

ABSTRACT

The period changes of the dwarf cepheids CY Aqr, EH Lib and DY Peg are discussed and O-C diagrams of these stars are constructed. EH Librae has a highly stable, constant period. The period of CY Aquarii changed suddenly in 1952 ($\Delta P = -1.81 \times 10^{-7}$ day = 0.016 sec). Before the abrupt change its period showed small fluctuations, such fluctuations have also been shown since that time. The period of DY Pegasi has become shorter during the past 45 years. At present no distinction can be made between the continuous change (at the rate $\beta = -7.6 \times 10^{-13}$ days·cycle^{-1} = -0.03 sec·century^{-1}) or the abrupt change of period ($\Delta P = -6.5 \times 10^{-8}$ day) in 1961.

INTRODUCTION

Interest has been shown in the period changes of pulsating variable stars. A dwarf cepheid lends itself well to investigations of this kind because of the large number of cycles passing in a relatively short time, say in 10 or 20 years.

The bright (m<12 mag.) northern dwarf cepheids have been on the observing programme of our observatory for several years and very many photographic and photoelectric observations of these stars have been collected during the past almost fifty years. We feel that the time is now ripe for publishing our results and we plan to publish our observations and studies in a series of papers on the following stars: GP And, CY Aqr, RV Ari, YZ Boo, AD CMi, XX Cyg, DY Her, EH Lib, SZ Lyn, V567 Oph, DY Peg and AE UMa. In the present paper the results on CY Aqr, EH Lib and DY Peg are given. A description of the equipment used both for our photographic and our photoelectric observations can be found in several publications of the Konkoly Observatory (see e.g. *Oláh* and *Szeidl*, 1978).

The observations published here represent the work of observers at the Konkoly Observatory. The photographic plates were obtained by *I. Csada* (2 plates, 45 exp.), *L. Detre* (3 plates, 73 exp.), *D. Elter* (4 plates, 126 exp.), *I. Guman* (4 plates, 65 exp.) and *J. Sinka* (1 plate, 23 exp.). The table below summarizes the photoelectric observations of our observers.

Table 1

Number of observations

Observer	CY Aqr	EH Lib	DY Peg	Total
L. Detre	-	-	43	43
K. Gefferth	-	-	6	6
K. Olah	-	48	-	48
L. Patkos	112	-	-	112
L. Szabados	-	81	34	115
B. Szeidl	50	193	472	715
J. Tatai	-	-	60	60

All the available observations on each star are discussed separately and we construct the O-C diagrams as a means of studying the period changes.

CY AQUARII

The star BD $+0^{\circ}4900$ was discovered to be variable by *Hoffmeister* (1934) on Berlin-Babelsberg patrol plates. The star first received the preliminary designation 391.1934 Aqr, shortly after it was given its final name CY Aqr. *Jensch*'s (1934a) early observation revealed a short period for this star - about 88 minutes. *Hoffmeister* confirmed this period. Later, *Jensch* (1934b) made a thorough visual investigation of this star. He also observed it photographically on old Babelsberg plates and was able to trace back its behaviour to 1928 to obtain the elements:

$$\text{Max.hel.} = \text{J.D. } 2427658.4103 + 0\overset{d}{.}0610388 \cdot E$$

Because of its very short period CY Aqr has attracted considerable attention in the past almost fifty years. It has always been a favourite object of visual observations. About 500 visual maxima have been published due to the work of *Ashbrook* (1949, 1954), *Barroso* (1969), *Braune* et al. (1972, 1977, 1979), *Busch* (1973, 1975, 1977, 1978), *Fedorov* (1950), *Figer* (1978), *Gossner* and *Ashbrook* (1946), *Graff* (1936), *Jensch* (1934a, b, 1935, 1937), *Kanishcheva* et al. (1966), *Kühn* (1951), *Lange* (1959), *Lange* and *Nekrasova* (1943), *Lause* (1934), *Mandell* et al. (1960), *Martynov* (1938), *Miczaika* (1938, 1946), *Parenago* (1935), *Pohl* and *Kizilirmak* (1964), *Rabkin* (1935), *Romanov* (1965), *Selivanov* (1934, 1936), *Smak* (1959), *Socher* (1955), *Soloviev* and *Shakovskoj* (1958), *Steinman* (1958), *Tsesevich* (1948) and *Wenzel* (1950, 1952). The star's short period, however, renders it a difficult object to study with high precision by visual methods. A more rigorous study made it evident that the visual maxima are unusable for the investigation of minute period changes. In view of this, we simply ignored the visual observations and confined ourselves to photographic and photoelectric observations.

From its discovery, the star was fairly regularly observed photographically until the early 50's and subsequently photoelectrically.

As early as in 1934 and 1935, *Balázs* and *Detre* (1935), *Dawson* (1934), *Gaposchkin* (1935), *Kulikovsky* (1937), *Schneller* (1936) and *Wachmann* (1935) made extensive photographic observations. They used fairly short exposure times in order not to distort the light curve. It is interesting to note that *Balázs* and *Detre* found no significant variations either in phase or height of maximum light whereas *Wachmann* found some deviations of the individual light curves from the mean one.

Gaposchkin (1935) and *Müller* (1935) made an attempt to determine the colour variation of CY Aqr. *Müller*'s exposure times were fairly long (6-14 minutes) compared with the star's period therefore not too much significance should be ascribed to his observations.

Wesselink (1941) started a thorough photographic investigation of this star at Leiden Observatory a month after the announcement of its discovery. His last exposure was made in the autumn of 1940 so that his homogeneous material consisted of 604 exposures covering over 36000 periods. Because the exposure times were sufficiently short ($1\frac{3}{4}$ - 2 minutes), the light curves were accurate enough to determine the correct value of the period:

$$P = 0.061\,038\,4798 \text{ day}$$
$$\pm .000\,000\,0061$$

The light curves appeared to be quite regular. For his period discussion *Wesselink* used a special point on the ascending branch of the light curves and did not give the epochs of maximum light. Using his mean light curve we were able to derive 18 times of maximum light from his rich observational material.

During the war less attention was paid to this star. The only publication was that of *Gossner* and *Ashbrook* (1946) who published three photographic maximum times for the year 1944.

Lohmann and *Miczaika* (1947), investigated the star's colour and light variation using their photographic and photovisual exposures made on two consecutive nights in 1946. The photovisual exposures were too long so they were not utilized to determine times of maximum light.

Alania (1954, 1956) also made photographic observations and published two epochs of light maximum but because of their very low accuracy they have been omitted from our discussion of period changes.

Both the photographic and the visual observations led to hopes of interesting results in the early 50's. Combining his observations with those of other astronomers *Ashbrook* (1954) stated that a phase jump of 0.0028 day had occurred about 1944-45. *Sauer* (1953) fancied waves on the visual light curve. Since 1950 a great number of photoelectric observations has been collected and we now know the photometric behaviour of the star fairly well. The light curve is smooth and is characteristic of the group to which the star belongs.

Detre was the first to observe CY Aqr photoelectrically. On four nights in 1950 and 1954 he made some two hundred observations without filters and obtained seven times of maximum light. As these observations were available, we thought it reasonable to publish here the epochs of the maxima mentioned (see Table 3).

Smith (1955) made a thorough investigation of the intrinsic variables with periods of less than 0.2 day and proposed the name "dwarf cepheids" for this group of stars. Among these objects he observed CY Aqr as well. Unfortunately, his observations are unavailable to the present authors.

The first photoelectric observations to be published were those of *Detre* and *Chang* (1960). Their nearly two hundred photoelectric measurements were made at the Purple Mountain Observatory, China, without filters on four nights in 1959. The variation in height and phase of the maxima was less than 0.06 mag. and 0.001 day, respectively, which showed a good repetitive nature of the light variation. *Detre* and *Chang* published only two epochs of maximum light but their observations allowed the determination of three further epochs. They also noticed that the O-C diagram could no longer be approximated by a linear formula and they derived an ephemeris with a quadratic term:

$$\text{Max.hel.} = \text{J.D. } 2427658.4079 + 0^{d}\!.061038576\cdot E - 7^{d}\!.42\times10^{-13}\cdot E^{2}.$$

Hardie and *Tolbert* (1961) secured over sixteen hundred UBV observations on thirteen nights in 1959 and 1960. They found the light curves to be somewhat variable in shape and amplitude (about 0.1 mag.) at different cycles. A discussion of all the data available to them suggested that the period was gradually decreasing and a second-degree solution seems to have appeared to them as being satisfactory:

$$\text{Max.hel.} = \text{J.D. } 2431291.6657 + 0^{d}\!.061038475\cdot E - 6^{d}\!.0\times10^{-13}\cdot E^{2}.$$

These same authors published only four epochs of maxima (*Hardie* and *Tolbert*, 1961). Their observations did, however, make it possible to determine the times of 22 individual maxima.

In the same year *Geyer* (1961) also published his study on short-periodic, pulsating variables. In his paper he gave an epoch of maximum light of CY Aqr.

Sanwal (1962) reported 39 times of maxima of this star observed at the Uttar Pradesh State Observatory, India, on twenty-two nights during the years 1959 to 1961. He found that the period had decreased significantly since the early observations.

In 1960 on one night 36 narrow band observations were secured by *McNamara* et al. (1961) for a study of the physical parameters of CY Aqr. One epoch of maximum was given by *McNamara* et al.; a further one could, however, be deduced from their observations.

Oosterhoff published *Ponsen*'s five-colour observations obtained on one night in August, 1961 (*Ponsen* and *Oosterhoff*, 1966). These observations have allowed us to determine an epoch of maximum light. *Fitch* et al. (1966) also observed this star in the UBV system on two nights in 1964 and gave two times of maximum.

In September-October 1964 *Karetnikov* and *Medvedev* (1966) also observed this star and collected almost 600 observations in B and V on 11 nights. They determined 11 times of maxima and, combining these epochs with all the others available to them, they obtained the new elements with a quadratic term:

$$\text{Max.hel.} = \text{J.D. } 2431291.6657 + 0^{d}\!.061038475\cdot E - 6^{d}\!.35\times10^{-13}\cdot E^{2}.$$

Judging by their measurements, CY Aqr does not have a significant light curve variation (it being less than 0.1 mag. in the height of maximum in both colours).

Zissell (1968) obtained more than 2000 photoelectric observations in V during the autumns of 1965 and 1966. These observations covered twenty-four cycles and made possible an accurate study of the variations in the period of CY Aqr. In his study *Zissell* used the epochs of the magnitude on the rising branch at which the rising and descending branches were separated by 0.220 period. The corresponding epochs of that critical magnitude are given in his paper only. Since in our investigations we have always used the times of maximum light we had to determine these times from *Zissell*'s material. In contrast with *Detre* and *Chang*'s (1960), *Hardie* and *Tolbert*'s (1961) and *Karetnikov* and *Medvedev*'s (1966) results *Zissell* stated that the period was essentially constant, at least between 1953 and 1966:

$$P = 0.061\ 038\ 3405 \text{ day}$$
$$\pm.000\ 000\ 0022$$

and that an ephemeris with a quadratic term was inadequate as a means of accounting for all the observations. *Zissell* also found from his observations that the individual cycles were significantly different, especially at maximum. The variation in the height of maximum exceeded 0.1 mag.

Nather and *Warner* (1972) made sequential three colour observations of CY Aqr on two nights in November 1970, with fairly high time resolution. They did not find the irregularities on the light curves reported by other observers. Since *Nather* and *Warner*'s technique was superior to that of other observers, the reported irregularities can obviously be explained by the inferior technique. According to *Nather* and *Warner* the light curve of CY Aqr is smooth but small changes in the height of light maximum may occur. Their excellent observations also show that no dependence of time of maximum on colours could be obtained.

Elst (1972) looked for overtones in the pulsation of CY Aqr. He analysed *Zissell*'s (1968) and his own 255 UBV observations and found a beat period of P_b= 0.1222 day. He remarked, however, that the beat phenomenon of this star was very small and therefore his results could not be regarded as definitive.

Fitch (1973) reanalysed the published photoelectric observations and found that CY Aqr had a beat period of probable length 0.17766 day. His result can be interpreted using the present theory of pulsation whereas *Elst*'s result is not consistent with that.

Percy (1975) rediscussed all the observations available to him. According to his investigation the period of CY Aqr remained constant from 1934 to 1951, changed abruptly in 1951, and since then it has remained constant again. He also analysed several well observed light curves of this star by the maximum entropy method of spectral analysis and found that the beat period of *Elst* (1972) was not real; it was, rather, an artifact of his harmonic analysis method.

A fairly high speed photoelectric photometry was carried out by *Geyer* and *Hoffmann* (1974, 1975a) with a double-beam photometer in B and V for five consecutive cycles in October 1973. They published six times of maxima. It is worth mentioning that their observations did not confirm the beat period given by either *Elst* (1972) or *Fitch* (1973). They considered it likely that the beat phenomenon of this star was fictitious.

Recently, *Ficarrotta* and *Romoli* (1979) performed photoelectric observations in B and V, and published 14 times of light maxima for the years 1974 and 1977.

Since 1935 a great number of photographic and photoelectric observations have been collected at the Konkoly Observatory, Budapest, in order to study the stability of the period of CY Aqr. The 267 photographic observations obtained on ten nights between 1935 and 1952 are given in Table 9. In measuring the photographic plates we used the comparison stars of *Balázs* and *Detre* (1935). These observations allowed us to determine 12 epochs of photographic maxima.

The photoelectric investigation of this star in two colours was commenced at Konkoly Observatory in 1972. In all, 162 observations have been collected and are given in Tables 10-11. As a comparison star we used BD $+0^{\circ}4903$. Table 2 gives the comparison stars for CY Aqr used by different authors.

Table 2

Comp. star	V	B−V	U−B	References
BD $+0^{\circ}4902$	9.72	+0.76	+0.38	Hardie and Tolbert (1961)
BD $+0^{\circ}4903$	10.19	+1.32		Geyer (1961)
	10.08	+1.19		present paper
BD $+0^{\circ}4906$	9.69	+0.50		Karetnikov and Medvedev (1966)

The differential magnitudes were corrected for transformation to the standard system and for differential extinction. In Figure 1 all our photoelectric B and V observations are plotted against phase.

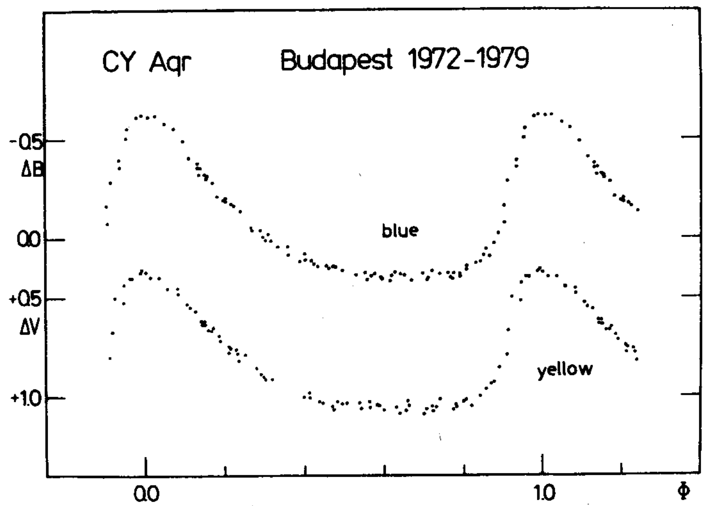

Figure 1: B and V light curves of CY Aqr

In Table 3 we have gathered all the photographic and photoelectric maxima available to us; as we mentioned earlier, we disregarded the visual maxima. The O-C diagram (Figure 2) was completed by using the ephemeris:

$$\text{Max.hel.} = \text{J.D. } 2434308.4310 + 0\overset{d}{.}061038395 \cdot E.$$

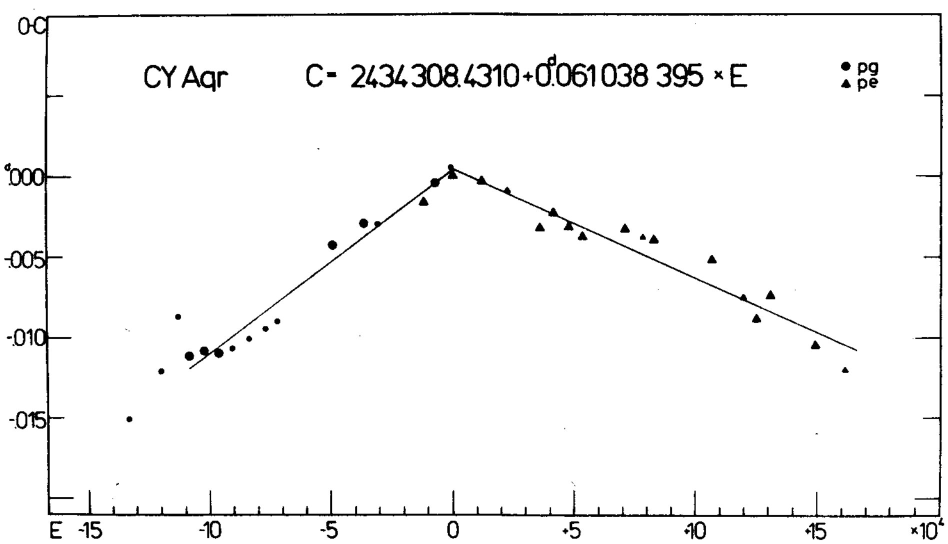

Figure 2: O-C diagram of CY Aqr

Table 3

Photographic and photoelectric maxima of CY Aqr

year	Hel.Max.J.D.	Remarks	E	O-C	$\overline{E}$	$\overline{O-C}$	n
1930	2426159.485	pg Je[1]	-133505	-0.0151	-133505	-0.0151	1
1932	27013.293	pg Je[1]	-119517	-0.0121	-119517	-0.0121	1
1933	413.220	pg Je[1]	-112965	-0.0087	-112965	-0.0087	1
1934	671.5317	pg BD	-108733	-0.0115	-108294	-0.0112	19
	.5922	pg BD	-108732	-0.0120			
	684.4712	pg Wa	-108521	-0.0121			
	685.3875	pg Wa	-108506	-0.0114			
	688.3780	pg Wa	-108457	-0.0118			
	.5010	pg BD	-108455	-0.0109			
	690.3940	pg BD	-108424	-0.0101			
	692.5287	pg Wa	-108389	-0.0117			
	.652	pg Ga	-108387	-0.0105			
	693.3829	pg We[2]	-108375	-0.0120			
	.4462	pg BD	-108374	-0.0098			
	694.3590	pg Wa	-108359	-0.0126			
	695.4600	pg BD	-108341	-0.0102			
	697.4721	pg We[2]	-108308	-0.0124			
	710.5949	pg Da	-108093	-0.0129			
	712.3069	pg BD	-108065	-0.0099			
	717.4332	pg Wa	-107981	-0.0109			
	744.2302	pg BD	-107542	-0.0097			
	.2909	pg BD	-107541	-0.0101			
1935	28045.3924	pg Pp	-102608	-0.0110	-102360	-0.0108	14
	046.3071	pg Ku[2]	-102593	-0.0118			
	.4901	pg Ku[2]	-102590	-0.0120			
	047.2826	pg Ku[2]	-102577	-0.0130			
	.3464	pg Ku[2]	-102576	-0.0102			
	.4064	pg Ku[2]	-102575	-0.0112			
	.4065	pg Mü	-102575	-0.0111			
	.4668	pg Ku[2]	-102574	-0.0119			
	048.3823	pg Ku[2]	-102559	-0.0119			
	074.3254	pg Pp	-102134	-0.0102			
	.3860	pg Pp	-102133	-0.0106			
	090.3189	pg Sc[2]	-101872	-0.0087			
	.3800	pg Sc[2]	-101871	-0.0087			
	094.2860	pg Sc[2]	-101807	-0.0091			
1936	397.5233	pg Pp	- 96839	-0.0106	- 96184	-0.0110	11
	422.4259	pg We[2]	- 96431	-0.0116			
	.4874	pg We[2]	- 96430	-0.0112			
	.5490	pg We[2]	- 96429	-0.0106			
	423.3418	pg We[2]	- 96416	-0.0113			
	.4027	pg We[2]	- 96415	-0.0114			
	.4650	pg We[2]	- 96414	-0.0102			
	.5251	pg We[2]	- 96413	-0.0111			
	451.4802	pg We[2]	- 95955	-0.0116			
	501.2275	pg We[2]	- 95140	-0.0106			
	.2878	pg We[2]	- 95139	-0.0113			
1937	782.5534	pg We[2]	- 90531	-0.0107	- 90531	-0.0107	1
1938	29195.3568	pg We[2]	- 83768	-0.0099	- 83719	-0.0101	2
	201.3382	pg We[2]	- 83670	-0.0103			
1939	568.3020	pg We[2]	- 77658	-0.0093	- 77486	-0.0095	2
	589.2989	pg We[2]	- 77314	-0.0096			

Table 3 (cont.)

year	Hel.Max.J.D.	Remarks	E	O-C	$\overline{E}$	$\overline{O-C}$	n
1940	2429880.4529	pg We[2]	− 72544	−0.0088	− 72144	−0.0090	2
	929.2833	pg We[2]	− 71744	−0.0091			
1944	31268.8978	pg GA	− 49797	−0.0042	− 49486	−0.0043	3
	296.9139	pg GA	− 49338	−0.0048			
	297.8304	pg GA	− 49323	−0.0038			
1946	32091.3914	pg LM[2]	− 36322	−0.0030	− 36310	−0.0029	4
	.4532	pg LM[2]	− 36321	−0.0023			
	092.3680	pg LM[2]	− 36306	−0.0030			
	093.4056	pg Pp	− 36289	−0.0031			
1947	440.4700	pg Pp	− 30603	−0.0030	− 30603	−0.0030	1
1950	33560.4638	pe De	− 12254	−0.0027	− 12219	−0.0016	4
	563.2728	pe De	− 12208	−0.0015			
	.3350	pe De	− 12207	−0.0003			
	.3947	pe De	− 12206	−0.0017			
1951	860.5310	pg Pp	− 7338	−0.0003	− 7281	−0.0004	4
	861.5070	pg Pp	− 7322	−0.0009			
	.5679	pg Pp	− 7321	−0.0010			
	(867.452	pg Al	− 7224	−0.0376)			
	872.5565	pg Pp	− 7141	+0.0007			
1952	34253.5575	pg Pp	− 899	0.0000	− 762	+0.0005	2
	270.3440	pg Pp	− 624	+0.0010			
	308.4310	pe Sm[3]	0	0.0000	0	0.0000	1
1954	35032.4075	pe De	+ 11861	+0.0001	+ 12071	−0.0003	4
	036.3750	pe De	+ 11926	+0.0001			
	.4353	pe De	+ 11927	−0.0006			
	075.6218	pe HT[4]	+ 12569	−0.0008			
1955	(337.422	pg Al	+ 16858	+0.0057)			
1956	689.9121	pe HT[4]	+ 22633	−0.0009	+ 22633	−0.0009	1
1958	36487.1936	pe Sa	+ 35695	−0.0029	+ 36292	−0.0033	18
	490.1231	pe Sa	+ 35743	−0.0033			
	.1837	pe Sa	+ 35744	−0.0037			
	.3068	pe Sa	+ 35746	−0.0027			
	491.2216	pe Sa	+ 35761	−0.0034			
	.2831	pe Sa	+ 35762	−0.0030			
	492.1979	pe Sa	+ 35777	−0.0038			
	.2595	pe Sa	+ 35778	−0.0032			
	.3201	pe Sa	+ 35779	−0.0036			
	541.2740	pe Ge	+ 36581	−0.0025			
	546.0949	pe Sa	+ 36660	−0.0037			
	.1555	pe Sa	+ 36661	−0.0041			
	549.0860	pe Sa	+ 36709	−0.0034			
	.1472	pe Sa	+ 36710	−0.0033			
	568.0690	pe Sa	+ 37020	−0.0034			
	569.0457	pe Sa	+ 37036	−0.0033			
	.1069	pe Sa	+ 37037	−0.0031			
	570.0834	pe Sa	+ 37053	−0.0032			
1959	735.8044	pe HT[2]	+ 39768	−0.0015	+ 41546	−0.0023	26
	.8654	pe HT[2]	+ 39769	−0.0015			
	749.7819	pe HT[2]	+ 39997	−0.0018			
	.8432	pe HT[2]	+ 39998	−0.0015			
	792.6920	pe HT[2]	+ 40700	−0.0017			
	.7528	pe HT[2]	+ 40701	−0.0019			
	.8750	pe HT[2]	+ 40703	−0.0018			
	803.8012	pe HT[2]	+ 40882	−0.0015			

Table 3 (cont.)

year	Hel.Max.J.D.	Remarks	E	O-C	$\overline{E}$	$\overline{O-C}$	n
1959	2436803.8617	pe HT[2]	+ 40883	-0.0020			
	832.6114	pe HT[2]	+ 41354	-0.0014			
	.7330	pe HT[2]	+ 41356	-0.0019			
	835.6017	pe HT[2]	+ 41403	-0.0020			
	.6624	pe HT[2]	+ 41404	-0.0023			
	842.6818	pe HT[2]	+ 41519	-0.0023			
	.7430	pe HT[2]	+ 41520	-0.0022			
	845.7345	pe HT[2]	+ 41569	-0.0015			
	871.1246	pe Sa	+ 41985	-0.0034			
	902.0108	pe DC[2]	+ 42491	-0.0026			
	.0716	pe DC[2]	+ 42492	-0.0029			
	903.0490	pe DC	+ 42508	-0.0021			
	906.0397	pe DC	+ 42557	-0.0023			
	928.0728	pe Sa	+ 42918	-0.0040			
	.1343	pe Sa	+ 42919	-0.0036			
	.9895	pe DC[2]	+ 42933	-0.0029			
	929.0511	pe Sa	+ 42934	-0.0024			
	.1105	pe Sa	+ 42935	-0.0040			
1960	37195.7276	pe HT[2]	+ 47303	-0.0026	+ 47759	-0.0032	21
	.7894	pe HT[2]	+ 47304	-0.0018			
	196.6437	pe HT[2]	+ 47318	-0.0021			
	.7054	pe HT[2]	+ 47319	-0.0014			
	.7658	pe HT[2]	+ 47320	-0.0021			
	198.2906	pe Sa	+ 47345	-0.0032			
	202.1968	pe Sa	+ 47409	-0.0035			
	204.1506	pe Sa	+ 47441	-0.0029			
	222.1557	pe Sa	+ 47736	-0.0041			
	.2165	pe Sa	+ 47737	-0.0044			
	224.2303	pe Sa	+ 47770	-0.0048			
	225.6365	pe HT[2]	+ 47793	-0.0025			
	.6978	pe HT[2]	+ 47794	-0.0023			
	226.1231	pe Sa	+ 47801	-0.0042			
	233.6340	pe Mc	+ 47924	-0.0010			
	.6940	pe Mc[2]	+ 47925	-0.0021			
	250.1112	pe Sa	+ 48194	-0.0042			
	253.1013	pe Sa	+ 48243	-0.0050			
	255.1161	pe Sa	+ 48276	-0.0045			
	257.1307	pe Sa	+ 48309	-0.0041			
	279.1041	pe Sa	+ 48669	-0.0045			
1961	524.5425	pe PO[2]	+ 52690	-0.0015	+ 53450	-0.0038	6
	578.1311	pe Sa	+ 53568	-0.0046			
	.1930	pe Sa	+ 53569	-0.0038			
	.2539	pe Sa	+ 53570	-0.0039			
	583.1360	pe Sa	+ 53650	-0.0049			
	.1980	pe Sa	+ 53651	-0.0039			
1964	38643.4958	pe KM	+ 71022	-0.0041	+ 71292	-0.0033	13
	644.4117	pe KM	+ 71037	-0.0038			
	645.3895	pe KM	+ 71053	-0.0026			
	.4508	pe KM	+ 71054	-0.0023			
	652.4082	pe KM	+ 71168	-0.0033			
	.4693	pe KM	+ 71169	-0.0032			
	653.4454	pe KM	+ 71185	-0.0037			
	654.4835	pe KM	+ 71202	-0.0033			
	675.2981	pe KM	+ 71543	-0.0028			

Table 3 (cont.)

year	Hel.Max.J.D.	Remarks	E	O-C	$\overline{E}$	$\overline{O-C}$	n
1964	2438675.3592	pe KM	+ 71544	-0.0027			
	676.3344	pe KM	+ 71560	-0.0041			
	680.730	pe Fi	+ 71632	-0.0033			
	.791	pe Fi	+ 71633	-0.0033			
1965	39089.5647	pe Zi^{a}	+ 78330	-0.0038	+ 78330	-0.0038	1
1966	350.6861	pe Zi^{b}	+ 82608	-0.0046	+ 83001	-0.0040	22
	.7490	pe Zi^{b}	+ 82609	-0.0028			
	.8087	pe Zi^{b}	+ 82610	-0.0041			
	.8692	pe Zi^{b}	+ 82611	-0.0046			
	351.7253	pe Zi^{b}	+ 82625	-0.0031			
	.8460	pe Zi^{b}	+ 82627	-0.0045			
	355.6920	pe Zi^{b}	+ 82690	-0.0039			
	.7546	pe Zi^{b}	+ 82691	-0.0023			
	.8145	pe Zi^{b}	+ 82692	-0.0035			
	.8763	pe Zi^{b}	+ 82693	-0.0027			
	356.7300	pe Zi^{b}	+ 82707	-0.0035			
	.7908	pe Zi^{b}	+ 82708	-0.0038			
	.8527	pe Zi^{b}	+ 82709	-0.0029			
	401.5920	pe Zi^{b}	+ 83442	-0.0048			
	.6527	pe Zi^{b}	+ 83443	-0.0051			
	.7139	pe Zi^{b}	+ 83444	-0.0049			
	405.6204	pe Zi^{b}	+ 83508	-0.0049			
	.6822	pe Zi^{b}	+ 83509	-0.0041			
	.7428	pe Zi^{b}	+ 83510	-0.0046			
	406.5980	pe Zi^{b}	+ 83524	-0.0039			
	.6578	pe Zi^{b}	+ 83525	-0.0051			
	.7196	pe Zi^{b}	+ 83526	-0.0044			
1970	40779.7783	pe El^{a}	+106021	-0.0044	+106768	-0.0052	5
1973	.8390	pe El^{a}	+106022	-0.0047			
	.9005	pe El^{a}	+106023	-0.0043			
	892.6364	pe NW	+107870	-0.0063			
	894.6507	pe NW	+107903	-0.0062			
1972	41623.2647	pe Pp	+119840	-0.0076	+119840	-0.0076	1
	958.3639	pe GH	+125330	-0.0091	+125344	-0.0089	6
	959.2799	pe GH	+125345	-0.0087			
	.3405	pe GH	+125346	-0.0092			
	.4018	pe GH	+125347	-0.0089			
	.4634	pe GH	+125348	-0.0083			
	.5234	pe GH	+125349	-0.0094			
1974	42302.5015	pe FR	+130968	-0.0060	+130987	-0.0074	7
	.5607	pe FR	+130969	-0.0079			
	303.4778	pe FR	+130984	-0.0063			
	.5371	pe FR	+130985	-0.0081			
	304.3927	pe FR	+130999	-0.0070			
	.4533	pe FR	+131000	-0.0074			
	.5126	pe FR	+131001	-0.0092			
1977	43401.3706	pe FR	+148971	-0.0111	+148981	-0.0105	7
	.4327	pe FR	+148972	-0.0101			
	.4937	pe FR	+148973	-0.0101			
	402.3478	pe FR	+148987	-0.0106			
	.4086	pe FR	+148988	-0.0108			
	.4699	pe FR	+148989	-0.0105			
	.5311	pe FR	+148990	-0.0104			
1979	44158.3069	pe Pp	+161372	-0.0120	+161372	-0.0120	1

Remarks to Table 3: Je = Jensch (1934b), BD = Balazs and Detre (1935), Wa = Wachmann (1935), Ga = Gaposchkin (1935), We = Wesselink (1941), Da = Dawson (1934), Ku = Kulikovsky (1937), Mü = Müller (1935), Sc = Schneller (1936), GA = Gossner and Ashbrook (1946), LM = Lohmann and Miczaika (1947), De = Detre (unpubl.), Al = Alania (1954, 1956), Sm = Smith (1955), HT = Hardie and Tolbert (1961), Sa = Sanwal (1962), Ge = Geyer (1961), DC = Detre and Chang (1960), Mc = McNamara et al. (1961), PO = Ponsen and Oosterhoff (1966), KM = Karetnikov and Medvedev (1966), Fi= Fitch et al. (1966), Zi = Zissell (1968), El = Elst (1972), NW = Nather and Warner (1972), GH = Geyer and Hoffmann (1974), FR= Ficarrotta and Romoli (1979), Pp = present paper
pg = photographic, pe = photoelectric, [1]= normal maxima, [2]= maximum time determined by us, [3]= as quoted by Sanwal (1962), [4]= observed by Fitch, [5]= maximum time determined by Fitch (1973)

We are convinced, from the O-C diagram, that the period change of CY Aqr cannot be described by a quadratic term. Our results are in agreement with *Percy*'s (*Percy*, 1975): the period of CY Aqr remained more or less constant until 1952, at that time it changed abruptly and became shorter after which it again remained constant.

Using the yearly means of the O-C values in Table 3 we formed yearly mean epochs of maximum light. These mean photographic and photoelectric maxima of CY Aqr are given in Table 4. The data of this table were used to carry out a least-squares solution for the period before 1952 (C_1) and after it (C_2). The resulting ephemerides are:

$$C_1\text{(Max.hel.)} = \text{J.D. } 2434308.4314 + 0\overset{d}{.}061038509\cdot E$$
$$C_2\text{(Max.hel.)} = \text{J.D. } 2434308.4314 + 0\overset{d}{.}061038328\cdot E$$

Table 4

Mean photographic and photoelectric maxima of CY Aqr

year	Mean Hel. Max.		W	E	$O-C_1$	$O-C_2$
1930	J.D.2426159.485	pg	0	-133505	-0.0003	--
1932	27013.293	pg	0	-119517	+0.0011	--
1933	27413.220	pg	0	-112965	+0.0038	--
1934	27698.3279	pg	2	-108294	+0.0008	--
1935	28060.5301	pg	2	-102360	+0.0005	--
1936	28437.5030	pg	2	- 96184	-0.0005	--
1937	28782.5534	pg	1	- 90531	-0.0007	--
1938	29198.3475	pg	1	- 83719	-0.0010	--
1939	29578.8004	pg	1	- 77486	-0.0011	--
1940	29904.8680	pg	1	- 72144	-0.0012	--
1944	31287.8807	pg	2	- 49486	+0.0010	--
1946	32092.1240	pg	2	- 36310	+0.0009	--
1947	32440.4700	pg	1	- 30603	+0.0001	--
1950	33562.6013	pe	2	- 12219	-0.0006	--
1951	33864.0101	pg	2	- 7281	+0.0001	--
1952	34261.9202	pg	1	- 762	+0.0001	--

Table 4 (cont.)

year	Mean Hel. Max.	W	E	$O-C_1$	$O-C_2$
1952	J.D 2434308.4310	pe 2	0	-0.0004	-0.0004
1954	35045.2252	pe 2	+ 12071	--	+0.0001
1956	35689.9121	pe 1	+ 22633	--	+0.0002
1958	36523.6331	pe 2	+ 36292	--	-0.0013
1959	36844.3299	pe 2	+ 41546	--	+0.0001
1960	37223.5605	pe 2	+ 47759	--	-0.0004
1961	37570.9294	pe 2	+ 53450	--	-0.0006
1964	38659.9770	pe 2	+ 71292	--	+0.0011
1965	39089.5647	pe 1	+ 78330	--	+0.0011
1966	39374.6748	pe 2	+ 83001	--	+0.0011
1970	40825.3732	pe 2	+106768	--	+0.0016
1972	41623.2647	pe 1	+119840	--	+0.0001
1973	41959.2187	pe 2	+125344	--	-0.0009
1974	42303.6599	pe 2	+130987	--	+0.0010
1977	43401.9816	pe 2	+148981	--	-0.0009
1979	44158.3069	pe 1	+161372	--	-0.0016

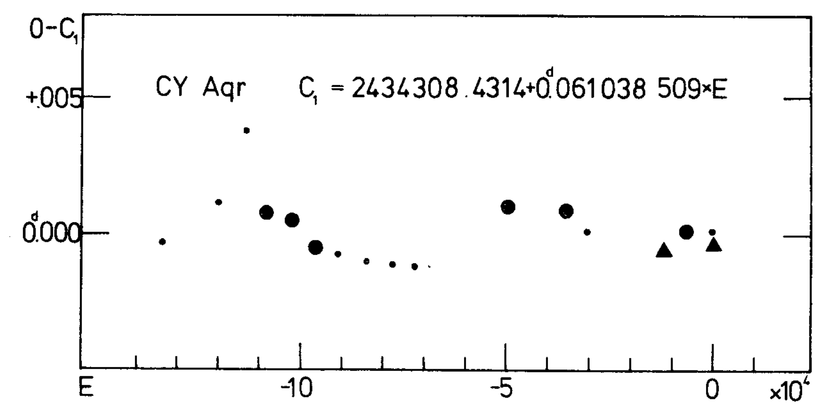

Figure 3: $O-C_1$ diagram of CY Aqr

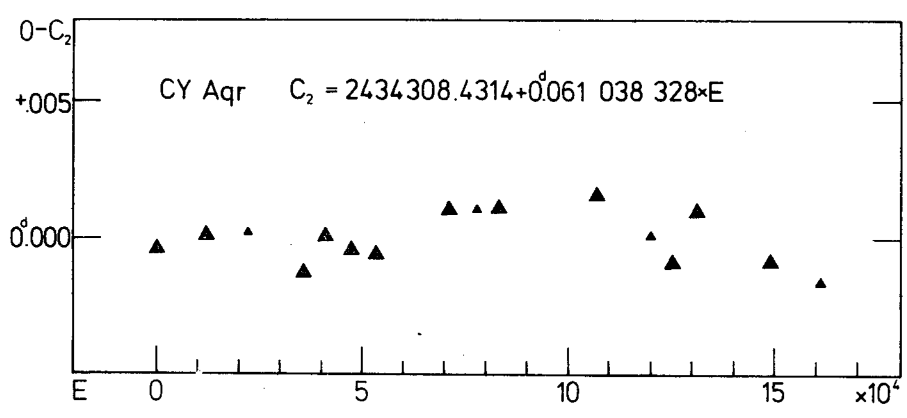

Figure 4: $O-C_2$ diagram of CY Aqr

The corresponding $O-C_1$ and $O-C_2$ diagrams are plotted in Figures 3 and 4, respectively. Some fluctuations with an amplitude of 0.002 day ≈ 3 minutes are clearly seen, but these do not appear to be periodic. Obviously the reality of these fluctuations can be questioned. They may be caused by systematic differences between the results of different authors. But the phase shift around E = -60000 was already noticed by *Ashbrook* (1954). His result also supports the idea that the period of CY Aqr before and after the large period jump (1.81×10^{-7}day ≈ 0.016sec) has not been strictly constant, it has always been subject to small random variations (in this context see *Balázs-Detre* and *Detre*, 1965).

EH LIBRAE

The star BD $-0^{o}2911$ ($8^{m}.9$) = EH Lib was found to be variable in light by *A.N. Vyssotsky* on an objective prism plate. He took note of the variation in density across the width of its spectrum. *Code* (1950) observed the star photoelectrically on three successive nights, June 4 through June 6, 1950. He determined the type of variability and gave a preliminary period of the star as 0.08842 day.

In the following year *Ashbrook* (1952) made 83 photographic observations which yielded three heliocentric Julian dates of maximum light and which resulted in the accurate new elements:

$$\text{Max.hel.} = \text{J.D. } 2433673.1688 + 0^{d}.08841381 \cdot E$$

Since *Code*'s photoelectric and *Ashbrook*'s photographic observations a great number of visual observations have been collected. *Batyrev* (1951, 1953a, 1957, 1964) observed the star visually between 1951 and 1963 and, utilizing his some 560 observations, he gave the time of 23 individual light maxima. He stated that light curve variation was present but he could not determine the secondary period. *Tsesevich* (1956) also gave a visual normal maximum.

The German amateurs (*Pohl*, 1954; *Braune* and *Hübscher*, 1967; *Braune, Hübscher* and *Mundry*, 1970, 1972, 1977, 1979; *Braune* and *Mundry*, 1973; *Berthold*, 1976) have been particularly busy in obtaining visual observations. Between 1951 and 1977 they determined 68 dates of visual maximum.

Berdnikov (1972, 1975, 1977) also put EH Lib on his observing programme of dwarf cepheids. Between 1972 and 1975 he made nearly 700 visual estimations, determined more than 30 maxima, and gave four normal maxima; one for each year from 1972 to 1975. Mostly discussing the visual observations he suggested that the period of the star varied with a period of about 1800 days ≈ 20400 cycles and the form of the light curve changed. As we shall see later on these statements are completely erroneous.

Because the observational errors of visual light estimation are always large and, in consequence, the errors in dates of visual light maxima are considerable, we have ignored all the observed visual maxima and have not listed them in Table 5. In a scrupulous period analysis they are of no value.

Some photographic observations were also made on the star.

Alania (1954), using only a few observations, gave a poorly determined time of photographic maximum. Although this is given in the table of maxima (Table 5), it has been disregarded in constructing the O-C diagram of EH Lib (Figure 6).

Burnicki and *Krygier* (1958) photographically investigated the colour variation of the variable during its light variation. From May 1954 to May 1956, 66 exposures were made: 41 in the pg and 25 in the pv spectral region. Even though *Burnicki* and *Krygier* gave no epochs of maximum light, we were able to determine one normal maximum from their accurate measurements.

The last observers to report on photographic observations were *Harding* and *Penston* (1966). Curiously enough their photographic photometry definitely indicated a period of less than 2 hours in 1965, and over a period of a year they deduced a period of 0.082478 day. In view of this, it is rather surprising that the maximum time given by them fits very well in the O-C diagram (Figure 6) calculated using our elements. We are convinced that the period was around $2^h07^m18\overset{s}{.}9$ in 1965. *Harding* and *Penston's* observations were somewhat poorer, but unfortunately they did not publish their measurements and it is thus hard to judge their mistake.

Fitch (1957) observed EH Lib photoelectrically in three colours of the UBV system, his observations totalled 6.1 cycles on 4 nights in 1955 and 1956. In a result inconsistent with the poor visual observations, he found that the light curve of the variable is quite regular and the height of maximum varies by less than ±0.015 mag. From a very accurate analysis of his photoelectric light curves of high precision he found a mean difference maximum minus median = +0.0086 ±0.0003 m.e. Using this value we converted his 8 epochs of median magnitude to the epochs of maximum light (6 in 1955 and 2 in 1956) and these dates are given in Table 5. He also noted that "maximum brightness in blue and yellow occurs at the same phase, within the limits of error of the observations". *Fitch*'s comparison star was BD $-0^{\circ}2909$ with its magnitude and colours as follows: V = 10.26, B-V = +0.44 and U-B = -0.03. Using the observations from 1950 to 1956 *Fitch* gave the highly accurate ephemeris:

$$\text{Max.hel.} = \text{J.D. } \underset{\pm.0003}{2433438.6078} + \underset{\pm.00000002}{0^{d}.08841325} \cdot E$$

In 1960 and 1961 *Sanwal* and *Pande* (1961) carried out photoelectric observations in blue and yellow lights on ten nights covering 15 cycles. They also found the light curve of this variable star quite regular and did not detect any differences between times of maximum brightness in blue and yellow light. They listed 9 epochs of maximum light for the year 1960 and 5 epochs for 1961. Their least-squares solution yielded the following very good elements:

$$\text{Max.hel.} = \text{J.D. } \underset{\pm.0003}{2433438.6079} + \underset{\pm.00000001}{0^{d}.08841324} \cdot E$$

In 1960 *Oosterhoff* and *Walraven* (1966) obtained more than 400 five-colour measurements of EH Librae, that unambiguously show the strictly repetitive nature of the light variation. They published three new epochs of light maximum. Because *Oosterhoff* and *Walraven* took into account the visual observations of low weight, as well, their elements:

$$\text{Max.hel.} = \text{J.D. } 2433438.6090 + 0^{d}.088413216 \cdot E$$

are less accurate than the elements determined by *Fitch* and by *Sanwal* and *Pande*.

Fitch et al. (1966) made 120 photoelectric observations in UBV on three nights in 1964, and gave two dates of maximum. Using *Fitch*'s (1957) old mean light curves we redetermined the two dates from their new observations. We have already listed these new epochs in Table 5.

Among other variable stars *Epstein* (1969) observed EH Lib in 1966 in the four-colour system of *Strömgren* and *Perry*. Unfor-

Table 5

Photographic and photoelectric maxima of EH Lib

year	Hel.Max.J.D.	Remarks	E	O-C	$\overline{E}$	$\overline{O-C}$	n
1950	2433438.6076	pe Co	0	-0.0002	0	-0.0002	1
1951	711.7165	pg As	+ 3089	+0.0002	3308	-0.0002	3
	737.709	pg As	3383	-0.0008			
	743.722	pg As	3451	+0.0001			
1953	(34485.518	pg Al	11841	+0.0090)	11868	-0.0003	2
	487.454	pg Pp	11863	-0.0001			
	488.426	pg Pp	11874	-0.0006			
1955	35223.7596	pe Fi	20191	0.0000	20271	+0.0002	6
	.8478	pe Fi	20192	-0.0002			
	.9372	pe Fi	20193	+0.0008			
	225.7932	pe Fi	20214	+0.0001			
	243.7414	pe Fi	20417	+0.0004			
	.8298	pe Fi	20418	+0.0004			
1956	599.958	pg BK[1]	24446	+0.0001	24446	+0.0001	1
	622.6799	pe Fi	24703	-0.0002	24704	-0.0001	2
	.7686	pe Fi	24704	0.0000			
1960	36996.4443	pe SP	40241	-0.0008	41170	+0.0001	12
	37054.2674	pe SP	40895	0.0000			
	.3552	pe SP	40896	-0.0006			
	075.2222	pe SP	41132	+0.0009			
	.3109	pe SP	41133	+0.0012			
	.3982	pe SP	41134	+0.0001			
	077.1670	pe SP	41154	+0.0006			
	082.2054	pe SP	41211	-0.0006			
	105.1927	pe SP	41471	-0.0007			
	114.301	pe OW	41574	+0.0010			
	116.245	pe OW	41596	-0.0001			
	.334	pe OW	41597	+0.0005			
1961	403.3217	pe SP	44843	-0.0012	44891	-0.0004	5
	.4115	pe SP	44844	+0.0002			
	408.3624	pe SP	44900	0.0000			
	410.3074	pe SP	44922	-0.0001			
	412.3402	pe SP	44945	-0.0008			
1964	38441.0300	pe FE[1]	56580	+0.0009	56727	+0.0004	2
	467.0225	pe FE[1]	56874	-0.0001			
1965	822.710	pg HP	60897	+0.0009	60897	+0.0009	1
1969	40365.6104	pe TR	78348	+0.0018	78515	+0.0021	8
	368.6169	pe TR	78382	+0.0023			
	.7054	pe TR	78383	+0.0024			
	387.5371	pe TR	78596	+0.0021			
	.6253	pe TR	78597	+0.0018			
	.7142	pe TR	78598	+0.0023			
	388.5100	pe TR	78607	+0.0024			
	.5978	pe TR	78608	+0.0018			
1970	794.6775	pe BH[1,2]	83201	-0.0005	83201	-0.0005	1
1972	41476.4327	pe Pp	90912	+0.0002	90912	+0.0002	1
1974	42159.5129	pe Pp	98638	-0.0004	98766	-0.0003	4
	162.5181	pe KM	98672	-0.0012			
	178.7868	pe MF	98856	-0.0005			
	182.4133	pe KM	98897	+0.0010			
1975	515.5531	pe BC	102665	-0.0003	102940	-0.0002	15

Table 5 (cont.)

year	Hel.Max.J.D.	Remarks	E	O-C	$\bar{E}$	$\overline{O-C}$	n
1975	2442515.6410	pe BC	+102666	-0.0008			
	519.5314	pe BC	102710	-0.0006			
	.6201	pe BC	102711	-0.0003			
	521.5654	pe BC	102733	-0.0001			
	541.4588	pe KM	102958	+0.0003			
	544.3758	pe KM	102991	-0.0003			
	.4653	pe KM	102992	+0.0008			
	547.3819	pe BC	103025	-0.0003			
	548.4427	pe Pp	103037	-0.0004			
	549.4154	pe BC	103048	-0.0003			
	.5032	pe BC	103049	-0.0009			
	551.4492	pe BC	103071	0.0000			
	.5375	pe BC	103072	-0.0001			
	577.4437	pe KM	103365	+0.0010			
1976	871.5051	pe Pp	106691	0.0000	106701	+0.0001	6
	.5069	pe KM	106691	+0.0018			
	.5933	pe KM	106692	-0.0002			
	872.4773	pe KM	106702	-0.0004			
	.5658	pe KM	106703	-0.0003			
	874.5107	pe KM	106725	-0.0005			
1977	43249.6478	pe GE	110968	-0.0008	111108	-0.0001	7
	254.5996	pe GE	111024	-0.0001			
	255.5728	pe GE	111035	+0.0006			
	.6613	pe GE	111036	+0.0007			
	256.6329	pe GE	111047	-0.0003			
	274.5807	pe GE	111250	-0.0004			
	287.5778	pe GE	111397	0.0000			
1979	957.5732	pe Pp	118975	-0.0002	118975	-0.0002	1

Remarks to Table 5: Co = Code (1951), As = Ashbrook (1952), Al = Alania (1954), Fi =Fitch (1957), BK =Burnicki and Krygier (1958), Sp =Sanwal and Pande (1961), OW =Oosterhoff and Walraven (1966), FE = Fitch et al. (1966), HP = Harding and Penston (1966), TR = Terzan and Rutily (1974), BH = Boardman and Heiser (1972), KM = Karetnikov and Medvedev (1977), MF = McNamara and Feltz (1976), BC = Broglia and Conconi (1977), GE = Garrido et al. (1979), Pp = present paper
pg = photographic, pe = photoelectric, [1]= maximum time determined by us, [2]= normal maximum

tunately the 7 published observations in V light are not sufficient to determine an epoch of maximum light.

Terzan and *Rutily* (1974) obtained 453 photoelectric observations in the UBV system on four nights in 1969. As a comparison star they used HD 132092 = BD $-0^{\circ}2906$ whose magnitude and colours are: V = 9.27, B-V = +0.32 and U-B = +0.13. They gave eight dates of maximum light. The O-C deviations of these epochs are surprisingly high, the cause of this is not clear and has no explanation; it is most likely that these epochs are due to systematic error. Because of this their period (0.088413276) is slightly longer than the correct one.

In 1970 *Boardman* and *Heiser* (1972) carried out uvby photometry of this star. They obtained 144 differential photoelectric observations on four nights. These observations enabled us to determine an accurate normal maximum.

In their paper *McNamara* and *Feltz* (1976) made a detailed study of the radial velocity variations of EH Librae. In order to be able to calculate the correct phase of the measured radial velocities, they secured a maximum light observation in 1974 which is well-represented by our elements.

Karetnikov and *Medvedev* (1977) obtained over 500 photoelectric observations close to B and V on 13 nights in the years 1974-1976. They determined 22 epochs of light maximum, 11 maxima in each colour. Since the earlier observations also showed that there was no systematic difference between the times of maximum in different colours, we formed mean values of the epochs determined from the blue and yellow observations. In this way 11 times of maximum are added to the list of epochs of EH Lib (Table 5) from *Karetnikov* and *Medvedev*'s observations. *Broglia* and *Conconi* (1977) made more than 900 photoelectric B and V observations (443 in B and 462 in V). They detected small variations in the height of the maxima, but they did not find any variations in the minima. They failed, however, to see any evidence of periodic oscillation in the O-C residuals, in particular with a period near 1800 days (*Berdnikov*, 1975). Their measurements indicate some cycle-to-cycle variations, and if this phenomenon is periodic they propose a period of about 300 cycles (≈27 day). Taking into account the visual observations, too, but with low weight, they found the elements:

$$\text{Max.hel.} = \text{J.D. } \underset{\pm .0002}{2433438.6082} + \underset{\pm .0000000020}{0\overset{d}{.}0884132445} \cdot E$$

On discussing the period changes they arrived at the conclusion that the period changed abruptly on two occasions. This conclusion is, however, based only on *Terzan* and *Rutily*'s (1974) observations. *Garrido* et al. (1979) observed EH Lib in B and V on six nights. They collected 146 photoelectric observations and determined 7 times of maximum light. We rediscussed these observations and by fitting *Fitch*'s (1957) mean B and V light curves to their observations we redetermined the maximum times. In Table 5 these newly determined maxima are given. *Garrido* et al. (1979) made an effort to find secondary periodicities of EH Lib. Their power spectrum, however, showed "no features which could be regarded as certainly significant".

The reality of all periods other than the fundamental one is questioned.

This variable star has long been on the programme at the Konkoly Observatory. It was observed photographically in 1953 and two times of light maximum could be determined for that year. Our 65 photographic observations made on three nights are given in Table 12. We observed the star photoelectrically on five nights in 1972, 1974, 1975, 1976 and 1979 and collected 322 observations in B and V. BD $-0^{\circ}2909$ was used as a comparison star, its magnitude and colours were adopted from *Fitch* (1957) (Tables 13-14). These observations yielded five times of maximum light which are included in the table of epochs of maximum of EH Librae (Table 5).

Our photoelectric observations also clearly show that EH Lib is a dwarf cepheid with a stable light curve of strictly repetitive character.

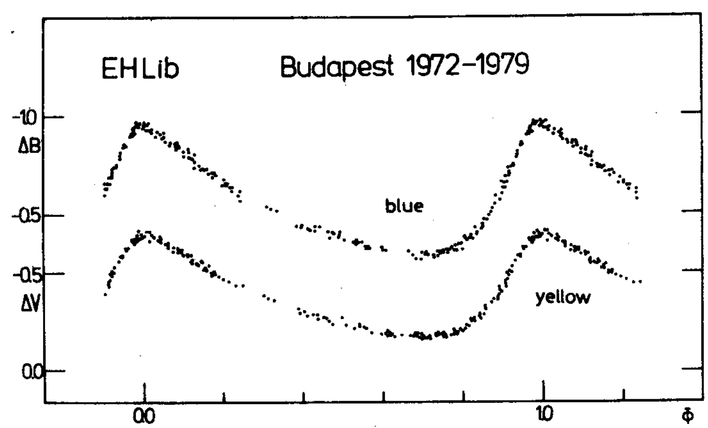

Figure 5: B and V light curves of EH Lib

Since the visual observations are of such low weight relative to the photoelectric observations it did not seem worthwhile to include them in a new solution. Using only the photoelectric maxima we cannot detect any change in the period of EH Lib in the past almost 30 years (2433400-2444000). A least-squares solution yields the following elements:

$$\text{Max.hel.} = \text{J.D. } 2433438.6078 + 0\overset{d}{.}088413243 \cdot E.$$

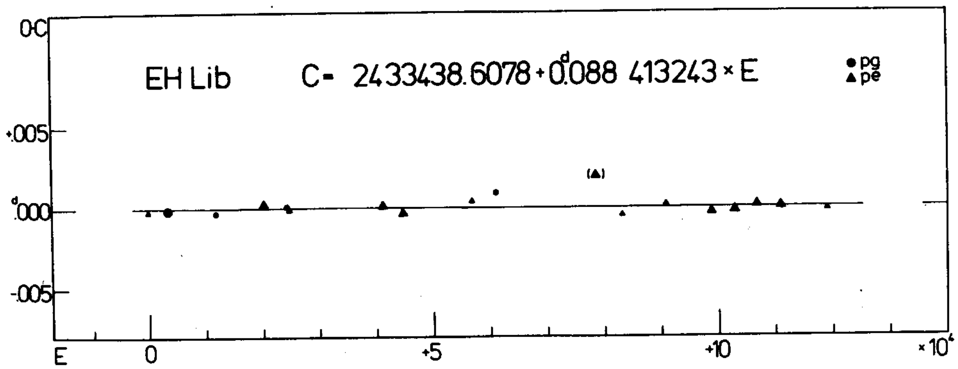

Figure 6: O-C diagram of EH Lib

Berdnikov (1977) believed that a periodic change with a cycle length of 1800 days in the period of EH Lib is present. Our O-C diagram does not show this phenomenon. Obviously the visual observations of poor quality led him to the erroneous interpretation.

DY PEGASI

The variability of DY Peg = BD +16°4877 ($9\overset{m}{.}3$) = HD 218549 (F5) = 112.1934 = P 5726 was discovered by *Morgenroth* (1934) on the Babelsberg survey plates.

First *Soloviev* (1938) made a series of visual observations of this star in August and September 1938 and he determined the type and period of the light variability. His 14 visual maxima enabled him to give:

$$\text{Max.hel.} = \text{J.D. } 2429169.1664 + 0\overset{d}{.}0729256 \cdot E.$$

Of course, the very short period attracted the attention of many visual observers to this star. The accuracy of visual observations is usually far too low so we have simply listed the references to these observations without giving full particulars. *Ahnert* (1938, 1939) observed the star back in October 1938 and confirmed *Soloviev*'s elements. *Bancilhon* and *Schmitt* (1940), *Batyrev* (1953b, 1955, 1962), *Kühn* (1951), *Lange* (1944, 1959), *Mandell* (1958a, b), *Mandell* and *Grigorevsky* (1959), *Satanova* and

Grigorevsky (1957), *Soloviev* (1940a, b, 1952) and *Steinman* (1958) made roughly 5000 further visual estimates. In particular, the German amateurs (*Braune* and *Hübscher*, 1967; *Braune, Hübscher* and *Mundry*, 1970, 1972, 1977, 1979; *Braune* and *Mundry*, 1973; *Busch*, 1973, 1975, 1976, 1977, 1978; *Domke* and *Pohl*, 1952; *Dueball* and *Lehmann*, 1964; and *Pohl*, 1954) were busy in obtaining visual observations. The most thorough investigation of visual observations was that of *Grigorevsky* and *Mandell* (1960). They made use of their own 3061 visual observations, too. From more than 500 maxima (observed up to 1958) they deduced the following elements:

$$\text{Max.hel.} = \text{J.D.}2436071.42469 + 0\overset{d}{.}0729263727 \cdot E$$
$$\pm.00028 \quad \pm.0000000076$$

According to their visual observations the star shows fairly strong light curve variations, especially in heights of maximum (0.3 mag.). *Soloviev* (1938) was the first to refer to this effect, but *Lange* (1944) soon questioned it. *Grigorevsky* and *Mandell* suggested a period of 0.2554 day for this secondary variation. These results are, however, hardly acceptable. As we will see later on, modern photoelectric observations show only a fluctuation of 0.04 mag. in the heights of the maxima. Obviously the visual observations have errors in the order of 0.3 mag., and no finer results can be deduced from them. *Grigorevsky* and *Mandell* claimed that they had found a long term variation in the phase of the light maxima of DY Peg. They gave a period of 4529·P = 330.28 days and an amplitude of 10 minutes for this long-term variation.

The first valuable photographic observations of this star were obtained by *Schneller* (1938) and he gave two epochs of light maximum.

In his two papers *Steinmetz* (1946, 1948) published 1874 photographic and 419 photovisual exposures. The observations span an interval from 28 July 1943 to 12 September 1947. He determined a revised value of the period, equal to 0.072926355 day from the complete photographic material and found this period to be constant during the whole interval of more than 20000 periods covered by his observations. In his discussions *Steinmetz* used the point on the rising branch at brightness $\Delta m = -0.46$ mag. and listed 46 epochs of that particular point. Unfortunately he did not give the epochs of observed maxima. We used the mean light curve of *Steinmetz* and have derived a phase difference of

$$\Delta\varphi = \varphi(\max) - \varphi(\Delta m = -0.46) = 0^{p}.088 = 0^{d}.0064$$

between the time of maximum light and *Steinmetz*'s favoured point. Adding this value $\Delta\varphi$ to the epochs given by *Steinmetz* we were able to determine the times of his photographic maxima. We then formed means of these times for the years 1943 (n=6), 1944 (n=10), 1945 (n=3), 1946 (n=3) and 1947 (n=24), these are given in Table 7. We should like to mention here that *Quigley* and *Africano* (1979) followed another procedure. They determined the times of maxima observed by *Steinmetz* by fitting his original data to a parabola. Obviously in this way they obtained maxima which were systematically delayed.

Alania (1954, 1956) also observed the star photographically and gave an epoch of maximum light. His observation can, however, be accepted only with reserve.

The very first photoelectric observations were made by *Hiltner* (*Iriarte*, 1952). On two nights, 19 and 20 July 1948, *Hiltner* obtained 301 observations in one colour which enable us to determine three times of maximum light. The light curve did not seem to repeat in all details, especially near minimum light.

Masani and *Broglia* (1954) obtained 573 photoelectric observations in blue and 523 in yellow light between 10 October and 14 November, 1953. Their light curve shows some non-repetitive character from cycle to cycle and the deviations are certainly larger than the observational errors. *Masani* and *Broglia* determined 28 epochs of maximum light based on their own observations but three were in fairly large error (they gave their epochs with an accuracy of 0.001 day only) and we have therefore omitted the three erroneous epochs from our table of maximum times (Table 7).

Hardie and *Geilker* (1958) obtained the first complete light curves in the UBV system for DY Peg in 1956. They published 1633 photoelectric observations (500 in V, 614 in B and 519 in U). Having analysed tha data they found the general character of the light curves to be repetitive, however, no two cycles were alike in detail. The irregularities did not appear to reveal any systematic trend during the time covered by their observations. It was found that there was a variation of 0.04 mag. at maximum in V. *Hardie* and *Geilker* did not give their observed times of maxima. Using their original published magnitude data we were able to determine 18 epochs of light maximum (6 in V, 7 in B and 5 in U). These times are given in Table 7.

In 1957 and 1960 *Broglia* (1961) secured 170 yellow photoelectric observations and gave five further epochs of maximum light. From his observations he found the amplitude of DY Peg to be slightly variable (some hundredths in magnitude). The new elements derived by him are:

$$\text{Max.hel.} = \text{J.D. } \underset{\pm.00009}{2434696.39682} + \underset{\pm.000000002}{0^{d}\!.072926371} \cdot E$$

From 23 July to 16 October 1963 *Karetnikov* and *Medvedev* (1964) observed the star photoelectrically at the Odessa Observatory with an 8-inch refractor. Oddly enough they found that the form of the light curve changed significantly and very rapidly. The variations in the amplitude of DY Peg exceeded $\Delta A \approx 0.4$ mag. Unusual humps occurred on both the ascending and descending branches of its light curve. *Karetnikov* and *Medvedev* investigated the phase of these humps and thought to find a correlation with a secondary period. They proposed $P_s = 0.255413$ day for its value. In that all other photoelectric observations before and after 1963 have not shown any evidence for the strong light curve variation we have to accept *Karetnikov* and *Medvedev*'s results, but we do so with reserve. We tend to believe that these irregular variations are an artifact of their observing technique rather than intrinsic to DY Peg. Because of this we have given only the mean moment of their maxima in Table 7.

A further 54 UBV observations were published by *Fitch* et al. (1966). They also gave an epoch of maximum light which was determined as the time of the brightest observed point in V light. Using our mean photoelectric light curves we redetermined the time of maximum light from *Fitch* et al.'s data.

In order to demonstrate the usefulness of their technique of sequential photoelectric photometry *Warner* and *Nather* (1972) observed DY Peg on two nights in November 1970. They have not published the observations, but only the graphs of the two observed light curves. From their figures we could read off two epochs of light maximum. We must, however, admit that the captions of their figures are inconsistent with the time scales on the horisontal axis. This ambiguity should be kept in mind. The most important conclusion of *Warner* and *Nather*'s observation is that the light variation with phase in each colour is smooth but small changes may occur from cycle to cycle.

Geyer and *Hoffmann* (1974, 1975b) carried out photoelectric photometry of this star in B and V with a double-beam photometer. They observed six cycles on two nights and gave six epochs of maxima. One of them (J.D. 2441957.5998) is somewhat uncertain but it does not significantly affect the average O-C value of the six maxima. *Geyer* and *Hoffmann* concluded that a short period beat phenomenon was not present in this variable and the light curve was smooth without anomalies.

While testing an amateur photoelectric photometer *Heiser* (1976) observed DY Peg on 22 November 1975. He gave two times of light maxima (*Braune, Hübscher* and *Mundry*, 1979), one of which could be determined more accurately using the graph in his paper (*Heiser*, 1976).

Recently *Quigley* and *Africano* (1979) carried out a high-speed photometry of this variable at the McDonald Observatory in order to update the star's ephemeris. The times of 19 maxima were recorded between November 1976 and 1977. Combining these with more than one hundred selected times of maxima they arrived at a revised ephemeris:

$$\text{Max.hel.} = \text{J.D. } 2432751.96195 + 0\overset{d}{.}072926332 \cdot E$$

Most of the selected times of maxima were calculated by *Quigley* and *Africano* using a least-squares fit of the light curve data near the maximum to a parabola. Since the maximum of short periodic variables is asymmetric this fit obviously results in an epoch which may give rise to a systematic delay of 0.001 day. Therefore, *Pogson*'s or any other "classical" method certainly give a better estimation of epoch of maximum light. Comparing the times of maximum light determined by us with those calculated by *Quigley* and *Africano* we came to the conclusion that their epochs of maxima have a lag of $+0\overset{d}{.}0005$. The corrected value of $\overline{O-C}$ is also given in Table 7 and in calculating the mean maximum of *Quigley* and *Africano* we have already taken this correction into consideration (Table 8).

Using the 122 entries of their Table I and Table II they also estimated the rate (β) of change of the period assuming that the O-Cs had a quadratic dependence on cycle numbers. They obtained the value $\beta=-6\text{x}10^{-12}$ days·day^{-1}=-0.02 sec·century^{-1} for the rate of change.

The photoelectric observations of this star were commenced at the Konkoly Observatory in 1954. The 1954 observations were carried out without using any filter but the 1960 observations were already made in the BV system. *Detre*'s observations of 1954 enabled us to determine one time of maximum light. Between August 1960 and August 1979 some 615 photoelectric BV observations were obtained. The 1974 observations were made with the 20 inch reflector of our Mountain Station; the others were carried out with the 24 inch telescope at Budapest. The two colour observations are given in Tables 15-16 and are plotted against phase in Figure 7. The comparison and check stars are given in Table 6. Their magnitudes and colours are adopted from *Hardie* and *Geilker* (1958).

Table 6

star	BD	V	B-V	U-B
comparison	$+16^{\circ}4878$	9.80	+0.59	+0.10
check	$+16^{\circ}4876$	10.94	+0.53	+0.06

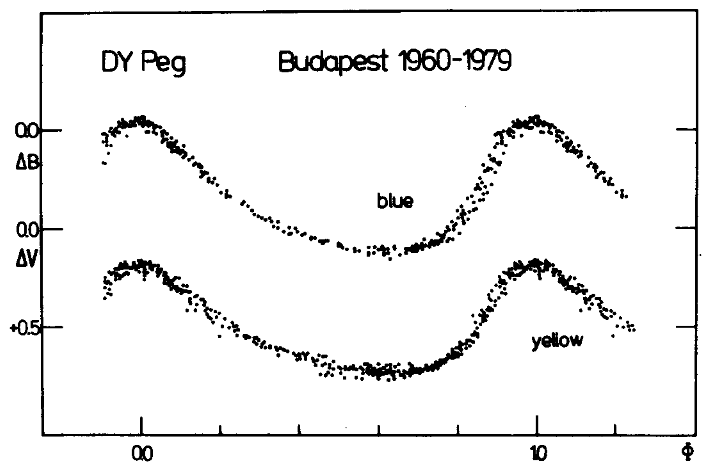

Figure 7: B and V light curves of DY Peg

We have not found any significant shift in time between the blue and yellow maxima. Some small changes of the light curve (e.g. in maximum about 0.05 mag.) have, however, been recorded. Whether these minute changes are periodic or not is open to fur-

Table 7

Photographic and photoelectric maxima of DY Peg

year	Hel.Max.J.D.	Remarks	E	O-C	$\bar{E}$	$\overline{O-C}$	n
1938	2429193.4456	pg Sc	- 48796	-0.0024	- 48789	-0.0012	2
	194.4691	pg Sc	- 48782	+0.0001			
1943	31022.0744	pg St[1,2]	- 23721	-0.0014	- 23721	-0.0014	1
1944	310.4978	pg St[1,2]	- 19766	-0.0016	- 19766	-0.0016	1
1945	764.3924	pg St[1,2]	- 13542	-0.0005	- 13542	-0.0005	1
1946	32092.4147	pg St[1,2]	- 9044	-0.0009	- 9044	-0.0009	1
1947	408.0396	pg St[1,2]	- 4716	-0.0011	- 4716	-0.0011	1
1948	751.8884	pe Ir[1]	- 1	0.0000	+ 4	0.0000	3
	.9613	pe Ir[1]	- 0	0.0000			
	752.9093	pe Ir[1]	+ 13	0.0000			
1953	(34626.462	pg Al	+ 25704	+0.0023)	+ 26533	+0.0005	25
	661.3915	pe MB	+ 26183	0.0000			
	.4644	pe MB	+ 26184	0.0000			
	662.3403	pe MB	+ 26196	+0.0008			
	.4857	pe MB	+ 26198	+0.0004			
	.5589	pe MB	+ 26199	+0.0006			
	689.3228	pe MB	+ 26566	+0.0006			
	690.3437	pe MB	+ 26580	+0.0005			
	.4165	pe MB	+ 26581	+0.0004			
	691.2919	pe MB	+ 26593	+0.0007			
	.3646	pe MB	+ 26594	+0.0004			
	.4376	pe MB	+ 26595	+0.0005			
	692.2401	pe MB	+ 26606	+0.0008			
	.3138	pe MB	+ 26607	+0.0016			
	.3858	pe MB	+ 26608	+0.0007			
	.4585	pe MB	+ 26609	+0.0004			
	693.2613	pe MB	+ 26620	+0.0010			
	.3338	pe MB	+ 26621	+0.0006			
	.4057	pe MB	+ 26622	-0.0004			
	.4789	pe MB	+ 26623	-0.0001			
	695.3021	pe MB	+ 26648	-0.0001			
	.3756	pe MB	+ 26649	+0.0005			
	.4487	pe MB	+ 26650	+0.0007			
	696.2515	pe MB	+ 26661	+0.0013			
	.3242	pe MB	+ 26662	+0.0010			
	.3966	pe MB	+ 26663	+0.0005			
1954	35070.2901	pe De	+ 31790	+0.0007	+ 31790	+0.0007	1
1956	745.5885	pe HG[1]	+ 41050	+0.0013	+ 41292	+0.0015	18
	.6611	pe HG[1]	+ 41051	+0.0009			
	.7343	pe HG[1]	+ 41052	+0.0012			
	.8069	pe HG[1]	+ 41053	+0.0009			
	760.6847	pe HG[1]	+ 41257	+0.0017			
	.7576	pe HG[1]	+ 41258	+0.0017			
	762.5808	pe HG[1]	+ 41283	+0.0017			
	.6536	pe HG[1]	+ 41284	+0.0016			
	.7266	pe HG[1]	+ 41285	+0.0017			
	.8003	pe HG[1]	+ 41286	+0.0025			
	770.6031	pe HG[1]	+ 41393	+0.0021			
	.6753	pe HG[1]	+ 41394	+0.0014			
	.7488	pe HG[1]	+ 41395	+0.0020			
	771.6229	pe HG[1]	+ 41407	+0.0010			

Table 7 (cont.)

year	Hel.Max.J.D.	Remarks	E	O-C	$\bar{E}$	$\overline{O-C}$	n
1956	2435771.6958	pe HG[1]	+ 41408	+0.0009			
	773.6654	pe HG[1]	+ 41435	+0.0015			
	.7375	pe HG[1]	+ 41436	+0.0007			
	780.6664	pe HG[1]	+ 41531	+0.0016			
1957	36155.3623	pe Br	+ 46669	+0.0020	+ 46715	+0.0019	3
	160.3214	pe Br	+ 46737	+0.0021			
	.3939	pe Br	+ 46738	+0.0017			
1960	37164.5170	pe Pp	+ 60507	+0.0021	+ 60596	+0.0016	7
	165.5375	pe Pp	+ 60521	+0.0017			
	167.4320	pe Pp	+ 60547	+0.0001			
	168.5276	pe Br	+ 60562	+0.0018			
	174.4348	pe Br	+ 60643	+0.0019			
	178.3734	pe Pp	+ 60697	+0.0025			
	.4451	pe Pp	+ 60698	+0.0013			
1963	38276.8624	pe KM[2]	+ 75760	+0.0022	+ 75760	+0.0022	1
1964	655.8598	pe Fi[1]	+ 80957	+0.0014	+ 80957	+0.0014	1
1970	40895.6447	pe WN[3]	+111670	-0.0001	+111684	0.0000	2
	897.6138	pe WN[3]	+111697	0.0000			
1972	41535.5012	pe Pp	+120444	+0.0008	+120444	+0.0008	1
1973	937.4701	pe GH	+125956	-0.0003	+126218	+0.0003	8
	.5444	pe GH	+125957	+0.0011			
	957.3785	pe GH	+126229	-0.0008			
	.4535	pe GH	+126230	+0.0013			
	.5243	pe GH	+126231	-0.0008			
	.5998	pe GH	+126232	+0.0018			
	963.4324	pe Pp	+126312	+0.0003			
	984.3615	pe Pp	+126599	-0.0005			
1974	42279.4210	pe Pp	+130645	-0.0009	+130645	-0.0009	1
1975	739.2955	pe He[4]	+136951	+0.0001	+136951	+0.0001	1
1976	43085.6951	pe QA	+141701	-0.0004	+141725	-0.0002*	6
	.7684	pe QA	+141702	0.0000		(-0.0007)	
	.8403	pe QA	+141703	-0.0010			
	088.6860	pe QA	+141742	+0.0005			
	.7582	pe QA	+141743	-0.0002			
	089.7064	pe QA	+141756	0.0000			
1977	305.9329	pe QA	+144721	-0.0001	+145201	+0.0003*	13
	307.8308	pe QA	+144747	+0.0017		(-0.0002)	
	.9023	pe QA	+144748	+0.0003			
	348.8143	pe QA	+145309	+0.0006			
	.8867	pe QA	+145310	+0.0001			
	.9598	pe QA	+145311	+0.0003			
	350.7833	pe QA	+145336	+0.0006			
	.8554	pe QA	+145337	-0.0002			
	.9288	pe QA	+145338	+0.0003			
	351.8042	pe QA	+145350	+0.0005			
	.8765	pe QA	+145351	-0.0001			
	353.7728	pe QA	+145377	+0.0001			
	.8459	pe QA	+145378	+0.0003			
1979	44113.5179	pe Pp	+155795	-0.0013	+155795	-0.0013	1

Remarks to Table 7: Sc = Schneller (1938), St = Steinmetz (1946, 1948), Ir = Iriarte (1952), Al = Alania (1956), MB = Masani and Broglia (1954), De = Detre (unpubl.), HG = Hardie and Geilker (1958), Br = Broglia (1961), KM = Karetnikov and Medvedev (1964), Fi = Fitch et al. (1966), WN = Warner and Nather (1972), GH = Geyer and Hoffmann (1974), He = Heiser (1976), QA = Quigley and Africano (1979), Pp = present paper

pg = photographic, pe = photoelectric, [1]= determined by us, [2]= mean epoch, [3]= read from Warner and Nather's figures, [4]=read from Heiser's figure, *= the mean value has been decreased by 0.0005 day (see text)

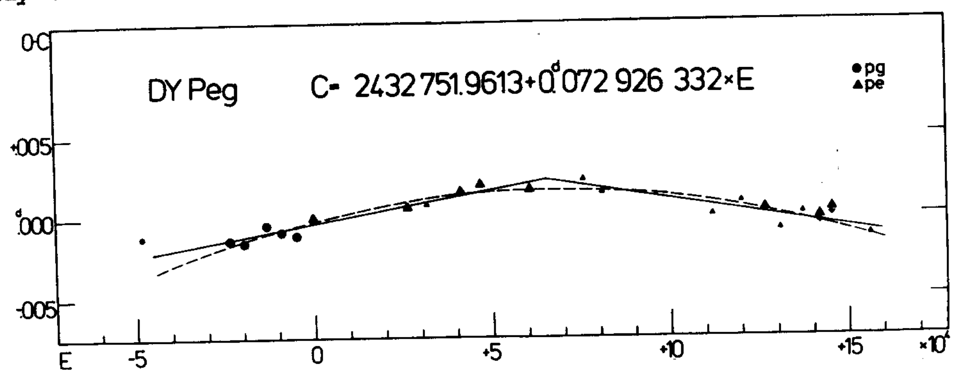

Figure 8: O-C diagram of DY Peg

ther investigation. Our observations do not confirm the 0.255 day secondary period and definitely contradict the 330 day long-term variation stated by *Grigorevsky* and *Mandell* (1960). Obviously they simply underestimated the errors of visual recordings and identified the observational scatter with real changes.

In order to analyse the period changes of this variable star we have collected all the available times of photographic and photoelectric maxima in Table 7. Again we left the visual observations out of consideration because they proved to be of no value.

The O-C values have been computed with the linear formula:

$$C(\text{Max.hel.}) = \text{J.D. } 2432751.9613 + 0.^{d}072926332 \cdot E .$$

For each year a mean O-C value ($\overline{O-C}$) and a mean epoch number ($\overline{E}$) were formed and then a yearly mean epoch of the observed light maxima was calculated. These epochs are given in Table 8. The data of this table were used to carry out least-squares solutions.

First we tried to make an approximation with two straight lines and obtained the linear ephemerides:

$$C_1(\text{Max.hel.}) = \text{J.D. } 2432751.9609 + 0.^{d}072926372 \cdot E$$

before J.D. 2437500; E<65000 and

$$C_2(\text{Max.hel.}) = \text{J.D. } 2432751.9658 + 0.^{d}072926297 \cdot E$$

after J.D. 2437500; E>65000.

Table 8

Mean photographic and photoelectric maxima of DY Peg

year	Mean Hel. Max.		W	E	$O-C_1$	$O-C_2$	$O-C_3$
1938	J.D.2429193.9573	pg	0	- 48789	+0.0012	--	+0.0025
1943	31022.0744	pg	1	- 23721	0.0000	--	+0.0003
1944	31310.4978	pg	1	- 19766	-0.0004	--	-0.0002
1945	31764.3924	pg	1	- 13542	+0.0004	--	+0.0005
1946	32092.4147	pg	1	- 9044	-0.0001	--	-0.0002
1947	32408.0396	pg	1	- 4716	-0.0005	--	-0.0007
1948	32752.2530	pe	2	+ 4	+0.0004	--	+0.0002
1953	34686.9162	pe	2	+ 26533	-0.0001	--	-0.0004
1954	35070.2901	pe	1	+ 31790	-0.0002	--	-0.0004
1956	35763.2369	pe	2	+ 41292	+0.0002	--	+0.0002
1957	36158.7168	pe	2	+ 46715	+0.0004	--	+0.0005
1960	37171.0069	pe	2	+ 60596	-0.0004	--	0.0000
1963	38276.8624	pe	1	+ 75760	--	+0.0003	+0.0006
1964	38655.8598	pe	1	+ 80957	--	-0.0002	-0.0001
1970	40896.6658	pe	1	+111684	--	-0.0006	-0.0008
1972	41535.5012	pe	1	+120444	--	+0.0005	+0.0002
1973	41956.5774	pe	2	+126218	--	+0.0002	0.0000
1974	42279.4210	pe	1	+130645	--	-0.0009	-0.0010
1975	42739.2955	pe	1	+136951	--	+0.0004	+0.0003
1976	43087.4450*	pe	2	+141725	--	-0.0002	-0.0002
1977	43340.9374*	pe	2	+145201	--	+0.0004	+0.0005
1979	44113.5179	pe	1	+155795	--	-0.0003	0.0000

*The mean epoch has been decreased by 0.0005 day (see text).

The corresponding O-C values are given in Table 8 under the headings $O-C_1$ and $O-C_2$. If the period had really a sudden change around J.D. 2437500, and before and after it the period was constant, the value of the period change was

$$\Delta P = -6.5 \times 10^{-8} \text{ day.}$$

The second order fit yielded the following formula:

$$C_3(\text{Max.hel.}) = \text{J.D. } 2432751.9611 + 0^d.072926384 \cdot E - 3.813 \times 10^{-13} \cdot E^2.$$

(C_3 was calculated in such a way that all the mean epochs -except *Schneller*'s- were given equal weight.) In this case

$$\beta = -7.6 \times 10^{-13} \text{ day} \cdot \text{cycle}^{-1} = -10.4 \times 10^{-12} \text{ days.day}^{-1} =$$
$$= -0.03 \text{ sec} \cdot \text{century}^{-1}$$

in rough agreement with the estimates of *Quigley* and *Africano* (1979).

At present, no difference can be made between the two approximations because

$$\frac{1}{n^2}\Sigma\{(O-C_1)^2 + (O-C_2)^2\} \text{ and } \frac{1}{n^2}\Sigma(O-C_3)^2$$

are in the same order. Further observations can only settle which approximation is the correct one.

GENERAL REMARKS

The number of dwarf cepheids investigated here is insufficient for making any definite conclusion on the possible evolutionary changes of the periods. Nevertheless, some comments can be made. CY Aqr and DY Peg can definitely be identified with the low-metal Population II (Breger, 1980) and both variable stars show decreasing periods; in contrast, EH Lib exhibits a normal Population I nature and has a very stable, constant period. The periods of both CY Aqr and DY Peg show some small random fluctuations, too, which are reflected in their O-C diagrams.

The light curve of EH Lib is also stable whereas the light curves of CY Aqr and DY Peg show small cycle-to-cycle changes the character of which are still obscure. Further high speed photoelectric observations are needed in order to disentangle this problem.

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Table 9

Photographic observations of CY Aqr

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2428045		2428074		2432440		2433860	
.3832	11.06	.3798	11.01	.4647	10.86	.5409	10.53
.3853	10.90	.3818	10.69	.4668	10.56	.5430	10.59
.3874	10.73	.3839	10.45	.4689	10.36	.5450	10.56
.3895	10.45	.3867	10.30	.4709	10.32	.5471	10.71
.3916	10.37	.3888	10.36	.4730	10.41	.5492	10.84
.3937	10.39			.4751	10.64	.5534	11.00
.3978	10.43	2428397		.4772	10.75	.5555	10.86
.3999	10.63	.5100	11.03	.4793	10.81	.5596	11.07
.4020	10.62	.5122	10.90	.4814	10.86	.5638	11.06
.4041	10.80	.5143	10.92	.4834	10.87	.5680	11.15
.4062	10.88	.5163	10.93	.4855	10.96	.5700	11.14
.4103	10.93	.5184	10.70	.4876	10.99	.5721	11.23
.4207	11.19	.5205	10.53	.4897	11.00	.5742	11.17
.4228	11.18	.5226	10.14	.4980	11.29	.5763	11.18
.4242	11.18	.5247	10.17	.5001	11.35		
.4284	11.20	.5267	10.32	.5022	11.23	2433861	
.4346	11.35	.5289	10.44	.5043	11.28	.4722	10.95
.4367	11.25	.5330	10.56	.5064	11.28	.4741	10.96
.4388	11.24	.5350	10.61	.5105	11.16	.4762	10.98
.4410	11.15	.5412	10.93	.5147	11.28	.4783	11.04
.4430	11.11	.5433	11.01	.5168	11.16	.4804	11.05
.4450	10.98	.5476	10.98	.5189	11.10	.4845	11.14
		.5496	11.03	.5209	11.03	.4866	11.20
2428074		.5517	11.13	.5230	10.94	.4887	11.18
.3214	10.40	.5538	11.19			.4908	11.03
.3235	10.37	.5559	11.23	2433860		.4929	11.00
.3257	10.28			.4825	10.59	.4970	10.94
.3277	10.22	2432093		.4846	10.83	.4991	10.90
.3298	10.42	.3938	11.12	.4867	10.91	.5012	10.66
.3318	10.62	.3958	11.10	.4888	11.02	.5054	10.30
.3339	10.62	.3979	11.18	.4930	11.04	.5074	10.17
.3360	10.72	.4021	10.58	.4950	11.16	.5095	10.24
.3381	10.73	.4042	10.32	.4972	11.17	.5595	11.06
.3402	10.90	.4063	10.24	.5034	11.17	.5616	10.84
.3423	10.92	.4083	10.34	.5055	11.18	.5637	10.78
.3443	11.13	.4104	10.46	.5075	11.22	.5658	10.40
.3464	10.99	.4125	10.60	.5096	11.24	.5679	10.10
.3485	11.14	.4146	10.66	.5117	11.32	.5699	10.20
.3506	11.18	.4167	10.69	.5138	11.16	.5720	10.22
.3527	11.25	.4188	10.76	.5159	11.22	.5741	10.48
.3548	11.22	.4208	10.88	.5180	11.12	.5762	10.60
.3568	11.28	.4271	10.88	.5200	11.14	.5783	10.75
.3589	11.32	.4292	10.90	.5222	10.98	.5804	10.78
.3610	11.33	.4313	11.07	.5242	10.80		
.3631	11.33	.4333	11.02	.5263	10.44	2433872	
.3673	11.22	.4354	11.08	.5284	10.37	.5079	10.96
.3693	11.23			.5305	10.32	.5100	10.99
.3714	11.26	2432440		.5325	10.22	.5121	11.14
.3735	11.26	.4564	11.04	.5346	10.40	.5142	11.05
.3756	11.06	.4605	11.17	.5367	10.40	.5163	11.23
.3777	11.15	.4626	10.98	.5388	10.46	.5184	11.21

Table 9 (cont.)

Photographic observations of CY Aqr

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2433872		2433872		2434253		2434270	
.5204	11.24	.5704	11.09	.5539	10.89	.3031	11.24
.5225	11.21	.5746	11.15	.5560	10.72	.3052	11.09
.5246	11.32	.5767	11.08	.5580	10.46	.3072	11.16
.5267	11.38	.5809	11.28	.5622	10.90	.3093	11.24
.5309	11.34	.5829	11.20	.5643	10.83	.3114	11.32
.5329	11.37	.5871	11.34	.5664	11.08	.3135	11.24
.5350	11.44	.5890	11.35	.5705	11.29	.3156	11.38
.5371	11.33			.5726	11.29	.3218	11.37
.5392	11.39	2434253		.5747	11.36	.3239	11.49
.5413	11.42	.5205	11.42	.5768	11.44	.3260	11.27
.5434	11.32	.5247	11.38	.5810	11.48	.3281	11.42
.5454	11.31	.5268	11.48	.5851	11.52	.3302	11.36
.5475	11.33	.5351	11.50	.5872	11.53	.3343	11.10
.5496	11.11	.5372	11.40	.5893	11.54	.3364	11.08
.5538	10.81	.5398	11.50	.5914	11.40	.3385	10.99
.5559	10.74	.5414	11.38			.3427	10.60
.5579	10.62	.5435	11.42	2434270		.3447	10.36
.5600	10.68	.5455	11.37	.2947	10.81	.3468	10.46
.5621	10.75	.5497	10.93	.2968	10.98	.3489	10.68
.5642	10.82	.5518	10.76	.2989	11.11	.3510	10.66
.5684	11.06						

Table 10

Photoelectric yellow observations of CY Aqr

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2441623		2441623		2441651		2444158	
.2511	+1.067	.3053	+1.047	.2500	+1.024	.2792	+1.060
.2539	1.057	.3081	1.067	.2514	1.037	.2804	1.027
.2553	1.000	.3095	1.057	.2549	1.052	.2863	1.028
.2596	0.668	.3185	0.931	.2563	1.048	.2899	1.050
.2629	0.397	.3213	0.495	.2590	1.059	.2912	1.018
.2643	0.364	.3227	0.427	.2604	1.073	.2937	1.044
.2671	0.395	.3254	0.353	.2632	1.090	.2949	1.029
.2719	0.545	.3310	0.474	.2646	1.073	.2984	0.964
.2747	0.662	.3324	0.527	.2681	1.058	.3005	0.856
.2761	0.692	.3351	0.634	.2695	1.021	.3016	0.793
.2789	0.762	.3365	+0.650	.2736	0.937	.3037	0.516
.2803	0.788			.2903	0.635	.3047	0.392
.2831	0.905	2441651		.2945	0.752	.3071	0.368
.2845	0.915	.2292	+0.615	.2959	0.819	.3080	0.391
.2893	1.001	.2306	0.664	.2993	+0.888	.3105	0.443
.2921	1.035	.2333	0.743			.3121	0.451
.2935	1.052	.2347	0.780	2444158		.3148	0.560
.2977	1.036	.2375	0.854	.2711	+0.985	.3162	0.617
.3004	1.043	.2389	0.912	.2749	1.066	.3187	0.715
.3015	1.069	.2458	1.005	.2763	+1.040	.3200	+0.773
.3039	+1.089	.2472	+1.028				

Table 11

Photoelectric blue observations of CY Aqr

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2441623		2441623		2441651		2444158	
.2490	+0.185	.3074	+0.180	.2507	+0.168	.2742	+0.152
.2504	0.178	.3089	0.170	.2542	0.178	.2756	0.150
.2532	0.160	.3122	0.179	.2556	0.181	.2784	0.192
.2546	0.123	.3164	0.119	.2583	0.190	.2800	0.214
.2574	+0.029	.3178	+0.096	.2597	0.184	.2823	0.209
.2589	−0.165	.3206	−0.287	.2639	0.204	.2835	0.219
.2622	0.555	.3220	0.398	.2674	0.200	.2869	0.214
.2636	0.615	.3303	0.559	.2688	0.198	.2893	0.206
.2664	0.621	.3317	0.491	.2729	+0.053	.2930	0.210
.2679	0.584	.3344	−0.358	.2896	−0.357	.2943	0.181
.2740	0.323			.2910	0.317	.2955	0.147
.2754	0.285	2441651		.2938	0.188	.2980	+0.089
.2782	0.174	.2285	−0.380	.2952	0.165	.3003	−0.024
.2796	0.136	.2299	0.306	.2979	−0.037	.3012	0.077
.2838	−0.015	.2326	0.190	.3000	+0.015	.3032	0.359
.2886	+0.120	.2368	0.051			.3042	0.506
.2914	0.149	.2382	−0.037	2444158		.3065	0.623
.2928	0.146	.2410	+0.049	.2641	−0.004	.3075	0.618
.2997	0.193	.2424	0.084	.2653	+0.019	.3141	0.415
.3011	0.202	.2451	0.112	.2680	0.047	.3155	0.319
.3032	0.173	.2465	0.136	.2704	0.084	.3180	0.210
.3046	+0.189	.2493	+0.144	.2716	+0.120	.3194	−0.196

Table 12

Photographic observations of EH Lib

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2434487		2434488		2434516		2434516	
.4294	10.14	.4294	9.44	.4013	10.09	.4534	9.45
.4349	9.94	.4349	9.52	.4034	9.94	.4555	9.44
.4405	9.89	.4377	9.60	.4055	10.00	.4576	9.54
.4433	9.75	.4405	9.67	.4075	10.01	.4596	9.57
.4460	9.73	.4433	9.73	.4096	9.94	.4617	9.54
.4488	9.53	.4460	9.77	.4117	9.98	.4638	9.63
.4516	9.44	.4488	9.84	.4159	9.99	.4659	9.62
.4544	9.42	.4516	9.80	.4180	10.07	.4680	9.70
.4572	9.42	.4544	9.85	.4305	10.11	.4700	9.76
.4599	9.56	.4572	9.97	.4346	10.02	.4770	9.81
.4627	9.63	.4627	9.94	.4388	10.00	.4791	9.80
		.4655	9.95	.4409	9.98	.4812	9.86
2434488		.4683	10.07	.4430	9.78	.4832	9.86
.4127	9.99	.4710	10.02	.4450	9.70	.4853	9.89
.4155	9.81			.4471	9.61	.4895	9.99
.4210	9.59	2434516		.4492	9.48	.4916	10.05
.4238	9.37	.3992	10.00	.4513	9.48	.4999	10.09
.4266	9.35						

Table 13

Photoelectric yellow observations of EH Lib

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2441476		2442159		2442548		2442871	
.4056	−0.190	.5056	−0.484	.3942	−0.273	.4839	−0.176
.4065	0.160	.5080	0.582	.4023	0.225	.4859	0.208
.4075	0.165	.5091	0.614	.4037	0.216	.4867	0.196
.4095	0.184	.5112	0.672	.4071	0.188	.4889	0.229
.4101	0.181	.5167	0.652	.4082	0.197	.4897	0.250
.4111	0.192	.5181	0.628	.4195	0.192	.4917	0.283
.4134	0.187	.5195	0.605	.4209	0.170	.4927	0.325
.4148	0.206	.5237	0.543	.4239	0.182	.4948	0.359
.4160	0.211	.5251	0.534	.4254	0.202	.4957	0.376
.4181	0.249	.5265	0.514	.4333	0.385	.4977	0.498
.4191	0.263	.5306	0.466	.4347	0.426	.4986	0.523
.4201	0.284	.5318	0.455	.4379	0.582	.5014	0.612
.4221	0.346	.5334	0.433	.4392	0.625	.5033	0.644
.4231	0.359	.5396	0.381	.4420	0.695	.5042	0.709
.4241	0.393	.5406	0.369	.4432	0.710	.5066	0.709
.4262	0.498	.5420	0.359	.4461	0.682	.5075	0.680
.4272	0.556	.5476	0.290	.4473	0.650	.5106	0.635
.4282	0.586	.5494	0.277	.4509	0.605	.5128	0.626
.4304	0.661	.5535	0.269	.4524	0.587	.5137	0.618
.4314	0.673	.5608	0.235	.4556	0.549	.5156	0.590
.4324	0.679	.5619	0.218	.4570	0.539	.5182	0.554
.4341	0.657	.5667	0.189	.4646	−0.438	.5191	0.525
.4363	0.667	.5677	0.179			.5210	0.494
.4382	0.638	.5688	0.173	2442871		.5218	−0.480
.4394	0.628	.5730	0.173	.4514	−0.316		
.4404	0.605	.5744	0.165	.4525	0.302	2443957	
.4426	0.597	.5751	0.176	.4546	0.285	.5650	−0.439
.4436	0.553	.5799	0.170	.4556	0.264	.5660	0.501
.4446	0.545	.5813	0.179	.4579	0.251	.5709	0.671
.4468	0.509	.5824	0.198	.4588	0.237	.5719	0.673
.4478	−0.499	.5858	0.255	.4610	0.272	.5733	0.688
		.5876	0.275	.4620	0.234	.5747	0.692
2442159		.5890	0.310	.4639	0.213	.5768	0.671
.4882	−0.165	.5920	0.409	.4677	0.194	.5782	0.649
.4896	0.171	.5937	0.454	.4712	0.203	.5806	0.609
.4905	0.181	.5944	0.499	.4744	0.179	.5816	0.588
.4952	0.206	.5987	0.663	.4763	0.178	.5837	0.561
.4966	0.223	.5997	−0.692	.4773	0.188	.5851	0.539
.4980	0.265			.4794	0.167	.5879	0.498
.5035	0.425	2442548		.4804	−0.158	.5886	−0.504
.5049	−0.445	.3928	−0.286				

Table 14

Photoelectric blue observations of EH Lib

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2441476		2441476		2441476		2441476	
.4051	−0.269	.4070	−0.289	.4100	−0.305	.4127	−0.312
.4062	−0.264	.4090	−0.283	.4106	−0.304	.4141	−0.310

Table 14 (cont.)

Photoelectric blue observations of EH Lib

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2441476		2442159		2442548		2442871	
.4155	−0.315	.5174	−0.890	.4015	−0.344	.4863	−0.335
.4176	0.368	.5188	0.866	.4034	0.333	.4884	0.370
.4186	0.401	.5202	0.830	.4075	0.315	.4894	0.372
.4196	0.419	.5244	0.762	.4202	0.295	.4922	0.444
.4216	0.504	.5258	0.726	.4216	0.313	.4943	0.523
.4226	0.546	.5268	0.725	.4247	0.347	.4952	0.589
.4236	0.564	.5313	0.654	.4261	0.361	.4972	0.656
.4257	0.709	.5323	0.635	.4297	0.472	.4982	0.704
.4267	0.749	.5341	0.591	.4308	0.488	.5000	0.798
.4277	0.813	.5403	0.534	.4340	0.630	.5010	0.858
.4299	0.892	.5413	0.526	.4354	0.727	.5028	0.900
.4309	0.946	.5426	0.515	.4385	0.842	.5038	0.955
.4319	0.961	.5483	0.441	.4399	0.909	.5061	0.955
.4336	0.929	.5497	0.419	.4425	0.950	.5070	0.932
.4346	0.913	.5538	0.408	.4437	0.930	.5091	0.906
.4356	0.897	.5549	0.402	.4468	0.885	.5123	0.861
.4377	0.870	.5563	0.385	.4484	0.852	.5133	0.839
.4389	0.864	.5605	0.365	.4516	0.821	.5152	0.815
.4399	0.848	.5615	0.356	.4530	0.787	.5160	0.781
.4419	0.796	.5626	0.322	.4628	0.613	.5178	0.745
.4431	0.789	.5674	0.299	.4641	−0.617	.5205	0.709
.4441	0.736	.5681	0.285			.5214	−0.697
.4461	0.731	.5737	0.275	2442871			
.4473	0.704	.5747	0.287	.4509	−0.435	2443957	
.4483	0.686	.5758	0.292	.4520	0.429	.5643	−0.598
.4502	0.642	.5806	0.296	.4541	0.414	.5657	0.657
.4512	0.645	.5820	0.308	.4551	0.408	.5678	0.783
.4522	0.633	.5829	0.341	.4583	0.372	.5684	0.840
.4544	−0.565	.5869	0.394	.4605	0.391	.5705	0.926
		.5883	0.428	.4615	0.363	.5712	0.964
2442159		.5893	0.466	.4635	0.353	.5730	0.966
.4889	−0.278	.5930	0.630	.4643	0.348	.5740	0.960
.4901	0.278	.5940	0.690	.4662	0.320	.5761	0.920
.4910	0.306	.5951	0.742	.4672	0.322	.5775	0.916
.4959	0.372	.5994	0.908	.4698	0.329	.5803	0.861
.4973	0.389	.6000	−0.953	.4707	0.309	.5809	0.846
.4983	0.428			.4759	0.308	.5830	0.830
.5042	0.662	2442548		.4768	0.288	.5844	0.801
.5052	0.683	.3924	−0.437	.4789	0.300	.5872	0.730
.5059	0.733	.3935	0.434	.4799	0.290	.5882	0.710
.5105	0.935	.3965	0.399	.4834	0.310	.5907	0.673
.5126	−0.934	.3979	−0.404	.4854	−0.327	.5914	−0.650

Table 15

Photoelectric yellow observations of DY Peg

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2437164		2437164		2437164		2437164	
.5129	+0.259	.5216	+0.261	.5247	+0.316	.5275	+0.383

Table 15 (cont.)

Photoelectric yellow observations of DY Peg

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2437164		2437167		2437178		2437178	
.5342	+0.501	.3703	+0.371	.3696	+0.246	.4372	+0.416
.5372	0.557	.3733	0.421	.3701	0.233	.4379	0.366
.5400	0.586	.3759	0.505	.3707	0.225	.4393	0.276
.5466	0.671	.3821	0.581	.3714	0.209	.4400	0.272
.5493	0.679	.3846	0.587	.3721	0.195	.4406	0.254
.5521	0.707	.3866	0.607	.3740	0.180	.4413	0.209
.5581	0.718	.3892	0.645	.3747	0.185	.4420	0.205
.5605	0.756	.3946	0.703	.3754	0.184	.4427	0.189
.5632	0.736	.3967	0.719	.3761	0.195	.4434	0.186
.5691	0.730	.3991	0.718	.3768	0.215	.4448	0.175
.5726	0.689	.4033	0.732	.3775	0.228	.4455	0.165
.5816	0.446	.4054	0.728	.3796	0.252	.4462	0.168
.5844	0.335	.4073	0.728	.3803	0.258	.4469	0.179
.5872	+0.213	.4129	0.717	.3816	0.297	.4476	0.170
		.4140	0.710	.3835	0.346	.4483	0.190
2437165		.4151	0.698	.3842	0.362	.4490	0.203
.4964	+0.656	.4173	0.675	.3849	0.390	.4504	0.234
.4971	0.665	.4185	0.645	.3861	0.413	.4511	0.258
.4978	0.679	.4195	0.633	.3868	0.425	.4518	0.278
.4985	0.675	.4207	0.619	.3875	0.436	.4525	0.303
.4992	0.704	.4233	0.527	.4122	0.714	.4532	0.305
.4999	0.697	.4243	0.462	.4129	0.722	.4539	0.319
.5006	0.705	.4253	0.405	.4136	0.708	.4546	0.318
.5021	0.715	.4263	0.376	.4143	0.696	.4560	0.354
.5028	0.721	.4293	0.209	.4150	0.696	.4566	0.358
.5035	0.713	.4303	0.189	.4157	0.701	.4573	0.362
.5042	0.706	.4315	0.183	.4171	0.697	.4580	0.381
.5049	0.719	.4326	0.177	.4178	0.718	.4587	0.408
.5056	0.722	.4337	0.174	.4185	0.710	.4601	0.446
.5062	0.721	.4347	0.190	.4192	0.700	.4614	0.464
.5076	0.734	.4373	0.240	.4199	0.704	.4621	0.495
.5082	0.724	.4384	0.261	.4206	0.697	.4628	0.480
.5089	0.747	.4394	0.289	.4213	0.707	.4635	0.503
.5096	0.743	.4404	+0.311	.4227	0.690	.4642	0.518
.5103	0.742			.4234	0.699	.4649	0.550
.5110	0.740	2437178		.4248	0.715	.4656	0.546
.5117	0.744	.3580	+0.665	.4255	0.717	.4670	0.557
.5138	0.730	.3587	0.663	.4261	0.722	.4677	0.570
.5145	0.738	.3594	0.643	.4268	0.717	.4684	0.601
.5152	0.726	.3601	0.617	.4282	0.695	.4691	0.610
.5159	0.736	.3608	0.604	.4289	0.680	.4698	0.611
.5166	0.725	.3615	0.583	.4296	0.668	.4712	0.624
.5173	0.725	.3622	0.563	.4303	0.665	.4726	0.617
.5187	0.713	.3636	0.476	.4310	0.636	.4733	0.633
.5199	0.714	.3643	0.450	.4317	0.639	.4740	0.642
.5207	0.685	.3650	0.414	.4324	0.590	.4747	0.647
.5214	0.671	.3657	0.397	.4337	0.572	.4754	0.638
.5221	0.665	.3664	0.358	.4344	0.540	.4761	0.637
.5228	+0.640	.3669	0.329	.4351	0.505	.4768	0.636
		.3674	0.309	.4358	0.493	.4789	0.644
2437167		.3691	+0.257	.4365	+0.431	.4796	+0.648

Table 15 (cont.)

Photoelectric yellow observations of DY Peg

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2437178		2441535		2441984		2442279	
.4802	+0.652	.5449	+0.734	.3623	+0.189	.4274	+0.271
.4816	0.681	.5482	0.748	.3641	0.208	.4281	0.280
		.5516	0.736	.3648	0.221	.4288	0.307
2441535		.5530	0.715	.3668	0.226	.4295	+0.314
.4850	+0.679	.5540	0.717	.3675	0.236		
.4857	0.642	.5565	0.675	.3693	0.296	2444113	
.4881	0.596	.5572	+0.667	.3700	0.317	.4685	+0.586
.4888	0.588			.3728	0.379	.4695	0.589
.4902	0.542	2441963		.3735	0.416	.4728	0.614
.4926	0.473	.4117	+0.719	.3755	0.435	.4762	0.670
.4933	0.414	.4131	0.704	.3762	+0.455	.4812	0.689
.4943	0.374	.4154	0.686			.4822	0.743
.4961	0.275	.4168	0.650	2442279		.4842	0.744
.4971	0.243	.4193	0.605	.3921	+0.729	.4851	0.762
.4978	0.237	.4228	0.540	.3930	0.720	.4871	0.756
.4998	0.196	.4238	0.440	.3939	0.734	.4881	0.771
.5002	0.192	.4262	0.330	.3946	0.720	.4900	0.750
.5016	0.182	.4269	0.301	.3955	0.731	.4910	0.760
.5040	0.205	.4293	0.230	.3993	0.741	.4929	0.775
.5051	0.220	.4307	0.201	.4001	0.720	.4939	0.767
.5061	0.241	.4328	0.199	.4008	0.728	.4958	0.758
.5093	0.326	.4338	0.200	.4016	0.730	.4968	0.746
.5107	0.360	.4367	0.222	.4024	0.718	.4987	0.742
.5144	0.452	.4415	0.314	.4057	0.677	.4997	0.717
.5169	0.497	.4439	0.388	.4077	0.619	.5017	0.695
.5183	0.512	.4453	+0.403	.4084	0.612	.5026	0.689
.5190	0.521			.4091	0.577	.5046	0.648
.5214	0.556	2441984		.4120	0.477	.5075	0.574
.5221	0.564	.3400	+0.701	.4126	0.442	.5085	0.526
.5232	0.558	.3425	0.695	.4133	0.416	.5105	0.446
.5259	0.597	.3432	0.687	.4142	0.344	.5114	0.358
.5269	0.607	.3450	0.656	.4150	0.318	.5133	0.269
.5280	0.619	.3474	0.614	.4155	0.288	.5143	0.229
.5311	0.645	.3481	0.587	.4163	0.251	.5162	0.182
.5322	0.672	.3501	0.515	.4171	0.223	.5172	0.170
.5343	0.695	.3519	0.472	.4181	0.227	.5192	0.173
.5357	0.702	.3529	0.430	.4196	0.199	.5201	0.181
.5367	0.704	.3547	0.361	.4202	0.198	.5221	0.217
.5387	0.709	.3571	0.240	.4209	0.197	.5231	0.219
.5398	0.714	.3578	0.250	.4216	0.199	.5250	0.249
.5405	0.720	.3596	0.199	.4223	0.206	.5260	0.264
.5428	0.735	.3603	0.194	.4231	0.217	.5279	0.291
.5439	+0.738	.3616	+0.188	.4238	+0.222	.5289	+0.316

Table 16

Photoelectric blue observations of DY Peg

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2437164		2437164		2437164		2437164	
.5115	−0.018	.5143	−0.072	.5198	−0.084	.5230	−0.019

Table 16 (cont.)

Photoelectric blue observations of DY Peg

J.D.	ΔB
2437164	
.5328	+0.212
.5358	0.281
.5386	0.336
.5451	0.426
.5507	0.481
.5567	0.513
.5591	0.527
.5622	0.529
.5677	0.501
.5707	0.484
.5740	0.458
.5802	0.226
.5830	+0.068
.5858	−0.055
2437165	
.5249	+0.377
.5256	0.358
.5263	0.345
.5270	0.306
.5284	0.257
.5291	0.225
.5298	0.175
.5305	0.116
.5312	0.071
.5319	+0.014
.5332	−0.069
.5339	0.089
.5346	0.110
.5353	0.129
.5360	0.137
.5367	0.155
.5374	0.147
.5381	0.133
.5395	0.138
.5402	0.133
.5409	0.121
.5416	0.099
.5423	0.094
.5430	0.085
.5437	0.059
.5444	0.038
.5450	−0.021
.5457	+0.002
.5464	0.019
.5485	0.082
.5492	0.112
.5499	0.124
.5506	0.154
.5513	0.170
.5520	+0.183

J.D.	ΔB
2437165	
.5527	+0.216
2437167	
.3724	+0.135
.3745	0.179
.3769	0.238
.3835	0.346
.3856	0.371
.3877	0.417
.3936	0.453
.3957	0.466
.3979	0.484
.4044	0.498
.4064	0.507
.4121	0.491
.4146	0.495
.4168	0.472
.4179	0.473
.4189	0.435
.4200	0.427
.4228	0.305
.4238	0.258
.4249	0.189
.4258	+0.102
.4279	−0.028
.4288	0.094
.4309	0.143
.4320	0.143
.4332	0.146
.4341	0.129
.4354	0.089
.4380	0.037
.4389	−0.021
.4399	+0.007
.4410	0.010
.4422	+0.035
2441535	
.4829	+0.469
.4843	0.438
.4853	0.420
.4877	0.347
.4884	0.305
.4895	0.248
.4919	0.171
.4929	0.114
.4940	+0.045
.4954	−0.038
.4968	0.078
.4975	0.086
.4995	−0.118

J.D.	ΔB
2441535	
.5002	−0.126
.5012	0.133
.5037	0.128
.5044	0.120
.5058	0.091
.5075	0.033
.5086	−0.005
.5100	+0.018
.5120	0.066
.5127	0.090
.5141	0.124
.5176	0.226
.5186	0.239
.5211	0.270
.5218	0.286
.5225	0.310
.5252	0.358
.5266	0.390
.5273	0.397
.5294	0.428
.5308	0.418
.5315	0.439
.5336	0.459
.5350	0.474
.5364	0.469
.5384	0.488
.5391	0.490
.5401	0.509
.5464	0.511
.5475	0.511
.5489	0.511
.5509	0.511
.5523	0.499
.5537	0.503
.5558	0.477
.5568	0.466
.5579	+0.438
2441963	
.4110	+0.518
.4151	0.466
.4161	0.457
.4186	0.381
.4200	0.334
.4221	0.265
.4255	+0.058
.4265	−0.031
.4290	0.099
.4321	0.142
.4335	0.130
.4360	−0.107

J.D.	ΔB
2441963	
.4374	−0.076
.4411	+0.005
.4432	0.039
.4446	0.090
.4471	+0.149
2441984	
.3397	+0.508
.3404	0.502
.3422	0.483
.3429	0.455
.3453	0.433
.3471	0.404
.3478	0.370
.3491	0.307
.3498	0.293
.3515	0.235
.3522	0.201
.3543	0.097
.3550	+0.048
.3568	−0.055
.3575	0.090
.3592	0.117
.3599	0.127
.3612	0.136
.3619	0.142
.3644	0.125
.3689	−0.011
.3696	+0.006
.3721	0.052
.3731	0.079
.3748	0.125
.3758	+0.163
2442279	
.3924	+0.503
.3942	0.512
.3950	0.501
.3959	0.525
.4004	0.520
.4012	0.502
.4028	0.489
.4061	0.451
.4073	0.412
.4081	0.391
.4088	0.350
.4095	0.330
.4123	0.197
.4129	0.148
.4137	0.081
.4147	+0.027

Table 16 (cont.)

Photoelectric blue observations of DY Peg

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2442279		2442279		2444113		2444113	
.4157	−0.066	.4298	−0.005	.4895	+0.538	.5099	+0.198
.4159	0.075			.4905	0.534	.5109	+0.109
.4166	0.084	2444113		.4924	0.541	.5128	−0.014
.4174	0.109	.4680	+0.333	.4934	0.559	.5138	0.070
.4187	0.113	.4712	0.353	.4953	0.535	.5158	0.136
.4192	0.126	.4723	0.373	.4963	0.532	.5167	0.147
.4201	0.113	.4746	0.407	.4983	0.522	.5187	0.140
.4205	0.130	.4757	0.406	.4992	0.509	.5197	0.137
.4213	0.118	.4778	0.429	.5012	0.490	.5216	0.117
.4220	0.124	.4788	0.451	.5022	0.474	.5226	0.091
.4227	0.126	.4817	0.480	.5041	0.439	.5245	0.058
.4235	0.116	.4847	0.500	.5051	0.411	.5255	−0.026
.4242	0.088	.4866	0.516	.5070	0.366	.5274	+0.014
.4277	0.049	.4876	+0.522	.5080	+0.317	.5284	+0.033
.4284	−0.026						