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THE SHORT-PERIOD ECLIPSING BINARY V728 HERCULIS[1]

This short-period W UMa system was discovered along with dozens of others by N. E. Kurochkin (1977) from 10° x 10° astrographic plates taken for a study of M92. In Kurochkin's work it is identified as Cπ 2086. The photographic light curve presented by Kurochkin suggests a contact system and we elected to attempt to obtain photoelectric light curves of this relatively bright system.

The system has been observed at the Rothney Astrophysical Observatory with the Rapid Alternate Detection System (RADS) for the past two seasons. The photometry system is a chopping, gated pulse-counting two-star-and-sky device and has been described by Milone et al. (1982) and by Milone and Robb (1983). Partial BVI light curves were obtained during 1986 and complete BVI light curves were obtained in 1987. Because the ephemeris provided by Kurochkin and cited in Kholopov (1985) failed to successfully reproduce the light curve, we applied a modified version of the period-finding program of Jurkevich (1971) to the 1987 season data to obtain a preliminary period: P = 0.471302 d. The epoch used was E_0 = HJD 2441571.273, from Kurochkin. The evidence, however, is that the same period can not fit adequately the data from both seasons and the large uncertainty obtaining from the early photographic data is too great to permit a significant q (dP/dt) term to be found. With the above elements, the O-C phases of minima were obtained for each of the wavelengths and weighted means were found. The results are:

<HJD>	O - C
2446612.868	0.1635 ± 0.0013
613.809	0.1604 ± 0.0018
949.835	0.1357 ± 0.0008

The system will be observed again this season with special attention to observing phases of minima in order to determine if abrupt or continuous changes of the period are involved.

We have also observed the system spectroscopically with the 1.8-m telescope of the Dominion Astrophysical Observatory in Victoria for radial velocity studies. This work has also provided the spectral type of the system: F3 with an estimated uncertainty of 1/10 class. Complete analyses of the system will be published elsewhere.

Student observers who helped to gather the data during the

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[1] Publications of the Rothney Astrophysical Observatory Series B No. 12

past two seasons included J. van Leeuwen and D. Thistlethwaite. This work was supported by grants from the Canadian Natural Sciences and Engineering Research Council to EFM, by Student Temporary Employment Programme Grants from the Goverment of Alberta to EFM and JEP and by the Department of Physics of the University of Calgary, all of which are gratefully acknowledged.

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AG VIRGINIS: NEW TIMES OF MINIMA AND PERIOD STUDY

Photoelectric observations of the eclipsing binary star AG Virginis (BD+13° 2481) were made on seven nights (Februrary, March and April 1987) using the one meter telescope at the Stephen F. Austin Observatory. The photometer was a Thorn EMI Gencom, Inc. "Starlight-1R" photon counting system equipped with an uncooled EMI 9798A S-20 response tube. Telescope positioning, photometer operation, and data logging was controlled automatically by a Commodore 64 microcomputer (Markworth and Rafert, 1985). Using the comparison star BD+13° 2485, 2,209 observations were obtained in the natural Blue, Visual, and Red bandpasses. These observations resulted in nearly complete BVR light curves and 15 new times of minimum light (12 primary and 3 secondary). The differential magnitudes were normalized and the resulting visual light curve is presented in Figure 1.

Determining accurate times of minimum light for AG Virginis is complicated by the asymmetries found in the eclipse branches and the distorted primary minimum. The light curve presented in Figure 1 shows a much smaller distortion in the primary minimum and a more symmetrical secondary eclipse than reported by past observers (Wood, 1946, Binnendijk, 1969, and Blanco and Catalano, 1970). Nightly variations at the bottom of primary eclipse were also evident in the new observations.

TABLE 1

JD HEL.	MIN	O-C	OBSERVER
2429329.8510	II	+.0144	WOOD(1946)
9334.9930	II	+.0152	WOOD(1946)
9335.9560	I	+.0142	WOOD(1946)
9337.8840	I	+.0142	WOOD(1946)
9338.8510	II	+.0172	WOOD(1946)
9339.8110	I	+.0133	WOOD(1946)
9346.8790	I	+.0121	WOOD(1946)
9359.7340	I	+.0141	WOOD(1946)
9363.9100	II	+.0129	WOOD(1946)
9368.7320	I	+.0150	WOOD(1946)
2433387.8540	I	-.0004	NASON AND MOORE(1951)
4086.4195	I	+.0039	KWEE(1958)
4120.4787	I	+.0026	KWEE(1958)
4455.2919	I	-.0052	SZCZEPANOWSKA(1958)
4458.5090	I	-.0014	SZCZEPANOWSKA(1958)
4487.4297	I	+.0000	SZCZEPANOWSKA(1958)
4776.6215	I	-.0010	SZCZEPANOWSKA(1958)
5197.5551	I	-.0036	SZCZEPANOWSKA(1958)
5198.5286	II	+.0059	SZCZEPANOWSKA(1958)
5219.4146	I	+.0058	SZCZEPANOWSKA(1958)
5561.2974	I	-.0016	SZCZEPANOWSKA(1958)
5562.2619	II	-.0010	SZCZEPANOWSKA(1958)
5848.5649	I	+.0011	SZCZEPANOWSKA(1958)
7028.4755	I	+.0050	PURGATHOFER AND WIDORN(1964)
8846.5350	I	+.0058	BLANCO AND CATALANO(1970)
9587.5065	I	+.0010	BLANCO AND CATALANO(1970)
9596.5040	I	+.0014	BLANCO AND CATALANO(1970)
2439618.3520	I	-.0007	BLANCO AND CATALANO(1970)
9643.4142	I	-.0019	BLANCO AND CATALANO(1970)
9943.8593	II	+.0040	BINNENDIJK(1969)
9944.8191	I	-.0002	BINNENDIJK(1969)
9946.7472	I	+.0000	BINNENDIJK(1969)
9948.6755	I	+.0003	BINNENDIJK(1969)
2441391.4270	I	+.0011	KIZILIRMAK AND POHL(1974)
2451.4800	II	+.0018	POHL AND KIZILIRMAK(1977)
2892.6620	I	+.0041	MALLAMA et. al.(1982)
4709.4356	I	+.0042	POHL et. al.(1977)
5741.2071	II	+.0000	KALUZNY(1987)
6855.8809	I	-.0038	MICHAELS
6855.8821	I	-.0026	MICHAELS
6855.8835	I	-.0012	MICHAELS
6859.7363	I	-.0043	MICHAELS
6859.7381	I	-.0025	MICHAELS
6859.7389	I	-.0017	MICHAELS
6860.7096	II	+.0051	MICHAELS
6860.7103	II	+.0058	MICHAELS
6860.7120	II	+.0075	MICHAELS
6875.8047	I	-.0021	MICHAELS
6875.8051	I	-.0017	MICHAELS
6875.8059	I	-.0009	MICHAELS
6911.7914	I	-.0039	MICHAELS
6911.7924	I	-.0029	MICHAELS
6911.7935	I	-.0018	MICHAELS

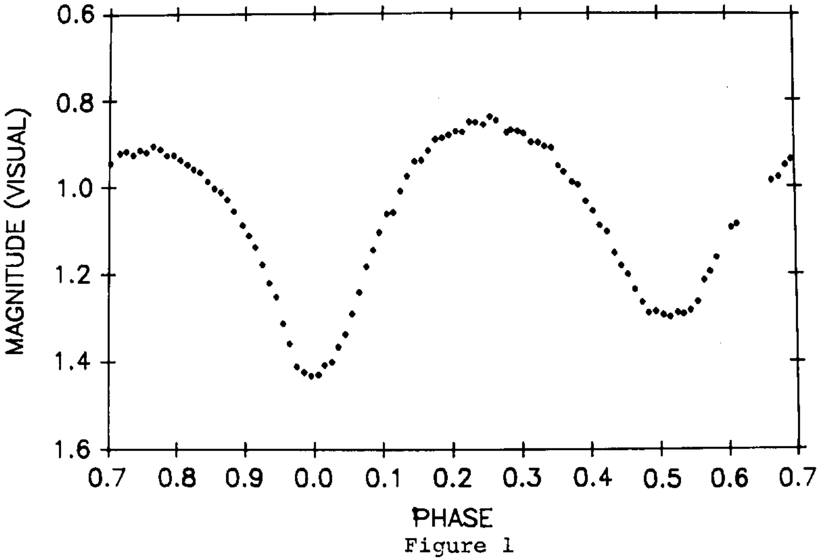

Figure 1
The normalized visual differential magnitudes of AG Virginis in the sense variable-comparison .

TABLE 2

OBS#	TIME	N (PRI)	O-C (PRI)	N (SEC)	O-C (SEC)	DIFF.	SECONDARY DISPLACEMENT
WO	MAR 1939-APR 1939	6	.0138	4	.0149	-.0011	1.6 MIN. LATE
SZ	APR 1955-MAR 1956	3	.0002	2	.0025	-.0023	3.3 MIN. LATE
BI	MAR 1968-APR 1968	3	.0000	1	.0040	-.0040	5.8 MIN. LATE
MI	MAR 1987-APR 1987	12	-.0025	3	.0061	-.0061	12.4 MIN. LATE

WO = Wood (1946); SZ = Szczepanowska (1958); BI = Binnendijk (1969); Mi = Michaels

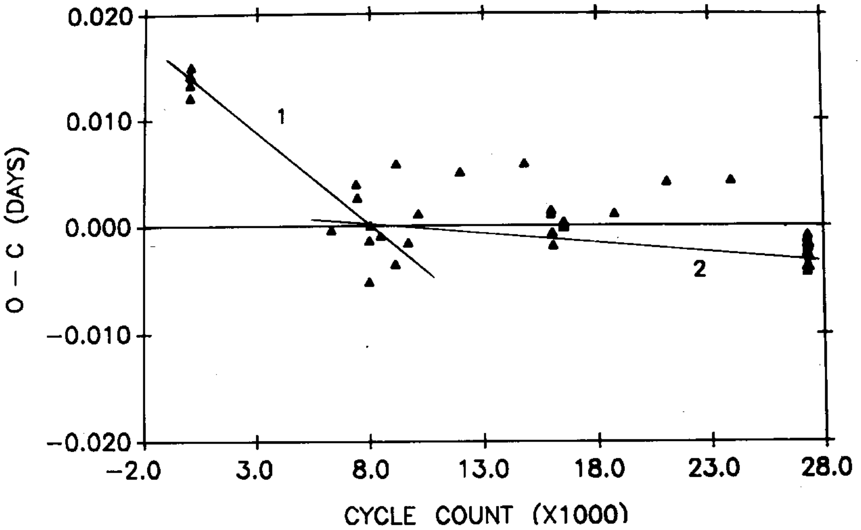

Figure 2

The O-C diagram for AG Virginis using only photoelectric primary minima. Line Segment 1 and Segment 2 illustrate a possible period change.

Photoelectric minima for this star typically show a significantly smaller scatter in the O-C diagram compared to those determined from visual and photographic observations. Only photoelectric minima are, therefore, compiled in Table 1 and used in this period study. The new times of minimum in this paper were determined by using a FORTRAN program that applied a parabolic least squares fit to the branches of each eclipse (the lower part of primary minimum was not used because it was clearly distorted). The new times of minima are contained in Table 1.

Another interesting feature of the light curve is the displaced secondary eclipse, which was reported in previous studies (Binnendijk, 1969, Blanco and Catalano, 1970). Since a displaced secondary minimum will affect the accuracy of a period study, an effort was made to determine whether the displacement is a permanent feature of the light curve. A good method for measuring a change in the phase of the secondary minimum would be to difference the observed minus the calculated (O-C) times of the primary eclipse with the observed minus the calculated (O-C) times of the secondary eclipse. By computing the O-C's at several epochs (using the same orbital period) any change in secondary displacement would become apparent. For a circular orbit where primary eclipse occurs at 0.0 phase and secondary at 0.5 phase the difference should be zero. In Table 2 the minima of four different observers were used in the procedure outlined above. TIME is the calendar dates for each set of observations. $(O-C)_{pri}$ and $(O-C)_{sec}$ are the average residuals (O-Cs) for primary and secondary eclipse respectively. N_{pri} and N_{sec} are the number of minima used to compute each average O-C. The period used to form the O-C's was computed using Binnendijk's ephemeris (1969)

$$\text{Hel. JD(Min)} = 2439946.7472 + 0\overset{d}{.}64265068E.$$

The difference in primary and secondary O-Cs indicates the displacement of the secondary eclipse has been increasing and is presently (April 1987) occuring 12.4 minutes late! The displaced secondary minimum is most likely the result of inaccurate times of minimum light due to distortions in the light curve. The distortions may affect both primary and secondary eclipses. A period study of AG Virginis should, therefore, use either primary minima or secondary minima but not both.

Table 1 lists the Heliocentric Julian Date of each minimum, the O-C in days using Binnendijk's (1969) linear ephemeris, the type of minimum (primary or secondary) and the reference. Figure 2 is the O-C diagram using only the primary minima from Table 1. Despite the large scatter in the residuals it seems likely that one period change may have occured as first reported by Binnendijk (1969). The two line segments in Figure 2 represent the best linear fits before and after the period change. Using the primary minima only a least squares solution for the initial epoch and the period for each segment is given by,

$$\text{SEGMENT 1} \quad \text{Hel. JD(Min)} = \underset{.0015}{2429335.9547} + \underset{.000000211}{0\overset{d}{.}642649295}E$$

$$\text{SEGMENT 2} \quad \text{Hel. JD(Min)} - \underset{.0008}{2433387.8556} + \underset{.000000059}{0\overset{d}{.}642650549}E$$

The period increase amounted to only 0.11 seconds. Segment 2 gives the best current light elements for AG Virginis.

Another period study by Blanco and Catalano (1970) suggests the orbital period of AG Virginis undergoes a slow variation with a period of about 40 years. Considering the scatter in the O-C diagram (Figure 2) this conclusion is far from secure. A period variation on this time scale is unlikely given the short orbital period and the lack of any observed periodic displacement of the secondary minimum about 0.5 phase which would suggest apsidal motion. A complete discussion and light curve analysis of AG Virginis will be published elsewhere.

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REMARKS ON MODIFIED AUTO-CORRELATION ANALYSES AND THEIR APPLICATION IN A SEARCH FOR "TIME SIGNATURES" OF MICRO-VARIABILITY IN THE dMe FLARE STAR, V1285 AQL

Characteristic time intervals between low-amplitude photometric variations in dMe stars (henceforth termed flare star "time signatures") have been suspected in several wide-band observations, notably in the U-band for three dMe stars, V1285 Aql, V645 Cen and V1045 Oph (Andrews 1988a). The modified auto-correlation (MAC) technique utilized, which employs a statistic defined by the means of the squares of successive differences for equally-spaced samples, stems from the work of Baines (1951) and Burki et al. (1974). In order to test the method we have investigated the results from several sets of synthetic data generated from a pure sinusoidal signal with superposed gaussian noise. To a sinusoid of period 30 seconds and semi-amplitude 0.15 units we have added gaussian noise with a sigma of 0.30. The synthetic data consisted of 110 points, sampling continuously with 1-second integrations. Performing the MAC analysis of this synthetic data we have the result shown in Figure 1. The 30-second signal is clearly detected over the entire range even though the noise in the data was substantial. The "data" is plotted against time in days in Figure 2. The periodogram of the MAC parameter was useful in this case since the MAC statistic was weak (see Figure 2). For a good comparison with the data from V645 Cen (Andrews 1988b) we have employed a larger number of data points (860) for our synthetic data, again with 1-second integrations from a "star" monitored continuously. This time we introduced two frequencies as shown in

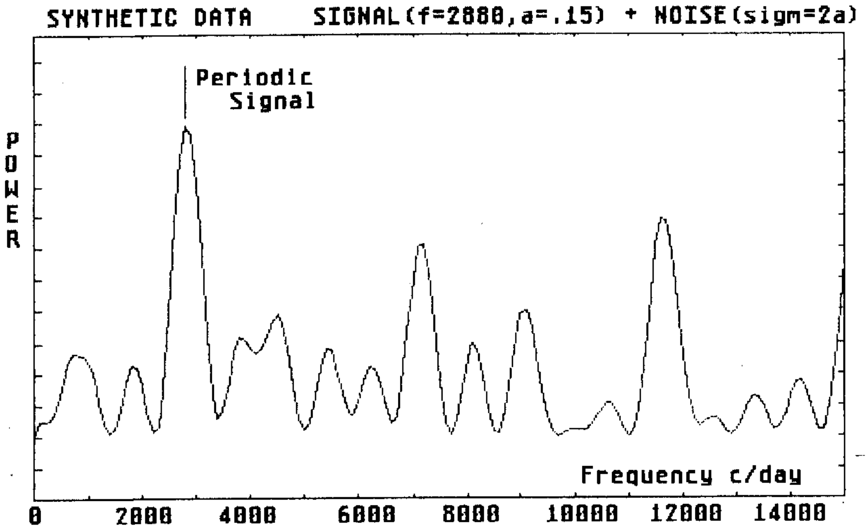

Figure 1

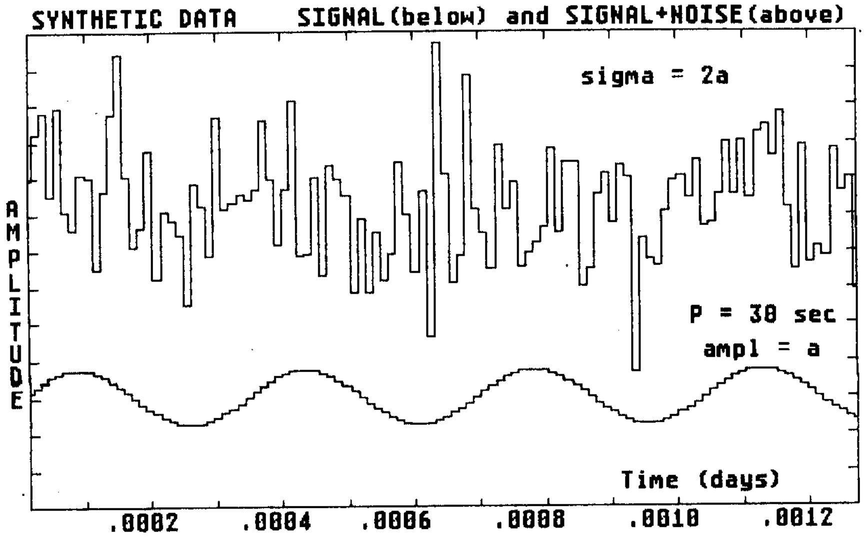

Figure 2

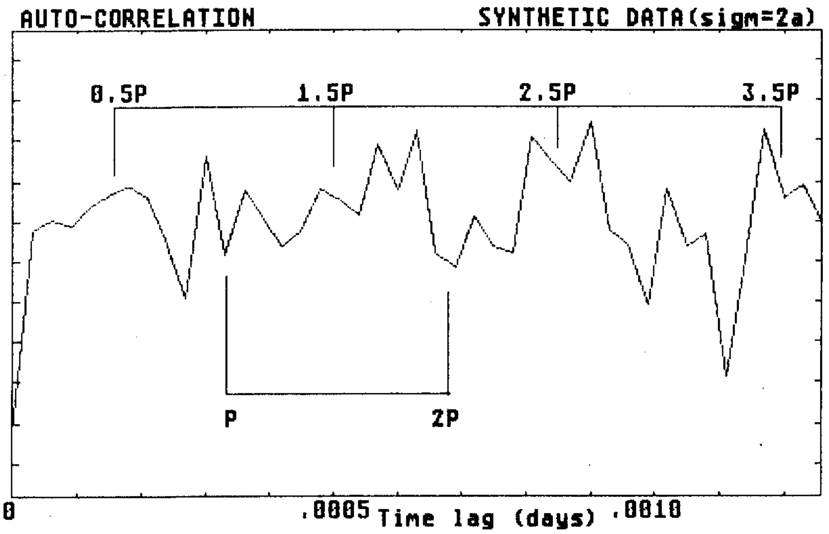

Figure 3

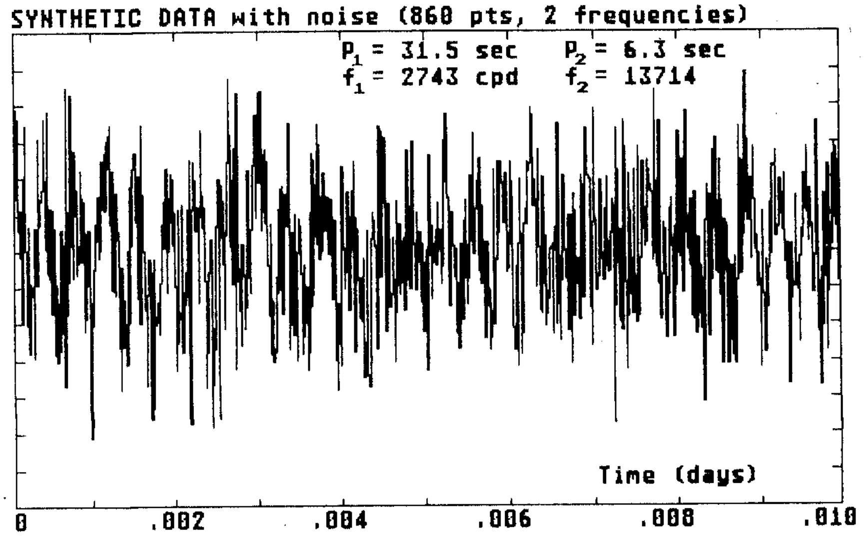

Figure 4

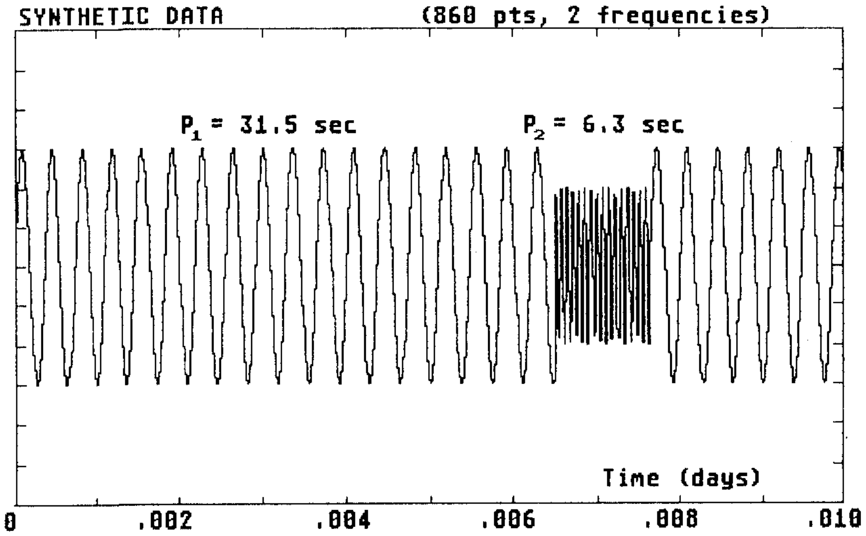

Figure 5

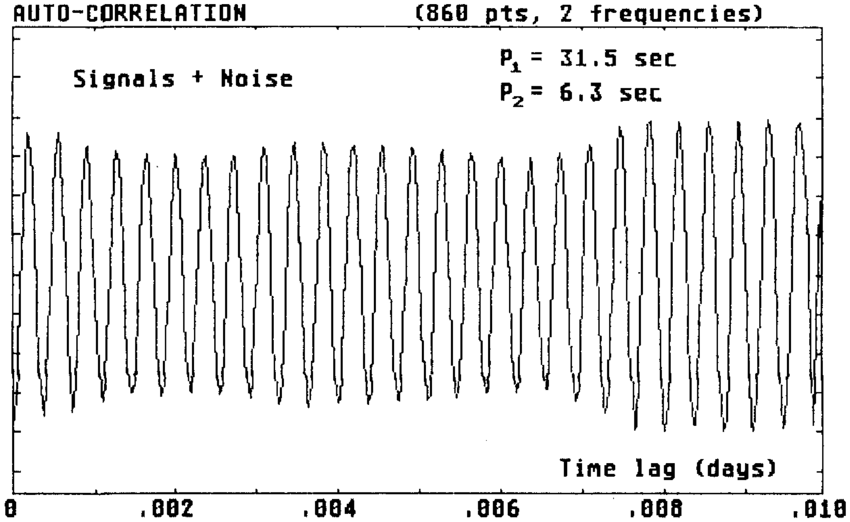

Figure 6

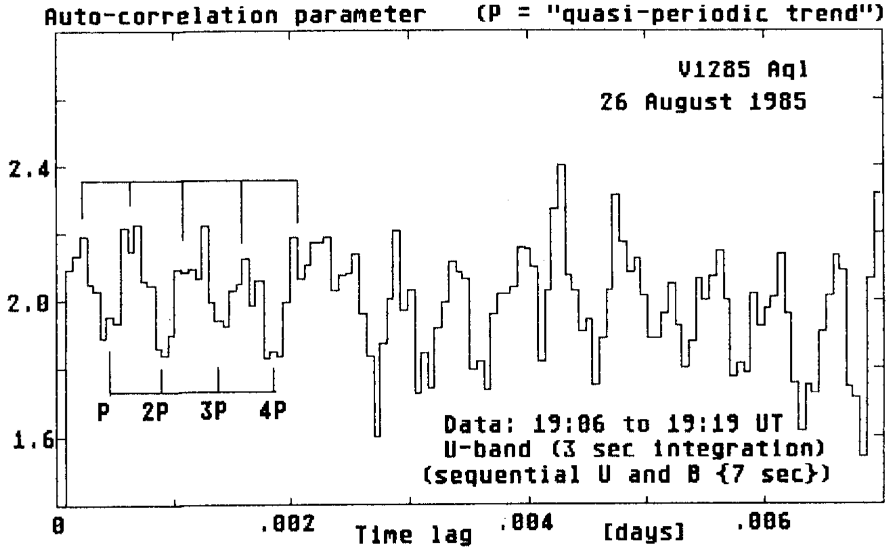

Figure 7

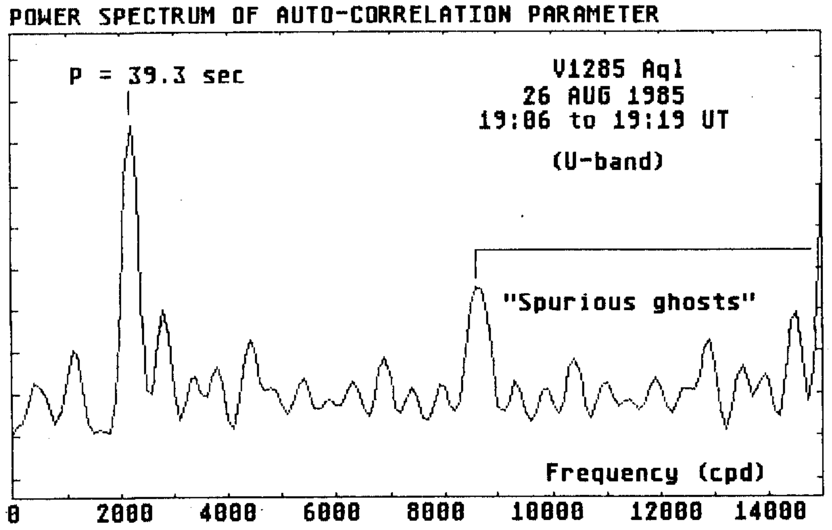

Figure 8

the "data" plot, and gaussian noise with a sigma of 0.3 (twice the semi-amplitude, a, of the stronger sinusoidal signal; see Figures 4 and 5). The weaker sinusoidal signal (period 6.3 seconds) was not detected in the MAC analysis using a unit time lag of 0.00003 days, but the stronger signal (31.5 second) was detected (Figure 6). We see an amplitude modulation caused by the time interval when this weaker signal occurred. The detection was so clear that we did not construct the periodogram of the MAC parameter. We find in the case of real stellar data that the MAC analysis is more powerful than a straight-forward classical periodogram analysis and although there are ambiguities in selecting "time signatures" for dMe stars, the method appears sufficiently interesting to pursue further. As an illustration we show new results for V1285 Aql using U-band data sampled at 7-second intervals (see Figure 2 in Andrews 1988a). The U-band time signature was 39.3 seconds (Figures 7 and 8), i.e. at a frequency too high to have been previously detected using longer sampling intervals (Andrews 1988a). The unit time-lag employed in the present work was 0.00003 days (near 2.5 seconds). The results for V1285 Aql show the difficulties of spurious ghost frequencies in periodograms which are present when there is insufficient sampling at high frequencies. Further investigations into dMe time-signatures during "quiescent phases" and near large flares, and in several photometric bands and in spectral emission-line strengths, would be worthwhile.

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PLEIONE AGAIN WITHOUT SHELL

Pleione(BU Tauri = HD23862 = HR1180 = 28Tau: B8Ve, Vsini = 341 km s^{-1}) is a well known Be/shell star. It has been widely explored for nearly one century and during this time underwent through different (Be, shell and normal B) phases. Full description of the variations and discussion on the observations of Pleione can be found in Gulliver (1977) and Doazan (1982). After a shell phase from 1938 to 1954 the star entered a Be phase with strong hydrogen emission lines exhibited in its spectrum (Morgan et al., 1973). In the course of this Be phase emission lines of Fe II had also been present. In December 1972 Pleione entered a new shell phase and since then the shell strength had been found continuously increasing till 1981. Recently Goraya et al. (1987) reported about increase of the brightness of Pleione at two wavelengths (3300 and 3600 Å) after 1981. This increase may be considered as a first precursor of the shell phase end which is in agreement with the conclusions of Doazan (1982) about the photometric behaviour of Pleione in the time of previous phase changes.

Pleione was among the stars included in the Be star observing programme carried out in the National Astronomical Observatory "Rozhen". During the autumn season of 1987 six plates were obtained with the coudè spectrograph of the 2m RCC telescope in NAO. Some data for them are listed in Table I.

Table I

Plate No.	JD ● 2447000+	Spectral range (Å)	Dispersion ($Åmm^{-1}$)
2c2920	26.545	3350 - 4900	9.0
2c2925	39.573	3450 - 5000	9.0
2c2928	40.575	3450 - 5000	9.0
2c2933	43.586	3450 - 5000	9.0
2c2954	164.267	3350 - 4900	9.0
2c2965	167.317	4800 - 6800	17.8

Our observations showed that significant changes happened to Pleione in 1987. In Figure 1 the shell spectrum of the star and its spectrum after the shell lines had disappeared is compared. One can see that instead of the huge amount

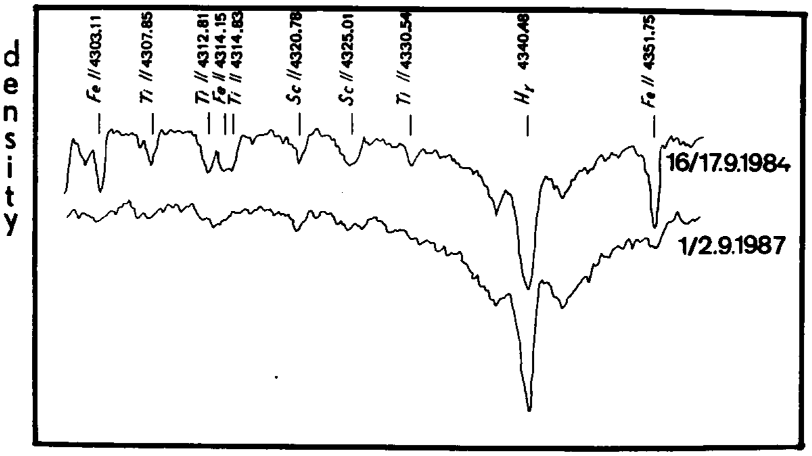

Figure 1

Density tracings of Hγ region of Pleione's spectrum with and without shell lines.

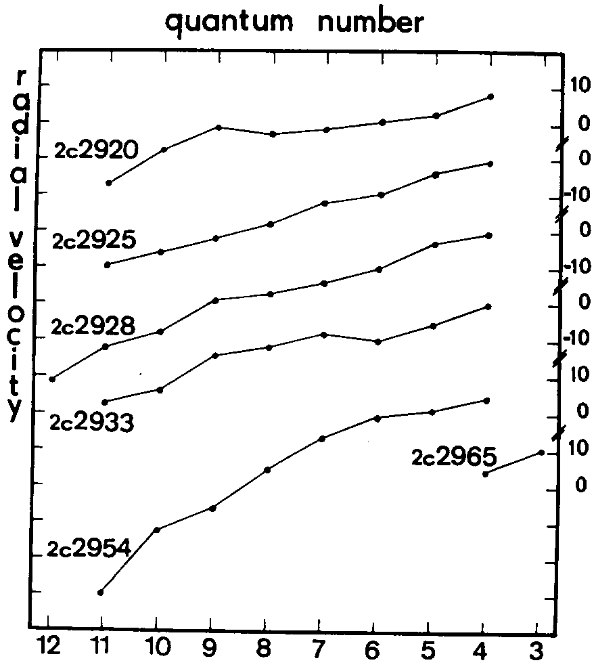

Figure 2

Radial velocities of the Balmer lines' absorption cores.

of sharp shell lines only a few shallow lines, mainly of singly ionized metallic ions, have remained. There is no evidence of the broad absorption of the Ca II K line, which was present in the star's spectrum in the time of the last shell phase (Gulliver, 1977: Hirata and Kogure, 1976, 1977). No He absorption lines are noticeable. Balmer absorption lines are visible up to H_{20}. On all our plates they have significant asymmetry in their profiles with the violet wing widened. One has to mention that the lower Balmer lines have greater asymmetry than the higher. The low members also show double peaked emission which is seen up to Hδ. Throughout the period of observations the V component of the hydrogen emission was less than the R component. On the 2c2965 plate from 6/7 January 1988 some Fe II lines can be seen to have P Cygni type profiles with weak red-wing emission. The strongest among them are the Fe II lines at 4923.92, 5018.43, 5169.03, 5316.61 and 5891.36 Å. It must be noticed that Fe II emission were formerly present in the spectrum of Pleione when hydrogen emission lines reached their maximal intensity during the previous Be phase in 1954-1972. All our plates were measured for radial velocities with the oscilloscopic comparator device in NAO. The radial velocities were measured at the minima of the line profiles. On all the plates there was found remarkably great Balmer progression with the lower members less blueshifted (Figure 2). The observed progression is bigger than that reported for the preceding phases (Gulliver, 1977: Ballereau, 1980). Throughout the period of the observations no significant variations in the radial velocities of the hydrogen and metallic spectral lines were detected.

Even from this very preliminary results it is clear that Pleione is undergoing quick evolution now, caused by the expansion of its shell. The question now is how it will continue and the answer could be obtained only from further observations.

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ON THE RECENT PERIOD CHANGE OF THE RR LYRAE STAR XZ CYGNI

Bezdenezhnyi (1988) gave a system of nine linear elements for XZ Cygni, which is known for its large period changes. The elements no. 9 of the quoted paper, however do not fit the observations from 1984 onwards, because they had been derived from too short a time interval (2445200 to 6300).

From numerous maxima observed by Blasberg (1983a, 1984, 1985, 1986, 1988) the following elements could be secured:

$$\text{Max. hel.} = 2445546.4160 + 0\overset{d}{.}4666215 \cdot E$$

They follow those given by Blasberg (1983b) or no. 8 of Bezdenezhnyi (1988) and are valid from 1983.7 up to the present. They are confirmed for instance by the BAV data of Wunder (1987a, b). The difference between the observed maxima and the dates computed by no. 9 of Bezdenezhnyi (1988) amounted to about $0\overset{d}{.}06 = 1\overset{h}{.}4$ in 1987. Details will be published in Mitt. Veränderl. Sterne 11, p.117 ff.

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A PERIOD CHANGE IN WY CANCRI

Chambliss (1965, 1975) presented epochs of minimum light for WY Cancri and combined these with previously published times of minimum light to get a period of $0\overset{d}{.}8293712$, with a probable error of 1 in the last place. Chambliss noted the constancy of the period, while Ahnert (1973) noted that the period had remained constant for 40 years. Faulkner (1986) presented two epochs of minimum light which had small negative (O-C)'s using Chambliss's light elements. This suggests that a small period change may have occurred, though Faulkner did not comment on this. We present two new times of minimum light and a new set of light elements that indicate that the period has changed.

An Optec photometer was used on the 41cm David Irons telescope of the Charlotte Amateur Astronomy Club. Differential B and V measurements were made using BD+27°1701 as the comparison and BD+28°1672 as the check star. Because the size of the detector exceeded 40", no attempt was made to exclude the light of a faint companion 20" from WY Cancri (Chambliss, 1975). Because of the color of WY Cancri, the B curves had much more scatter than the V curves, so only the V curves were used to find epochs of minimum light. The Hertzsprung method was used for this, and the epochs are given as:

Hel. J.D.	E	(O-C)
2447202.7774	25,140	-0.0049
2447241.7580	25,187	-0.0047

where the residuals were computed using the light elements of Chambliss (1975)

Because these residuals are about 7 minutes, a new set of light elements was obtained by combining these two epochs of minimum light with those of Faulkner:

$$\text{H.J.D. MIN.I} = \underset{\pm 2}{2446025.9017} + \underset{\pm 18}{0^{d}.82936984}E.$$

Note that this period is $0^{s}.12$ shorter than that of Chambliss, while the probable error in the period is about ten times smaller than this difference. The epochs of minimum light used to get the above light elements, as well as the residuals, are given below.

Hel. J.D.	E	(O-C)
2446025.9014	0	-0.0003
2446143.6726	142	+0.0004
2447202.7774	1,419	-0.0001
2447241.7580	1,466	+0.0001

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BLUE LIGHT CURVE OF VW Cep SYSTEM

VW Cep is one of the most frequently observed eclipsing systems. It is the brighter member of a visual binary (Hershey 1975) and has a light curve of W UMa type (subtype W). Variability of the period and shape of the light curve (Kwee 1966, Karimie 1983) is a reason of great interest in this system. By analyzing differences between the depths (heights) of two minima (maxima) Karimie obtained two different periods of changes for Δm_{min} and Δm_{max}. For Δm_{min} the suspected period is about 828 days while for Δm_{max} Karimie obtained a period of about 44 years. These data suggests that the changes of minima are connected with short time-scale changes of the system such as asynchronously moving spots or clouds, while the changes of maxima might be connected with longer time-scale changes, such as orbital motion of the eclipsing system around the third component (Hershey 1975, gives that orbital period as P≈30.5 years). Notice that the period of changes for Δm_{max} as estimated by Karimie is approximately four times greater than the "period" of changes of the orbital period of the system (Karimie 1983, gives 1931, 1941, 1961, 1971 as times when the orbital period changed abruptly). On the other hand, Hershey (1975) gives that the minimal separation between the eclipsing system and the third component took place at T=1966.48. It means that the sudden period changes occurred at the position of the third component around the eclipsing system about $\pm 90^{\circ}$ from the periastron.

The degree of contact is the most important thing in the investigation of physical status of VW Cep. Observations suggest that this parameter is not fixed, but changes on a time scale of a few years from detached to contact configuration (Lucy 1973, Rucinski 1973, Anderson et al. 1980, Leung 1980, Linnell 1980).

All the above mentioned peculiarities have encouraged us to make observations of the star.

Our observations include 171 measurements with b filter obtained on 5 nights between 16 March, and 5 May 1986. They were made at the Astronomical

Observatory of the Jagiellonian University in Cracow using the 35 cm Maksutov-type telescope with Russian photomultiplier FEU 92 and a blue Schott filter. The constancy of the primary comparison star BD+75°0889 was checked against the star BD+75°0884. It was constant within ±0.03 of a magnitude. The observations were corrected for atmospheric extinction using the mean coefficients for Cracow and reduced to the B magnitude of the Johnson-Morgan system.

The observations allowed to determine five moments of minima. The calculation of these moments was made by parabolic fitting to observational data. The errors δ_{JDhel} were calculated in the following way: for each observed magnitude m_i the "theoretical" (from fitted polynomial) time coordinate t_i was calculated, then the sum of squares $D=\sum_{i=1}^{N}\left[t_i-(JDhel)_i\right]^2$ was formed and δ_{JDhel} obtained from the formula: $\delta_{JDhel}=\left[\frac{D}{N^2}\right]^{1/2}$.

Adding to our results moments of minima obtained at our observatory by M. Banaczkowski (to be published) in the years 1985-1986 we obtained new elements of VW Cep assuming a constant period :

$$\begin{array}{rcl} JDhel(Min)=2446467.4000 & + & 0\overset{d}{.}2783094 \ E \\ \pm.0005 & & \pm.0000024 \end{array}$$

All the minima mentioned above and the corresponding O-C values are given in Table I.

Figure 1 presents all observations (comparison minus variable) as a function of the phase computed from elements given above. Unfortunately, not all parts of the light curve are covered with observation due to a bad weather that concerns mainly the max I.

The heights of both maxima (see Figure 1) show insignificant differences (but the small number of points within max I should be kept in mind). So, at the time of our observations (March-May 1986) the light curve of VW Cep was asymmetric, but the maxima were of similar heights. The asymmetry of the light curve manifests itself in an easily visible difference of slopes of ascending and descending branches of both minima and in a shift of secondary minimum (see also Karimie 1983 and Kwee 1966).

The normal points obtained by averaging measurements over 0.02 phase intervals were used for simulations of the light curve by the well known Wilson-Devinney program LC (Woodward and Wilson 1983).

For the bolometric albedo a and gravity darkening exponent g we have adopted the theoretical values for a convective envelope (Lucy 1973,

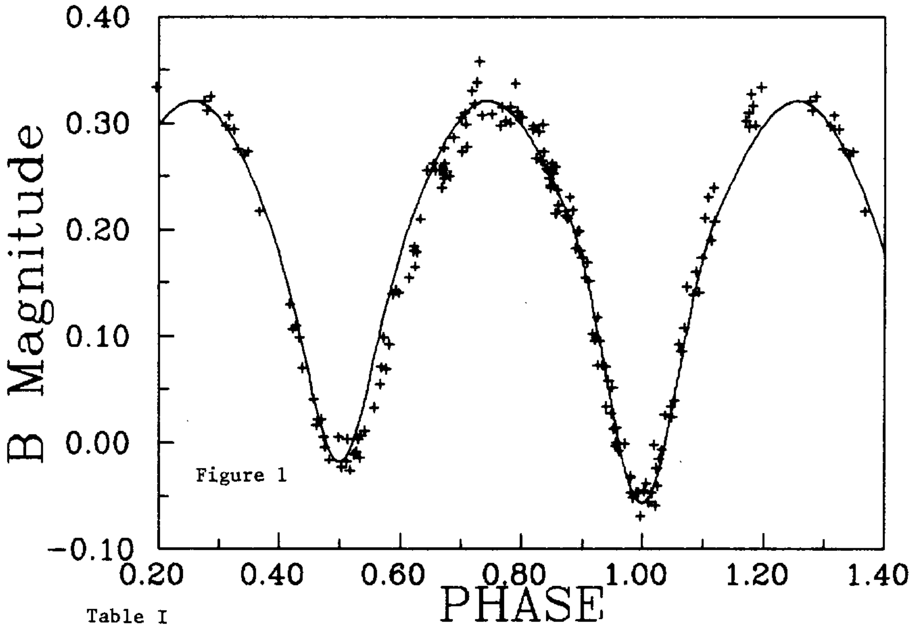

Figure 1

Table I

No	JDhel(Min)	E	δ_{JDhel}	O-C	Filter
	24....				
1	46373.3316	-338.0	0.0004	0.0002	V
2	46373.4712	-337.5	0.0001	0.0007	V
3	46378.4807	-319.5	0.0002	0.0006	V
4	46466.2828	-4.0	0.0005	-0.0039	V
5	46466.4262	-3.5	0.0001	0.0003	V
6	46467.2625	-0.5	0.0004	0.0017	V
7	46467.3995	0.0	0.0004	-0.0005	V
8	46506.6432	141.0	0.0005	0.0015	B
9	46508.3089	147.0	0.0003	-0.0026	B
10	46509.4247	151.0	0.0003	0.0000	B
11	46550.4754	298.5	0.0007	0.0000	B
12	46555.4869	316.5	0.0003	0.0020	B

(1-7) Banaczkowski (to be published)

(8-12) authors

Table II

i	q	f	T_1	T_2	x	a	g	l_1	l_2	l_3
67	0.41	0.03	5370	5280	0.83	0.5	0.08	0.314	0.644	0.042

Rucinski 1974). The coefficient of the limb darkening x for $T_{eff} \approx 5400$ K we adopted from Al Naimiy (1977). The brightness of the third light l_3 was taken into account following Linnell (1986). A value of mass ratio q we adopted according to Binnendijk (1967). The parameters fitted in our simulations were: inclination i, temperatures of both components T_1, T_2, the degree of contact. We started from semidetached systems (mode 4 and 5 of LV program) and fitting procedure always resulted in a contact configuration (mode 3). Fitting for a contact configuration showed a rather marginal contact, with degree of contact $f \approx 0.03$.

The temperature difference ΔT should be of order $\Delta T \approx 100$ K to fit depths of both minima and inclination is equal approximately to 67°. Table II lists the parameters given by our present best fit. The fit is plotted in Figure 1 as a solid line.

It may be interesting to find relationships between changes of the shape of the light curve, orbital period, motion around the third component and configuration status of the system. Such investigations may enable us to decide which model of the system is an adequate one, consistent with observations. Although VW Cep is a frequently observed object, the spectroscopic data are not sufficient to determine the fundamental physical and geometrical parameters well enough. More regular spectroscopic, astrometric and photometric observations of the system are needed.

Acknowledgement. We are grateful to S. Zola for calling our attention to that star and for his valuable discussion.

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OPTICAL BEHAVIOUR OF AT CANCRI IN THE SEASON 1988

In supplementing and completing the light curve of AT Cnc the cataclysmic star was measured on 24 blue-sensitive plates (ORWO-ZU21+GG13+BG12) from 9 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 13 February and 19 April 1988. The observations, which are linked to the sequence of comparison stars given in the IBVS No. 2363 are listed in Table I.

Table I

J.D.hel. 244...	m_B	J.D.hel. 244...	m_B	J.D.hel. 244...	m_B
7205.579	$12\overset{m}{.}28$	7239.414	$15\overset{m}{.}11$	7263.428	$12\overset{m}{.}53$
7205.598	12.20	7262.388	12.44	7263.451	12.48
7205.617	11.91	7262.407	12.33	7265.373	12.65
7206.540	12.28	7262.427	12.44	7265.396	12.66
7206.560	12.15	7262.449	12.12	7265.415	12.76
7207.497	12.21	7263.357	12.31	7265.437	12.41
7207.515	12.33	7263.379	12.54	7267.358	12.70
7207.533	12.33	7263.403	12.29	7271.345	15.37

The long-term light curve of AT Cnc, which results from the mean brightness values of each night and which is given in Figure 1 shows most of the observations in the high state. Only on 2 plates from 18 March and 19 April 1988 is the object in the low state.

Reducing all observations of the high state to one common epoch by means of the improved orbital elements given in the IBVS No.2918 the orbital light changes and the displaced minimum phase in the high state to the phase ≈0.5 can be confirmed. The results mentioned are given in Figure 2, where the magnitudes m_B are plotted against the phases.

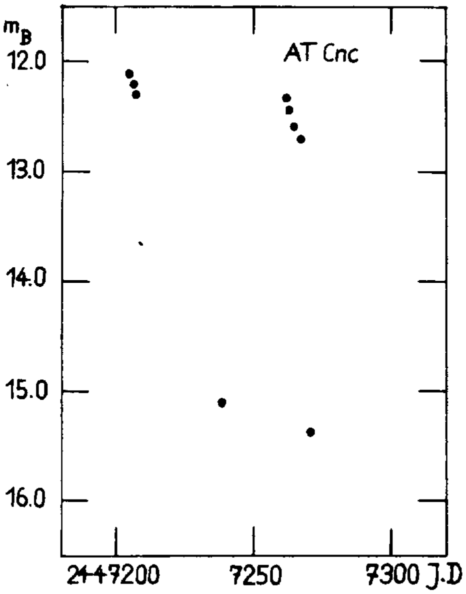

Figure 1

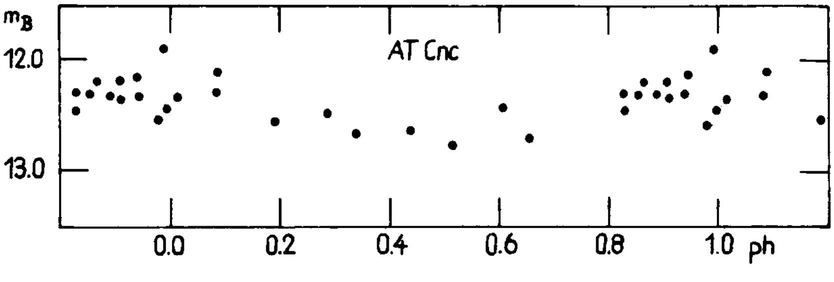

Figure 2

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EF PEGASI

Tsesevich et al. (1979) gave a report on this U Geminorum type object, which is separated by only 5" from a 15.5 magnitude star.

In order to search for further brightenings, I performed magnitude estimates on about 900 sky patrol plates covering the time interval 1928-1986. Because of the low limiting magnitude of the plates, only the brightness maxima, which are given in Table I could be observed (about $11^m.6...12^m.0$, near the brightness of the comparison star "c" in the paper of Tsesevich et al.). The maximum at J.D. 243 6071 given there was published by Tsesevich et al. (1979). As the maxima recur at rather regular intervals, they can be described with the following elements:

$$\mathrm{Max} = 242\,6335 + 162^d.5 \cdot E.$$

A similar cycle length was conjectured by Hoffmeister (1935).

Table I

J.D.	E	O-C
242 6333	0	-2^d
6987.88	4	+ 2
243 0547	26	-13
5781	58	+21
6071	60	-14
7906-11	71	+36
8680	76	- 5
9672	82	+12
244 5165	116	-20

The separation of EF Peg from the 5" comparison is, of course, not possible on our plates. Inspecting the figure on page 5 of the paper by Tsesevich et al. (1979), one may suppose that EF Peg belongs to the SU UMa subclass of dwarf novae. This question, however, could not be answered because brightness rises and declines could not be followed up on Sonneberg plates.

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MV LYRAE AT MINIMUM LIGHT IN MAY 1988

The cataclysmic binary MV Lyrae, included in our research programme of VY Scl systems, was observed in May 1988. On three plates taken with the 50/70 Schmidt telescope of the National Astronomical Observatory Rozhen on the nights of May 17/18 and 19/20, MV Lyr was at minimum light. The magnitudes determined according to the magnitude scale given by Andronov and Shugarov (1982) are as follows:

JD 244...	B
7299.511	17.26
7301.537	17.18
7301.560	17.21

Our programme of the observation of the star is going on. The observations, both spectroscopic and photoelectric, with short time resolution in minimum are urgently needed for comparison with the results of Robinson et al. (1981).

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VBI LIGHT CURVES OF CC And[1]

The δ Scuti type pulsating variable CC And was found by Eggen and Lindblad (1953) to have a period of 0.1249 days and a light amplitude V varying between 0.11 and 0.32 magnitudes. Fitch (1960) found a maximum yellow light curve amplitude of 0.25 magnitudes in the fundamental mode. Three other periods due to resonance-excited modes were also detected. Fitch also found a beat period of 5.233 days, based on observations over twenty seven nights. As part of an ongoing study of large-amplitude δ Scuti stars at the University of Calgary, and in fulfillment of their observing requirements in a senior undergraduate astrophysics laboratory course, C.R. and J.I.B. observed CC And on two nights: 1987 September 28 (85 observations) and October 4 (59 observations) U.T..

The observations were obtained with the 41 cm Cassegrain telescope of the Rothney Astrophysical Observatory near Calgary, Alberta, Canada, using a cooled RCA 31034 gallium-arsenide photomultiplier tube and V, B, I filters closely matching the standard Johnson system. The RADS differential photometry system (Milone et al., 1982) was operated in the 4-channel mode. The comparison star was BD+41°123 (SAO 036623) which has spectral type G5. The differential airmass was less than 0.002 throughout so that the differential extinction was negligible. The integration time was varied between 7 and 10 seconds depending on sky conditions (principally transparency) which were more photometric on September 28 and less so on October 4. The observations covered 2.4 cycles and 1.1 cycles on the first and second night respectively.

The light curve amplitudes for the different filter bands for each night are shown in Table I.

The overlap of consecutive cycles increases the scatter of the data. Minimum light occurs at $\phi \approx 0.55$ and maxima occurs at $\phi \approx 0.00$ for all curves, with the ephemeris given by Wilson and Walker (1956).

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[1] Publication of the Rothney Astrophysical Observatory, Series B, No. 13.

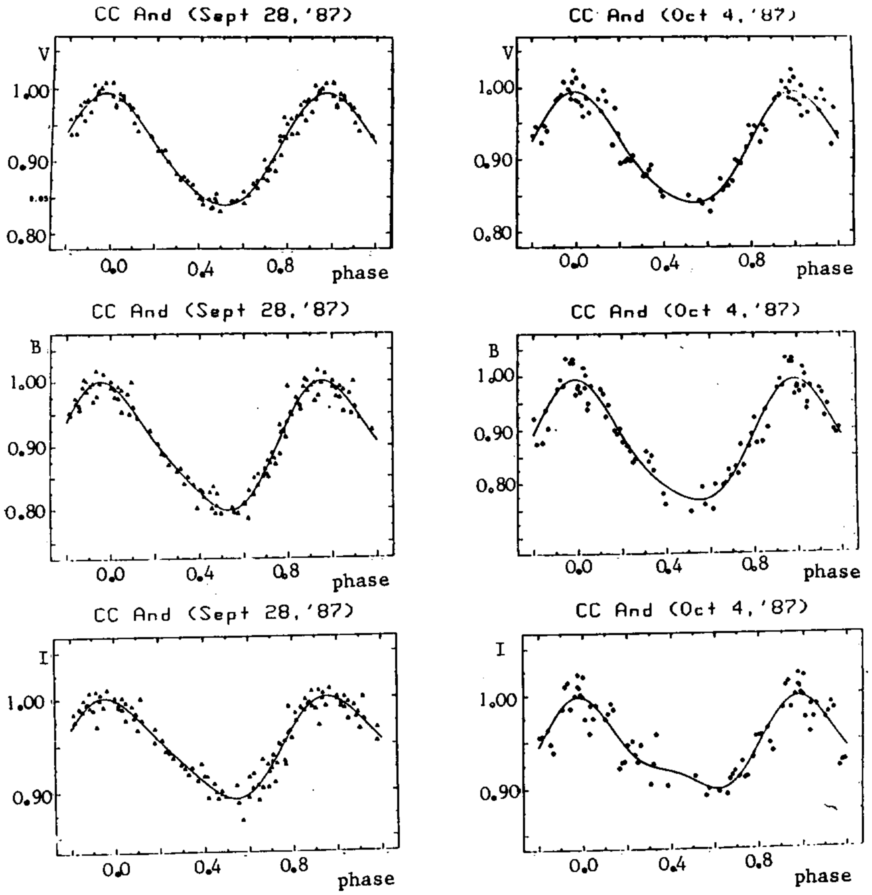

Figure 1 Fourier Fits Plotted on V,B and I Luminosity Curves for CC And on 1987 September 28 and October 4 U.T..

A five-term truncated Fourier series of the form:

$$L=A_0+A_1\cos\Theta+A_2\cos2\Theta+B_1\sin\Theta+B_2\sin2\Theta$$

was fit to the luminosity data using the relation:

$$L=L_0*10^{-0.4(m-m_0)}$$

where m_0 is the mean magnitude at maximum brightness and L_0 is normalized to unity. See Table II for Fourier constants, coefficients and error in the fit. Figure 1 shows the Fourier fits plotted on the luminosity data.

Table I
Photometric results for CC And on 1987 September 28 and October 4 U.T.

Julian Date	Filter	Amplitude	σ
2447066.844	V	0.175	0.015
2447066.844	B	0.230	0.018
2447066.844	I	0.109	0.014
2447072.820	V	0.180	0.022
2447072.820	B	0.299	0.039
2447072.820	I	0.111	0.022

Table II
Fourier constants, coefficients and fit error for all light curves

JD	Filter	A_0	A_1	A_2	B_1	B_2	Chi^2(mags)
2447066	V	0.91210	0.07702	0.00429	-0.00467	-0.00594	0.0125
2447066	B	0.89495	0.09741	0.00288	-0.00805	-0.01391	0.0179
2447066	I	0.94576	0.05220	0.00069	-0.00154	-0.00819	0.0130
2447072	V	0.90942	0.07631	0.00886	0.00332	-0.00443	0.0200
2447072	B	0.86795	0.11079	0.01442	0.00395	-0.00877	0.0295
2447072	I	0.94052	0.04415	0.01270	0.00379	-0.00788	0.0186

The present data were calculated to be at 0.15 and 0.29 phase respectively in the beat period of Fitch (1960). The corresponding predicted visual amplitudes are 0.19±0.02 and 0.22±0.02 magnitude. Our observed V and I light curves show a trend towards larger amplitude at 0.29 of the beat period although the increase is not as significant as the expected long period amplitude. The B filter band however, does show a clear variation in amplitude.

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BV OBSERVATIONS OF HU TAURI

The variable star HU Tau (HR1471, B8V) was recognized as an eclipsing binary by Strohmeier and Knigge (1960). Photoelectric light curves of the system have been observed by Tümer and Kurutac (1979), Parthasarathy and Sarma (1980) and Melendo (1985). However, none of these could cover the whole phases satisfactorily.

With the purpose to obtain BV light curves covering the whole phases, HU Tau was photoelectrically observed with the 15-cm refractor of Kakuda Women's Senior High Scool during thirty-four clear nights in 1986 and 1987. The photometer is furnished with a Hamamatsu 1P21 photomultiplier tube, Schott filters (GG385+BG12 for B and GC495 for V), a high-quality IC amplifier and a personal computer for output reading. HR1375 (V=5.99, B8IV-V) was used as the comparison star and HR1497 (V=4.29, B3V) as the check star. A total of 957 individual observations in V and 944 in B were obtained. All these observations in $m_{var}-m_{comp}$ are plotted in Figure 1.

During the observations, three primary minima were observed with the following epochs:

JD(Hel) 2446485.9948 ± 0.0003
6815.0052 ± 0.0013
6849.9584 ± 0.0003

Combining with the previous epochs of primary minimum observed photoelectrically by Wood (1977), Tümer and Kurutac (1979) and Parthasarathy and Sarma (1980), the period can be revised as

$$\text{Min I} = \text{JD(Hel) } 2446485.9967 + 2\overset{d}{.}0563056 \text{ E.}$$

The O-C values computed with this new ephemeris are given in the following table.

The depths of both minima in Figure 1 are found to be $0\overset{m}{.}830$(V) and $0\overset{m}{.}868$ (B) for the primary minimum and $0\overset{m}{.}069$ (V) and $0\overset{m}{.}050$ (B) for the secondary minimum, respectively.

Preliminary analysis of the present light curves with Kitamura's (1965) incomplete Fourier method yields the geometrical elements $i=77^{\circ}$, $r_a=0.18$ and

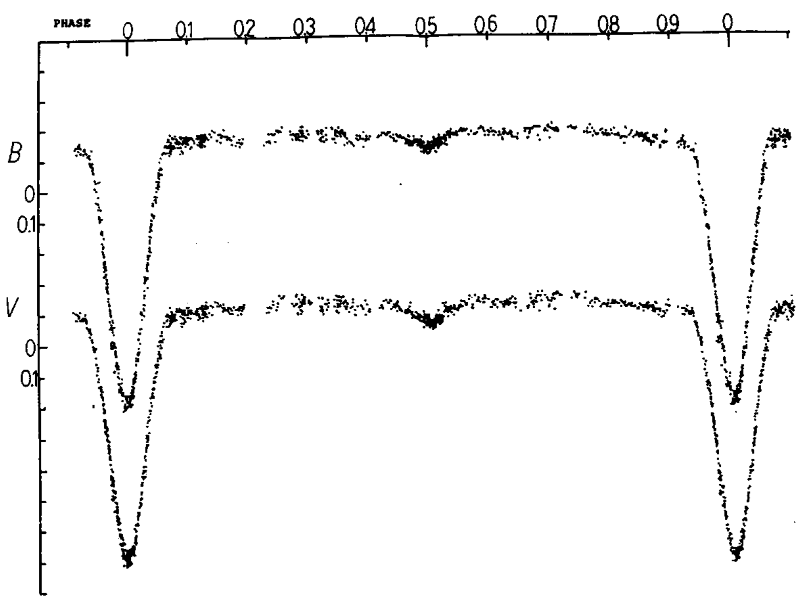

Figure 1. BV light curves of HU Tau.

Table I

JD(Hel)	E	O–C	Observers (photoelectric)
2440981,261	-2677	-0,0056	Parthasarathy and Sarma (1980)
1012,113	-2662	0,0018	"
1275.310	-2534	-0,0083	"
1707.145	-2324	0.0025	"
1984.745	-2189	0.0013	Wood (1977)
1986.801	-2188	0.0010	"
1990.914	-2186	0.0013	"
1992.970	-2185	0.0010	"
3833.3662	-1290	0.0037	Tümer and Kurutac (1979)
3835.4228	-1289	0.0040	"
3837.4797	-1288	0.0046	"
6485.9948	0	-0.0019	Present paper
6815.0052	160	-0.0004	"
6849.9584	177	-0.0044	"

r_b=0.28, with E_{pr}=0.235 and E_{sec}=0.109 which indicates that the primary minimum should be due to the occultation and the secondary due to the transit.

The data of the individual observations given in $m_{var} - m_{comp}$ (B, V) are available upon request.

I would like to express my hearty thanks to Prof. M. Kitamura of Tokyo Astronomical Observatory for his suggestion of the present programme and kind

guidance during the course of the present work. Thanks are also extended to Prof. T. Ohki of Fukushima University for his constant encouragement during my observations.

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TWO-COLOUR LIGHT CURVES AND PRELIMINARY ELEMENTS FOR CV Dra, DD Dra

We report upon preliminary results of our photoelectric observations of two variable stars in Draco. The instrument used was the fully-automatic driven 0.35 m Schmidt-Cassegrain telescope at F. Agerer's private observatory. The photometer was equipped with an EMI 9781B tube and Schott filters BG12(1mm) +GG385(2mm) for the B and GG495(1mm) for the V colour. The size of the diaphragm was 32". All measurement operations were performed fully automatic and controlled by a microcomputer programmed in FORTH (cf. Agerer, 1988).

CV Draconis

CV Dra = BV 341 = BD +57°1776 (8.8) = HD 159559 (F5) was discovered by Strohmeier and Knigge (1960) as a short period variable, with the range $9\overset{m}{.}5$ -$10\overset{m}{.}1$ (pg). No further details were given. Nikulina (1961) thereupon investigated this star on sky-patrol plates. However, she could not confirm any periodicity and classified the star as a rapid irregular variable. With these data CV Dra was included for the first time in the 4th edition of the GCVS (Kholopov *et al.*, 1985). Recently, J.Fabregat (Locher, 1988) communicated two times of minimum light observed visually by him which prompted us to put CV Dra on our observation program.

SAO 030449 (A2) was chosen as the comparison star and SAO 030426 (K5) as a control star. According to our observations during eight nights CV Dra is an eclipsing binary of W-UMa type. From five photoelectric minima observed by us (Agerer and Lichtenknecker, 1988) and the two visual minima we derive preliminary elements as:

$$\text{Min I} = \text{JD } 2447305.437 + 0\overset{d}{.}617617*E \ .$$

The amplitudes in V are $0\overset{m}{.}43$ resp. $0\overset{m}{.}40$ for Min I and Min II. The B and V light curves, with Δmag in the instrumental system, are shown in Fig. 1. Minimum II appears to be marginally displaced against phase 0.5.

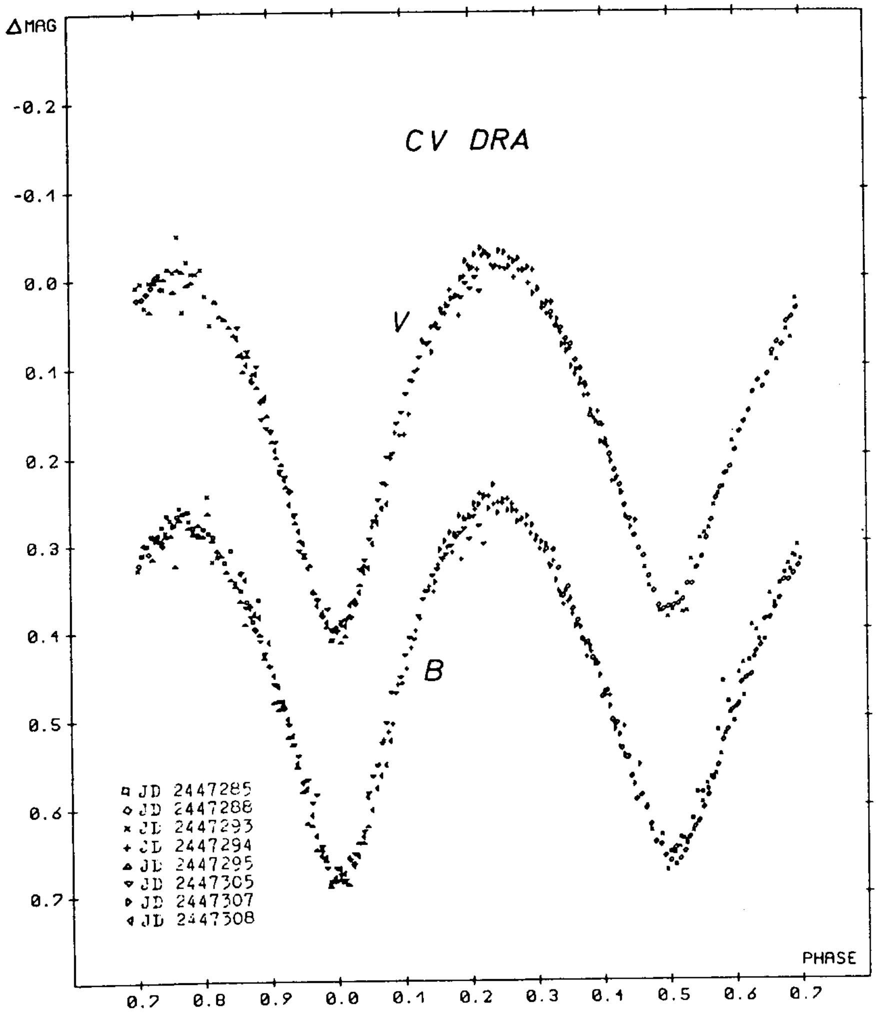
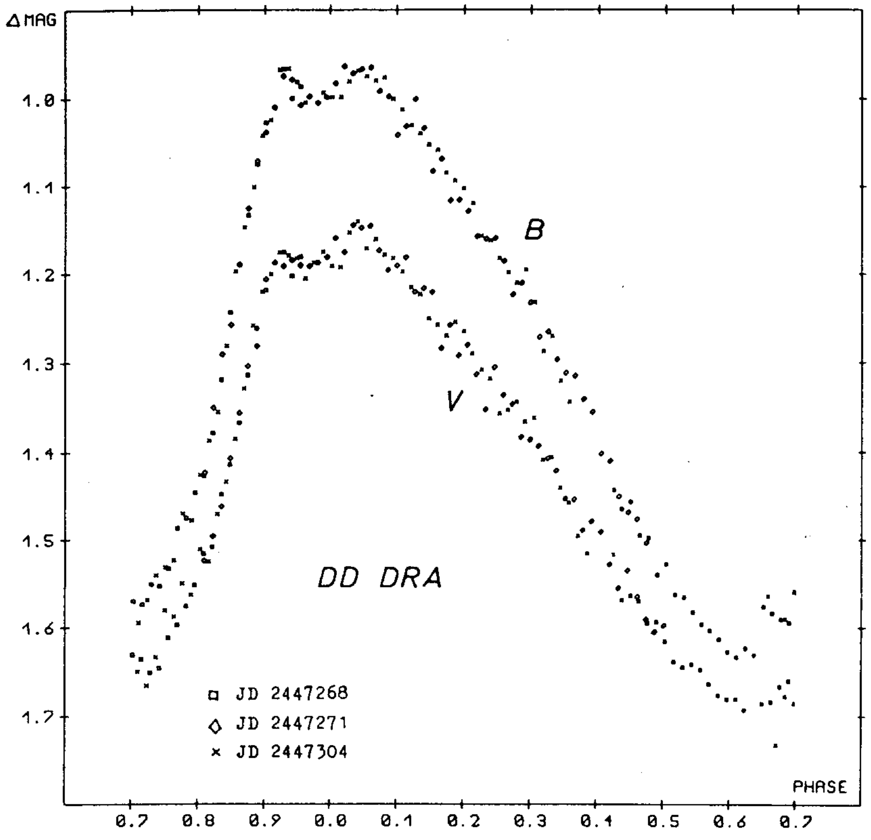

ΔMAG
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CV DRA
V
B
JD 2447285
JD 2447288
JD 2447293
JD 2447294
JD 2447295
JD 2447305
JD 2447307
JD 2447308
PHASE
0.7
0.8
0.9
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

Figure 1



Δ MAG
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
B
V
DD DRA
□ JD 2447268
◇ JD 2447271
× JD 2447304
PHASE
0.7
0.8
0.9
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

Figure 2

DD Draconis

DD Dra = BV 234 was discovered by Strohmeier (1958) as variable in the limits $11^{\mathrm{m}}.2$-$12^{\mathrm{m}}.0$ (pg) and classified as a long period variable. However, on reconsideration Filatov (1960) stated that it is really an eclipsing binary. From nine photographic plate minima (i.e. epochs of faint light) he derived the elements Min = JD 2431587.248 + 0.784·E. This very inaccurately determined period motivated us to observe DD Draconis.

The comparison star used was an *Anonyma* $1'.5$ west and $7'.9$ north of the variable, as a control star we chose SAO 018015 (K2). From our observations during three nights we conclude that DD Dra is a pulsating variable of type RRc for which we can give first preliminary elements as:

$$\mathrm{Max} = \mathrm{JD}\ 2447304.459 + 0^{\mathrm{d}}.32675\cdot E\ .$$

The amplitude of light variation was $0^{\mathrm{m}}.54$ in V and $0^{\mathrm{m}}.66$ in B. B and V light curves of DD Dra, with *Δmag* in the instrumental system, are shown in Fig. 2.

A detailed presentation of our observations is in preparation (Agerer and Lichtenknecker, 1988) and will be available on request from the "Berliner Arbeitsgemeinschaft für Veränderliche Sterne (BAV)", Munsterdamm 90, D-1000 Berlin 41.

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UBV PHOTOMETRY OF R CORONAE BOREALIS

Photoelectric observations of R CrB have been obtained at Mount John University Observatory (MJUO) during 1986 and 1987 as part of an ongoing survey of R Coronae Borealis–type (RCB) stars. The observations made during 1986 were obtained with the 0.6–m photometric reflector; the 1987 observations were obtained with the 1–m reflector. The measurements were made with the MJUO No.1 single channel photometer equipped with a cooled EMI6094B photomultiplier tube (S11 photocathode) and UBV filters as described by Bessell (1976).

The differential comparison star chosen (SAO 084005 = BD $+28^0$ 2475) was the same comparison star used in other recent photometric programmes of R CrB (e.g. Ashoka and Pukalenthi 1986, Bohme 1986, 1987).

Although transformation constants were derived from observations of E–region standards at MJUO, the magnitude and colours of the comparison star (V = 7.45, B–V = 0.44, U–B = 0.02) were set to the values used by Ashoka and Pukalenthi (1986) and Bohme (1986, 1987). Due to the lack of other suitable comparison stars in the field surrounding R CrB no secondary comparison (check) star was observed.

Despite the southern latitude of MJUO (lat = -43^0 59′) and the high airmass of the observations (X_{min} = 3.23) the scatter in the transformed comparison magnitudes and in the differentially determined magnitudes of R CrB indicate that uncertainties of only 0.02 magnitudes were typical. The UBV observations of R CrB are listed in Table 1.

Although we made few measurements of R CrB during 1986, these compare favourably with other published series of observations made during this year (Ashoka and Pukalenthi 1986, Bohme 1986). However, a comparison of our 1987 observations with those obtained by Bohme (1987), which covered the same time period, reveals alarming

Table I. Photoelectric observations of R CrB

	JD–2440000	V	B–V	U–B	JD–2440000	V	B–V	U–B
1986	6597.92	5.81	0.57	0.02	6599.95	5.84	0.57	0.07
	6598.96	5.87	0.57	0.06	6614.93	5.90	0.56	0.08
1987	6923.04	5.96	0.58	0.02	6981.90	5.94	0.57	0.06
	6924.03	5.96	0.56	0.01	6982.90	5.91	0.55	0.06
	6925.03	5.92	0.56	–0.01	6985.89	5.93	0.58	0.09
	6945.00	5.75	0.51	–0.01	7002.87	5.83	0.54	0.02
	6946.98	5.76	0.53	0.00	7016.84	5.85	0.54	0.04
	6954.97	5.79	0.57	0.04	7019.81	5.82	0.58	0.08
	6960.95	5.90	0.54	0.04	7021.81	5.83	0.57	0.08
	6963.95	5.90	0.56	0.04	7030.82	5.81	0.60	0.10
	6965.95	5.92	0.58	0.00	7047.83	5.85	0.53	0.06

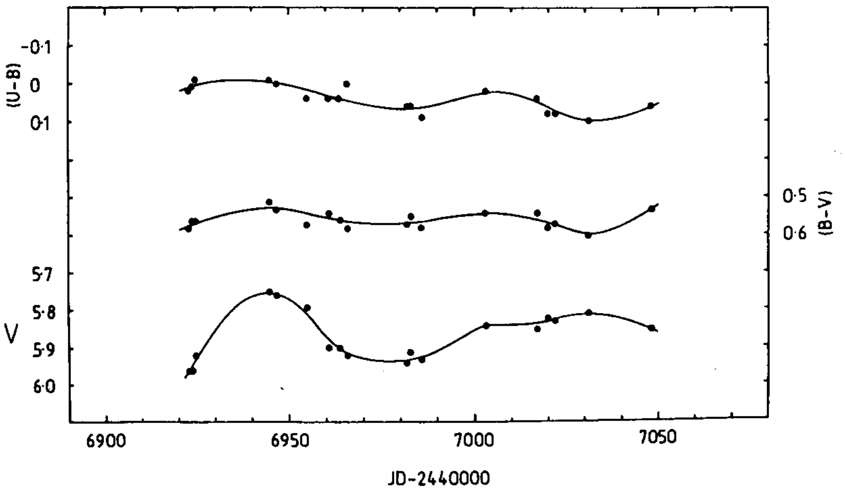

Figure 1

scatter, exceeding 0.1 magnitudes, in his observations.

The light and colour curves for our observations obtained in 1987 are reproduced in Figure 1. The behaviour of the light and colour curves are typical of the semi–regular nature of the pulsations of R CrB. The colour curves show variations of 50 to 60 day duration.

A mean period of 47 day has been noted by Raveendran et al. (1986) in radial velocity measurements published since 1972. We note that this mean can also be derived by averaging the two most dominant periods (54 and 40 day) found in Fourier analyses of the light curve of R CrB by Goncharova et al.(1983).

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COORDINATED ULTRAVIOLET, OPTICAL AND RADIO OBSERVATIONS OF EI Eri (= HD 26 337)

CALL FOR OBSERVATIONS

From 16 to 19 September 1988, the G5 IV single-line noneclipsing RS CVn-type system EI Eri (=HD 26337) will be concurrently observed with IUE, VLA, VLBI and several optical ground-based instruments with the main purpose of determining the size, location and physical characteristics of large-scale atmospheric structures.

The scheduled observations will provide high-resolution line profiles of Mg II h and k (IUE) and other lines at optical wavelengths, UV and optical continuum fluxes versus orbital or rotation phase. Radio fluxes and maps with VLA and VLBI will be also obtained to synthesize a 3-dimensional picture of EI Eri atmosphere, from photospheric up to coronal levels. We aim at covering two consecutive full orbital cycles in order to isolate short-term flare-like variations from those due to quasi-stable atmospheric structures, such as cool starspots, bright plages or coronal features, as they move across the projected stellar disc following the star's rotation.

The scientific rationale of this program is extensively discussed in several recent reviews (e.g., Linsky 1983, Rodonò 1986a, 1986b) and papers related to past observation campaigns on other stars,(Rodonò et al. 1986, 1987, Butler et al. 1986, Byrne et al. 1987, Andrews et al. 1988, Walter et al. 1987, Linsky et al. 1988, Neff et al. 1988). Essential data and information on previous photometry and spectroscopy of EI Eri may be found in Hall et al. (1987) and Fekel et al. (1987), respectively.

Unfortunately, EI Eri is not suitable for extensive ground-based coverage in September. However, we call for systematic optical photometry and spectroscopy that are already available or might be obtained in the fall of 1988. The interested observers are kindly requested to contact one of the undersigned about their observation plan and/or results.

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SHELL SPECTRUM VARIATIONS OF PLEIONE

We have been monitoring Pleione with the grating spectrograph attached to the 60/90-cm Schmidt telescope of the Beijing Observatory since the end of 1983. 27 spectrograms of the star at 50 Å/mm were obtained to date. They cover a wavelength range of λλ 3500-6600 Å.

Figure 1 gives the microphotometer tracings of the selected spectra of Pleione. On our plates the shell spectra of Pleione showed conspicuous variations. The shell absorption lines are weakening while the emission lines are strengthening with time. The rich metallic shell lines, in particular CaIIK and NaID, were strong on the spectrogram taken on 1983 December 17. Then the lines gradually weakened. Most of the metallic

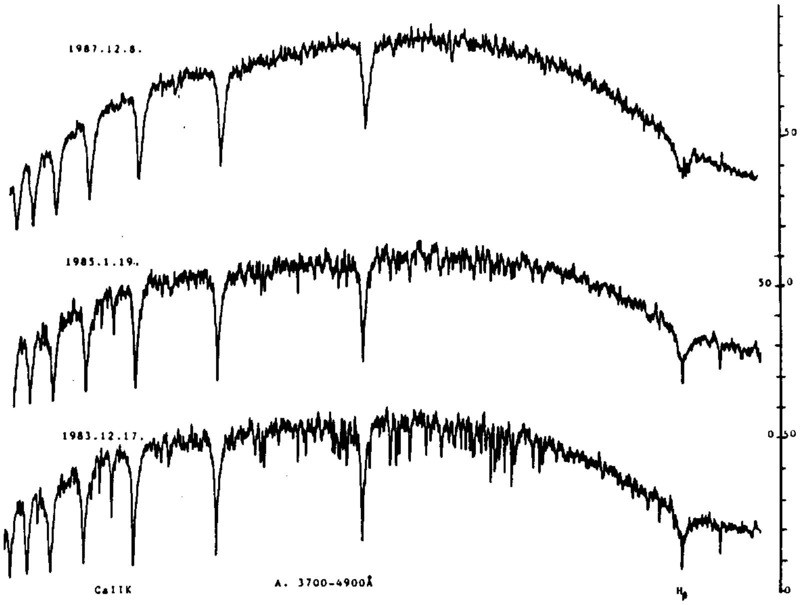

Figure 1 : The microphotometer tracings of the selected spectra of Pleione (The zero points of ordinate are fog of the plate).

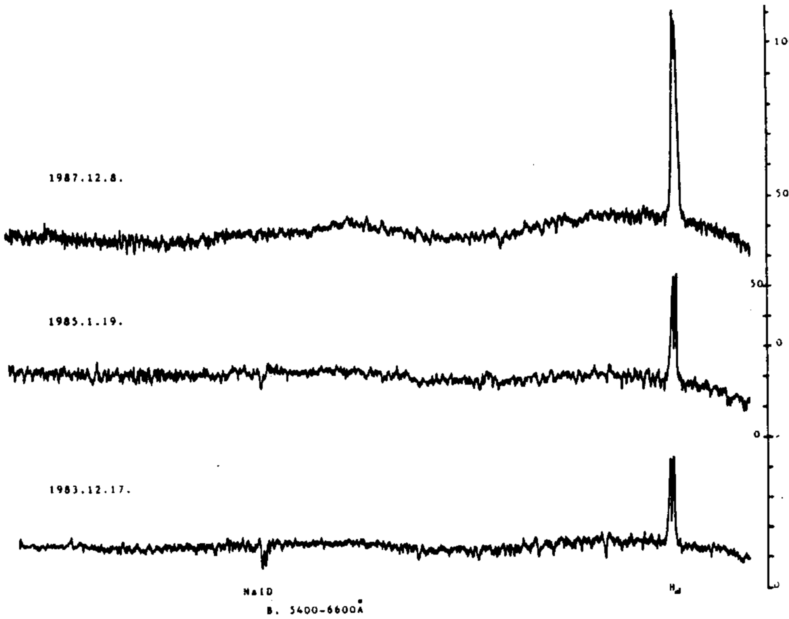

Figure 1(cont.)

shell lines, including CaIIK and NaID, became almost invisible on 1987 December 8. The Balmer shell lines gradually became diffuse, and the higher quantum number lines were the first to do so. The Hβ shell absorption was very strong on the plate of 1983 December 17. It weakened considerably with time because of the strengthening of Hβ emission. The two emission peaks at Hβ were distinctly visible to the eye on the plate of 1987 December 8. The emission at Hα also became appreciably stronger during the same time interval.

It appears that the shell phase of Pleione which began in 1972-1973 is ending slowly. Pleione is changing from shell phase to Be phase. Continued observation and analysis would be of great interest.

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ECLIPSING BINARY SIGNATURES IN ZETA CAPRICORNI

Zeta Capricorni (ζ Cap=HD 204075) was shown to be a Barium line spectroscopic binary, possessing strong BaII line by Böhm-Vitense (1980), Smith et al. (1980), Culiver (1981) and Smith and Lambert (1984). ζ Cap is shown to have a white dwarf companion by Böhm-Vitense (1980), which is much fainter than ζ Cap. Photoelectric observations of ζ Cap are hardly available in the literature except for the color indices (B-V=$1\overset{m}{.}00$ and U-B=$0\overset{m}{.}59$, Sp.=G5) given by Eggen (1972).

ζ Cap was chosen as standard star during the observations of the programme star δ Cap, and was observed on the 38 cm reflector of the Uttar Pradesh State Observatory employing thermoelectrically cooled (-20°C) 1P21 photomultiplier, conventional UBV filters, and d.c. techniques. A total of three nights of observations were obtained between JD 2444163 to JD 2444908, using γ Cap (=HD 206088) as comparison and ε Cap (=HD 205637) as check star. The apparent graphical errors of U, B and V observations are on the average $\pm\, 0\overset{m}{.}06$, $\pm 0\overset{m}{.}02$ and $\pm 0\overset{m}{.}02$ respectively. The differential magnitude and the differential colour curves are shown in Figure 1, wherein the large scatter in U observations is apparent and, as such, U observations may not be taken for granted.

The colour indices nearly at the mid-points of these light curves are given as follows:

J.D.(Hel.)	B-V	U-B
2444163	$1\overset{m}{.}07$	$0\overset{m}{.}71$
2444554	0.31	0.94
2444908	0.94	0.85

If the two eclipses that are thought to be present in Figure 1 on JD 2444163 and JD 2444908, separated by nearly two years are real, it may be possible that ζ Cap is a long period (may be few years, at least 4 years or more) eclipsing binary, which is not improbable in the light of the suggestion by Culiver (1981) that the spectroscopic period is 2300d. Also, McLaure et al. (1979) thought ζ Cap to be existing in a binary system with a long period,

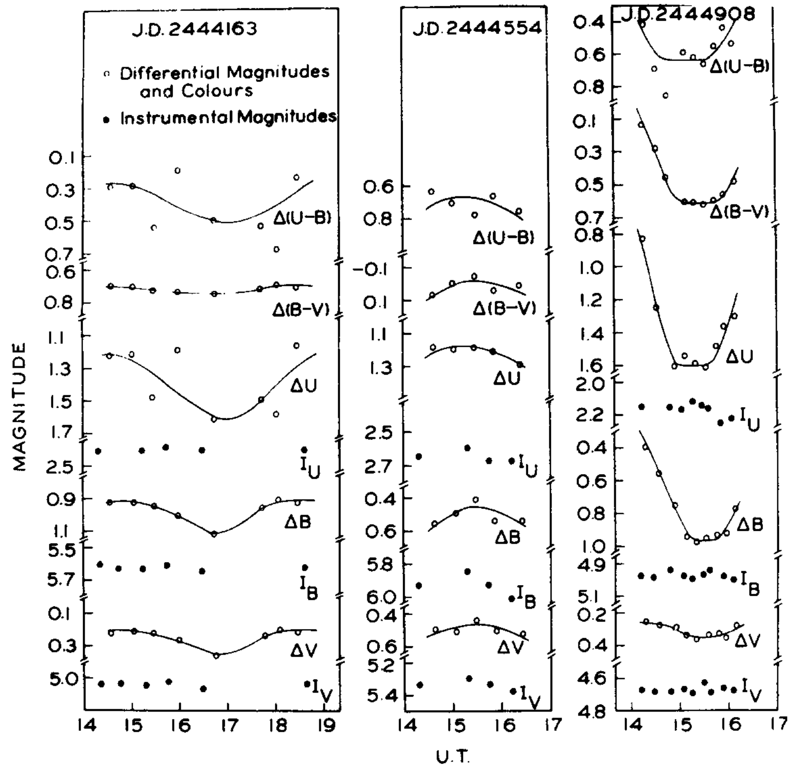

Figure 1

80 to 500 days at least. Although, the present observations are not sufficient to establish its eclipsing binary nature, yet they do point to the possibility of its being an eclipsing binary.

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PHOTOELECTRIC LIGHT CURVE OF V502 Oph

V502 Oph is a W UMa type eclipsing system with components of spectral types: G2V + F9V (Binnendijk 1969). The system shows variability in the period and in its light curve shape (Maddox and Bookmyer 1979).

The new observations were made at the Astronomical Station of the Jagiellonian University in Bieszczady Mountains using a 20 cm refractor equipped with a one-channel photometer with blue and yellow filters. The FEU 92 Russian photomultiplier was used. Observations were carried out during two seasons: 1985 and 1986, using BD + $1^{\circ}3300$ as the comparison star. Measurements were corrected for atmospheric extinction making use of the mean coefficients for the station and next, they were reduced to the UBV system (the reduction procedure was described by Flin et al. 1985). We were able to determine five moments of minima. The results are presented in Table I.

Phases in the paper were calculated with the following elements:

$$\text{Min. I. (HJD)} = 2446555.5244 + 0^{\text{d}}.45339293 \cdot E$$

In order to obtain the physical parameters of the system we used the Wilson-Devinney code: DCMP (Wilson 1979). The following parameters were adjusted: inclination and mass ratio of the system, temperature of the second component, luminosity of the primary component and its Roche potential. Calculations were performed in mode 3 of the code simultaneously in both filters, assuming that there is no third light in the system. As the starting mass ratio we adopted its spectroscopic value (Struve and Gratton 1948), for temperatures of components, the values corresponding to their spectral types (Allen 1965).

Table I

Times of minima of V502 Oph

min	time (HJD)	filter
primary	2446530.5866±0.0004	V
primary	2446555.5244±0.0004	V
primary	2446915.5165±0.0003	B
secondary	2446528.5488±0.0005	V
secondary	2446529.4572±0.0005	V

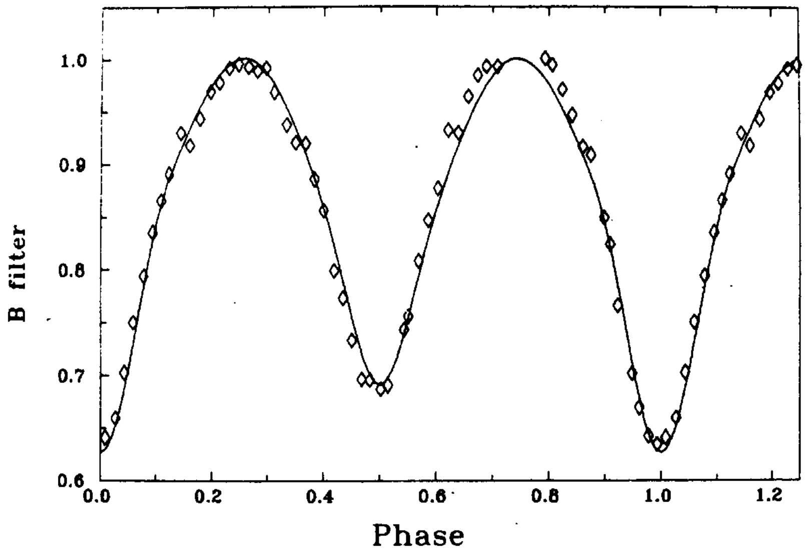

Figure 1

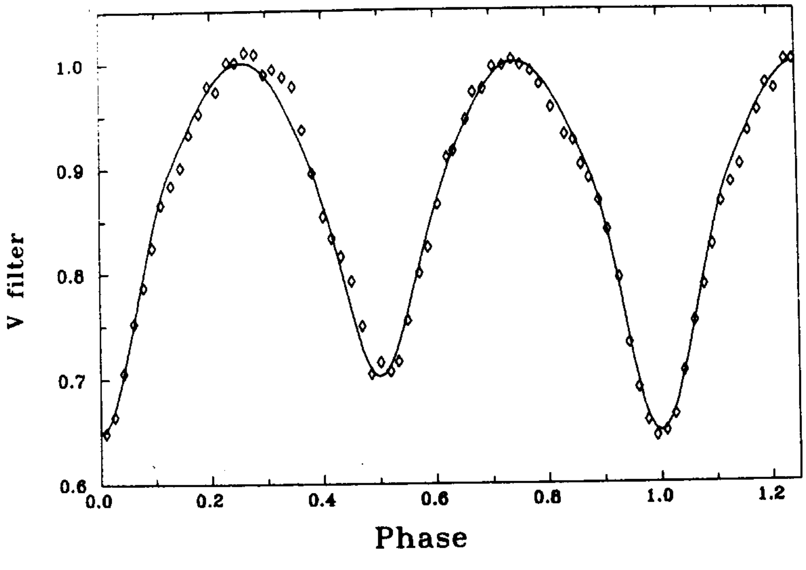

Figure 2

Table II

Parameters of V502 Oph

wavelength independent:

i	T_1	T_2	g	A	Ω	q
70.2 ± .2	6140	5750 ± 30	0.32	0.50	6.072 ± .025	2.64 ± .01

wavelength dependent:

	L_1	L_2	X
B	4.682 ± 0.009	7.863	0,78
V	4.498 ± 0.008	8,062	0,65

The limb darkening coefficients were taken from the tables published by Al Naimiy(1978) for bolometric albedo and gravity darkening we assumed their theoretical values. The starting value for the inclination was assumed to be 70°. The results of light curve synthesis are listed in Table II and graphically presented in Figure 1 and Figure 2 (B and V filters respectively).

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UBV PHOTOELECTRIC PHOTOMETRY OF THE LATE TYPE STARS HD 22649 AND HD 23475

Within our research programme on magnetic stars, photometric and magnetic observations were planned of the late type stars in which magnetic fields have been measured by Babcock (1958). However, while it was not possible to perform magnetic field measurements, photoelectric observations of the star HD 22649 (HR 1105=BD Cam, S 3.5) were carried out in 1973 and 1974 at the Stellar Station of the Catania Astrophysical Observatory. The measurements were performed in the UBV system at the 90 cm telescope with the equipment described by Blanco et al. (1978). The chosen comparison stars were HD 22764 (HR 1112, K4Ib) and HD 22375 (HR 1155, M2LLab). Search in the literature soon revealed that HD 23475 was also variable (with name BE Cam, Stebbins and Huffer 1930) so that the observations were referred to the other comparison, i.e. HD 22764. By the time when the programme on late type magnetic stars was dropped out because of a lot of difficulties, among which mainly the impossibility of systematic monitoring of these stars during

Table I
Magnitude differences HD 22649 minus HD 22764 versus Julian day in our natural system

JD 244 0000.0+	ΔU	ΔB	ΔV
1963.503	−0.830	−0.804	−0.707
1964.533	−0.842	−0.799	−0.706
1992.429	−0.769	−0.749	−0.693
2004.444	−0.765	−0.756	−0.715
2043.431	−0.822	−0.771	−0.709
2061.369	−0.812	−0.751	−0.681
2071.375	−0.802	−0.715	−0.648
2097.353	−0.821	−0.773	−0.712
2365.522	−0.856	−0.696	−0.610
2397.443	−0.783	−0.665	−0.609

winter time, we had collected some sets of measurements which were averaged to give one measurement per night. These data are listed in Table I for HD 22649 and in Table II for HD 23475, in the form of magnitude differences (variable minus comparison) versus Julian day.

Table II

Magnitude differences HD 23475 minus HD 22764 versus Julian day in our natural system

JD 244 0000.0+	ΔU	ΔB	ΔV
1963.509	-1.234	-1.326	-1.406
1964.542	-1.220	-1.295	-1.392
1992.438	-1.082	-1.219	-1.366
2004.481	-1.112	-1.235	-1.385
2043.437	-1.017	-1.180	-1.330
2061.384	-1.040	-1.211	-1.359
2071.382	-1.013	-1.172	-1.308
2097.362	-1.041	-1.254	-1.144
2365.526	-1.042	-1.166	-1.319
2397.448	-1.013	-1.163	-1.299

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ON THE PERIOD OF THE LIGHT VARIATIONS OF THE Mn STAR HD 27295

The star HD 27295 (HR 1339=53 Tau, B9 Mn) was used as a comparison in the observations of HD 27962 carried out in 1973 and 1974 at the stellar station of the Catania Astrophysical Observatory. The observations were made in the UBV system using the 90 cm telescope and the equipment described in Blanco et al. (1978).

From a first analysis of the observations it was evident that the dispersion of the measurements of HD 27295 was larger than allowed for a comparison star, so this star was eliminated from the programme.

From UBV observations made some years before, Winzer (1974) derived a period of 4.302 days using HD 27176 (HR 1331 = 51 Tau, F0V) as a comparison star. This period is very close to the orbital period of 4.452064 days found by Dworetsky (1972) from spectroscopic observations.

Since our measurements were too few to look for a period determination, but not too far in time from Winzer's observations we decided to use our observations together with Winzer's ones to check or improve his period. To this end we used the second comparison in the programme of HD 27962, i.e. HD 27934 (HR 1387 = 65 Tau, A7IV), which in turn was found to be a suspected δ Sct star in the literature . However, during our observing session, HD 27934 showed a small dispersion, of the order of the natural dispersion, so it proved to be suitable to be used as a comparison star. After transforming our set of data into Winzer's system, we searched for periodicity by means of computer programmes (Deeming 1975, Breger 1982) which have been recently available to us. The best representation of data has been obtained with the period of 4.424125 days; which is close to Winzer's (1974) value. The resulting light curve in U is reported in Figure 1, The ephemerides used are:

$$\mathrm{JD\ (U\ max)} = 244\ 1992.553 + 4\overset{d}{.}424125 \cdot E \qquad (1)$$

No reliable light curve is obtained when using the spectroscopic binary period by Dworetsky (1972).

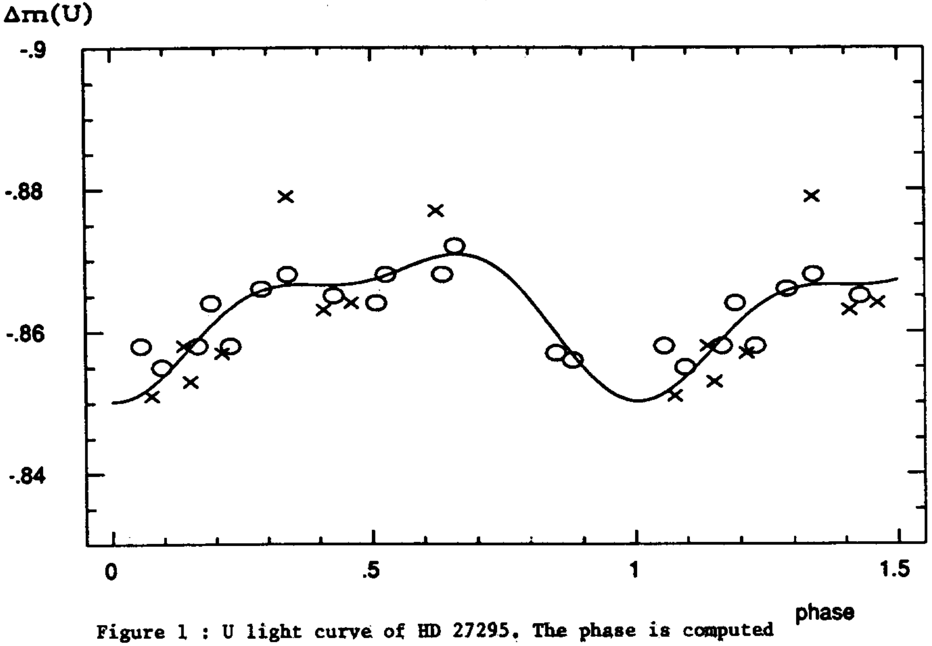

Figure 1 : U light curve of HD 27295. The phase is computed according to formula (1). Circles denote observations by Winzer (1974), crosses denote ours.

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A NEW SHORT PERIOD VARIABLE STAR IN ORION

During the observations of the W UMa type star ER Ori at the San Pedro Martir Observatory, Mexico on 10/11 and 12/13 December 1986, one of the comparison stars (C_2) clearly exhibited variation with respect to the other well-behaved comparison star. This behavior resembles that of a Delta Scuti type variable which has not been previously reported with a variable amplitude from one night to the other from two hundredths to 0.08 magnitude and a changing period on the order of hours, as shown in Figure 2.

The characteristics of these stars are summarized in Table I. They were observed with the 0.84 m telescope and a pulse counting system provided with Johnson's V filter. In order to increase the density of data points, the reference stars were considered as close to the variable star as possible. Therefore, the criteria of equal brightness and color was violated. The variable and reference stars are shown in the ID chart (Figure 1), taken from Taylor (1940), since the new variable star is not bright enough to appear in the BD catalogue.

In the original plan, the W UMa star ER Ori was going to be observed in differential photometry with respect to the two comparison stars. After the reductions, the dispersion in the magnitude difference C_1-C_2 was 0.014 on the first night and 0.012 on the second one, very large values for differential photometry.

The light curves obtained on these nights are presented in Figure 2. For each point, an integration time of 40s was used for each star and 10s was used for the sky background. The differences between the magnitude of the new variable star and the comparison star were calculated interpolating the latter to the times of observation of the new variable star. The precision of each point is of 0.003 in magnitude and 0.0035 d in time. On each night the mean value of the differences was subtracted to establish a zero base line. The resulting photometric values are presented in Table II.

To decide on the nature of this star more observations are needed, but one might speculate that because it has a period of the order of hours and a

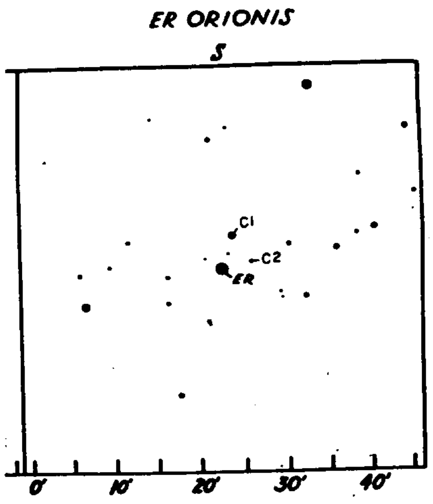

Figure 1: Identification chart of the new variable star.

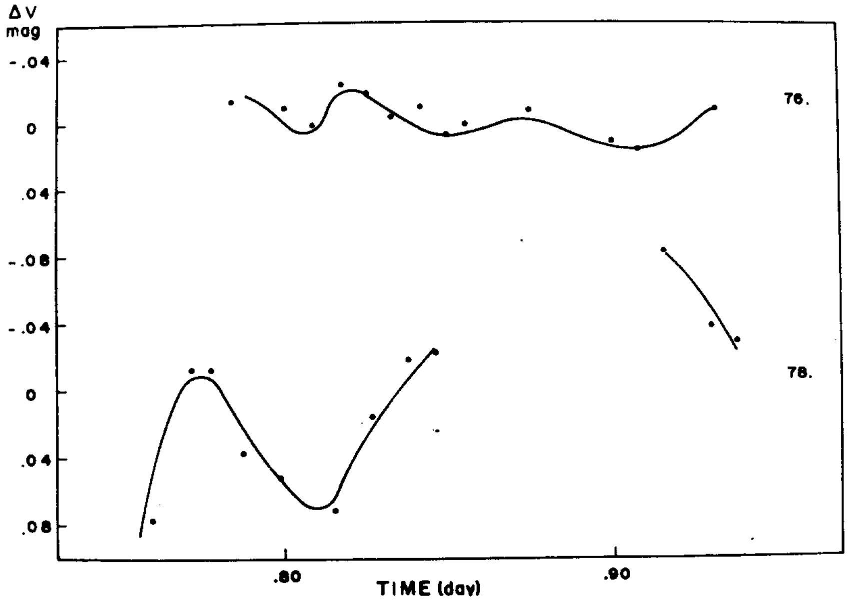

Figure 2: Light curve of the new variable star. On top: night HJD 2446776, bottom: night HJD 2446778.

Table I

Characteristics of the Observed Stars

	BD SAO	V	Sp	α	δ	Type
				(1950)		
ER Ori	$-8^{o}1050$ 131854	$9^{m}.8$	G2	$05^{h}08^{m}51^{s}$	$-08^{o}36'59''$	W UMa
C1	$-8^{o}1051$ 131855	8.9	F8	05 08 56	−08 41 00	Comp.
C2				05 09 07	−08 37 59	New Var.

Table II

Photoelectric photometry of the new variable star with respect to the reference star

HJD 2446700+	ΔV	HJD 2446700+	ΔV
76.784	−0.014	78.760	+0.077
76.802	−0.009	78.772	−0.013
76.809	+0.002	78.777	−0.013
76.818	−0.024	78.788	+0.037
76.825	−0.019	78.798	+0.052
76.833	−0.004	78.815	+0.071
76.841	−0.009	78.827	+0.017
76.849	+0.007	78.838	−0.018
76.857	+0.002	78.846	−0.023
76.865	+0.002	78.915	−0.083
76.874	−0.009	78.930	−0.038
76.900	+0.012	78.938	−0.003
76.908	+0.017		
76.931	−0.009		

changing amplitude of variation of about 0.03 mag and possibly interacting modes of pulsation it should be a Delta Scuti pulsator.

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PHOTOELECTRIC OBSERVATIONS OF γ Cas, X Per AND BU Tau

The three variable stars have been observed in the UBV bands with a 250/3250 Cassegrain telescope and a 1P21 PMT. These observations are the continuation of those published in IBVS No. 2893.

γ Cas

Comparison star: Alpha Cas (HD 3712),
(V=2.23, B-V=+1.17)

Check star : Eta Cas (HD 4614),
(V=3.44, B-V=+0.57)

Hel.J.D. 2440000+	V	Hel.J.D. 2440000+	V
6714.279	2.22	7071.317	2.10
6716.304	2.20	7079.313	2.16
6728.317	2.21	7083.263	2.23
6762.217	2.16	7095.242	2.27
6766.225	2.22	7096.229	2.25
6770.388	2.23	7107.225	2.21
7070.308	2.23	7170.250	2.19

X Per

Comparison Star: HD 24167,
(V=6.25, B-V=+0.20, U-B=+0.14)

Hel.J.D. 2440000+	V	B-V	U-B
6705.363	6.62	+0.08	−0.72
6709.365	6.60	+0.10	−0.72
6714.338	6.56	+0.09	−0.69
6716.321	6.58		
6728.305	6,57	+0.11	−0.72
6731.308	6.59	+0.11	
6766.238	6.45	+0.08	−0.58
6768.179	6.52	+0.01	−0.52
6770.182	6.52	0.00	−0.32:
7083.288	6.42	−0.02	
7095.279	6.36	+0.15	−0.83
7096.271	6.36	+0.19	−0.79

Hel.J.D. 2440000+	V	B-V	U-B
7115.238	6.29	+0.21	-0.68
7129.225	6.31		
7140.229	6.32	+0.18	-0.79
7170.275	6.30	+0.03	-0.66
7172.271	6.30	+0.11	-0.69
7174.345	6.25	+0.11	-0.72
7180.292	6.32	+0.01	-0.61
7203.292	6.32	+0.04	-0.65
7230.271	6.30	+0.10	-0.61

BU Tau

Comparison star: 16 Tau (HD 23280),
(V=5.46, B-V=-0.04, U-B=-0.31)

Check star : 19 Tau (HD 23338),
(V=5.65, B-V=-0.07, U-B=-0.36)

Hel.J.D. 2440000+	V	B-V
6705.396	5.13	-0.03
6709.375	5.14	-0.04
6714.358	5.17	-0.12
6728.300	5.08	-0.08
6731.313	5.15	-0.13
6746.321	5.14	
6762.183	5.23	-0.09
6763.267	5.06	-0.01
6766.179	5.14	-0.12
6768.171	5.18	-0.11
6770.233	5.09	-0.07
7083.279	5.09	0.00
7095.250	5.15	+0.03
7096.271	5.12	0.00
7129.238	5.06	
7140.200	5.08	-0.02
7170.275	5.11	-0.15
7172.250	5.06	-0.02
7174.313	5.12	-0.13
7180.283	5.06	-0.08
7203.250	5.09	-0.08
7230.292	5.02	-0.06

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SPECTRAL VARIATION OF CH CYGNI IN THE NEAR INFRARED

The recent visual magnitude estimations of the symbiotic star CH Cyg reveal an important drop in brightness from February 5.5 UT to May 18.5 UT when the star was reaching its lowest brightness since 1926 (Garnavich and Mattei, 1988).

Figure 1 shows 2 spectra of CH Cyg obtained on 1987 September 13.89 UT and 1988 June 22.96 UT at the 193 cm telescope of the Haute Provence Observatory with a CCD detector (range 6570-10300 A, dispersion 260 A/mm). For comparison we give the spectrum of Omicron Peg, A1 V spectral type, characterized by the stellar absorption hydrogen lines (Paschen series from P 11 at 8865 A to P 16). The other absorptions are telluric bands of O_2 and H_2O.

We note an important variation between the 2 spectra of CH Cyg: they both exhibit numerous and intense absorption bands of TiO, but on June 22.96, VO bands are also present.

In the figure are indicated the principal groups of these bands: TiO at 6714-7126-7590-8300-8452-8860 A, VO at 7400-7900 A. These different bands are currently used to classify the late-type stars: in particular, M stars classification is based upon their intensities (Sharpless, 1956; Mavridis, 1966; Wing, 1966; Albers, 1974; Turnshek et al., 1985; Schulte-Ladbeck, 1988).

From these studies, we tried to determine the spectral type of our 2 spectra mainly using the atlas of digital spectra of cool stars (Turnshek et al., 1985) established with a resolution similar to ours.

Spectrum obtained in 1987: TiO bands (at 8542 A and 7589 A (strong)) are present whereas VO bands are not detected which is typical of the M5 - M6 group (Mavridis, 1966). Our spectrum is similar to that of R Lyr classified M5 III (Turnshek et al., 1985).

Spectrum obtained in 1988: the VO bands at 7400 and 7900 A, which are characteristic features of the M7 type (Turnshek et al., 1985) are very well visible. However our spectrum is similar to that of RU Her, classified M6.5 III.

The photoelectric color determinations are consistent with those of a standard M6 III star (Garnavich and Goldader, 1988). This result is in slight disagreement with our spectral classification.

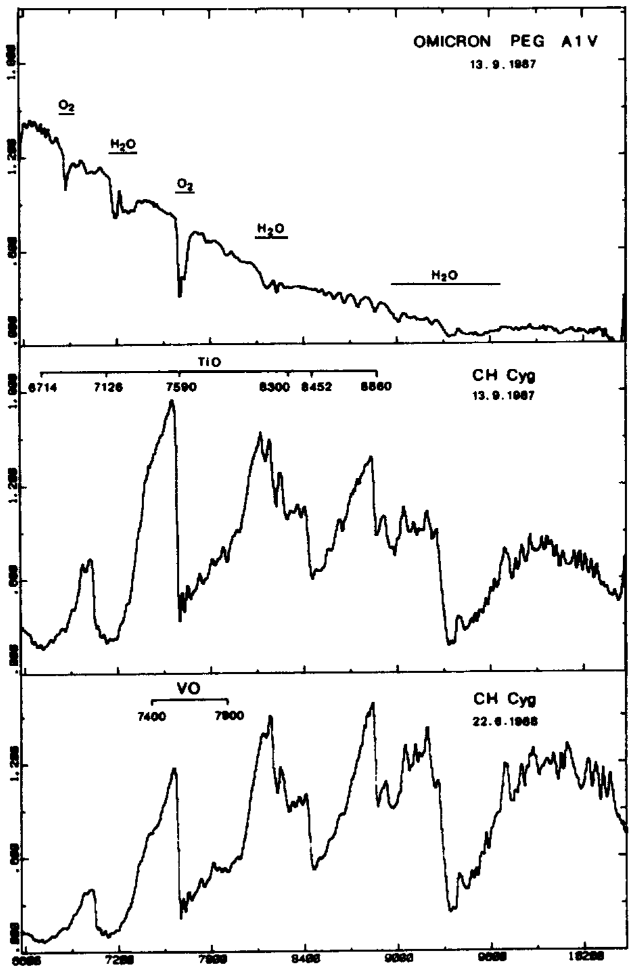
OMICRON PEG A1V
13.9.1987
O_2
H_2O
O_2
H_2O
H_2O
TiO
6714
7126
7590
8300
8452
8860
CH Cyg
13.9.1987
VO
7400
7900
CH Cyg
22.6.1988
.000
.600
1.200
1.800
6600
7200
7800
8400
9000
9600
10200

Figure 1

In June 1988, CH Cyg was in a quiet state: we observed no emissions in the near infrared region (see Figure 1); only Hβ is visible as a faint emission on a spectrum taken in the blue region.

Finally we conclude to a typical spectrum of a M7 III star, in good agreement with the model comprising an M7 giant and a hot component proposed by Taylor et al. (1986).

It is a spectrum of a type later than that obtained in September 1987 (M5 III), about 2 years after an active phase (Taylor et al., 1986; Mikolajewski and Wikierski, 1986; Hack et al., 1988).

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A TOTAL ECLIPSE IN RZ CASSIOPEIAE ?

This popular eclipsing binary was observed photoelectrically on seven nights between November 1980 and March 1981 with the 14-inch Schmidt-Cassegrain telescope of the Central Michigan University Observatory. A Pacific Photometrics photometer was used with an unrefrigerated RCA 1P21 photomultiplier and filters to match B and V of the UBV system. Output was recorded on a strip chart recorder.

Differential photometry was obtained using HD 15784 as our comparison star and HD 16769 as a check star. The former was used as the comparison star rather than the latter because (1) it was more nearly the magnitude of RZ Cas and thus changes in amplifier gain could be avoided and (2) HD 16769 is a known short-period spectroscopic binary (Batten, Fletcher, Mann 1978) and might have small light variations due to, for example, the ellipticity effect. Differential photometry between the two showed no evidence of variability, with the rms deviation from the mean being $\pm\, 0\overset{m}{.}020$ in V and $\pm\, 0\overset{m}{.}027$ in B.

All of the individual differential magnitudes in V and B, along with the heliocentric Julian dates, have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1986), where they are available as file no. 156.

Two nights were ideal for determination of times of mid primary eclipse because on both the entire eclipse, from first to fourth contact, was well covered. We applied the method of bisected chords, with points very near the shoulders and the toes ignored. The results were

$$\mathrm{JD(hel.)} = 2{,}444{,}543.7629 \pm 0\overset{d}{.}0002$$
$$\mathrm{JD(hel.)} = 2{,}444{,}634.6012 \pm 0\overset{d}{.}0003,$$

with no significant difference between V and B, and with no asymmetry significant enough to alter the times by much more than the uncertainties given above. The corresponding O-C residuals, computed with the ephemeris

$$\mathrm{JD(hel.)} = 2{,}429{,}875.6902 + 1\overset{d}{.}1952473 \qquad (1)$$

of Herczeg and Frieboes-Conde (1974), were

$- 0\overset{d}{.}0022 \pm 0\overset{d}{.}0002$ (cycle 12272)
$- 0\overset{d}{.}0027 \pm 0\overset{d}{.}0003$ (cycle 12348).

Although RZ Cas is famous for its small but real period changes (Herczeg and Frieboes-Conde 1974), we will not do a detailed period study here. It is reassuring, however, that O-C residuals of two times of mid primary eclipse obtained by Scarfe et al. (1984) shortly before and after our two times,

$- 0\overset{d}{.}0020 \pm 0\overset{d}{.}0008$ (cycle 12211)
$- 0\overset{d}{.}0028 \pm 0\overset{d}{.}0001$ (cycle 12513),

are consistent.

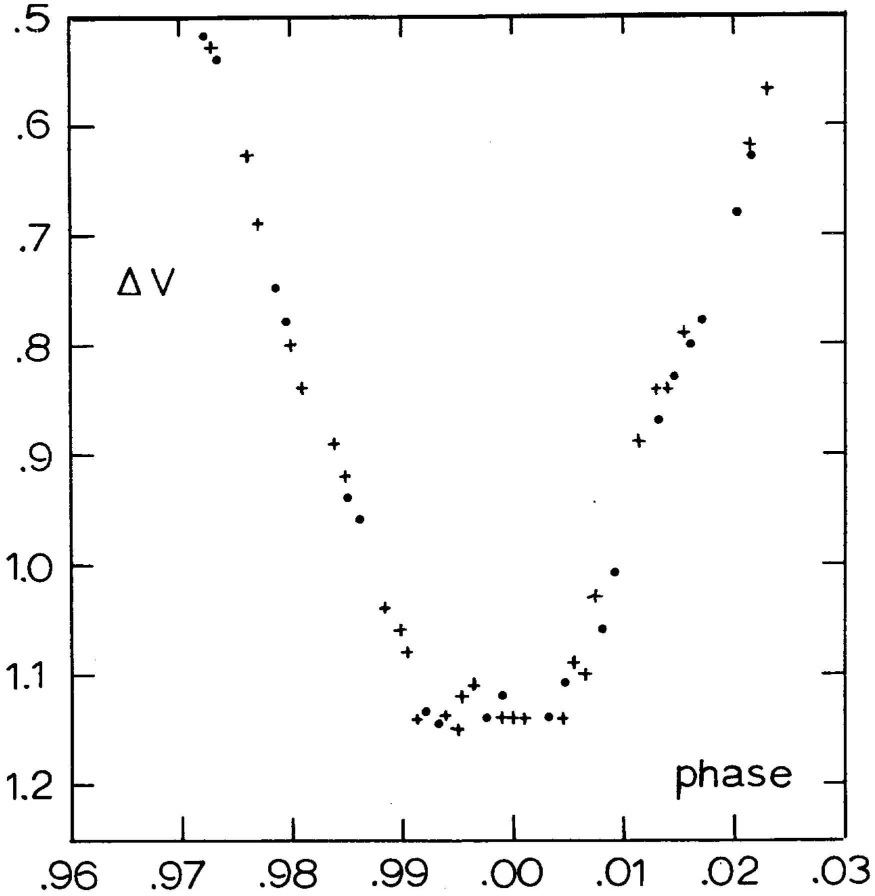

Figure 1. The bottom half of primary eclipse in V. Phase is computed with the ephemeris in equation (1). Notice the 22 minutes of apparently constant light at minimum. Filled circles are from JD 2,444,543 and crosses are from 2,444,634.

The most curious result of our photometry is the clearly apparent total phase, lasting 22 minutes, showing up on both nights and in both bandpasses. This can be seen in Figures 1 and 2. To make the primary eclipse appear partial, one would have to raise 2 or 3 points around second contact **and** 2 or 3 points around third contact, each by about $0^m\!.03$ or $0^m\!.04$, in both the V **and** the B light curves. Though perhaps possible, this would be an improbable and arbitrary application of Gaussian statistics. The rms deviation of the 15 points within the 22 minutes of apparent totality is only ± $0^m\!.013$ in V and ± $0^m\!.016$ in B.

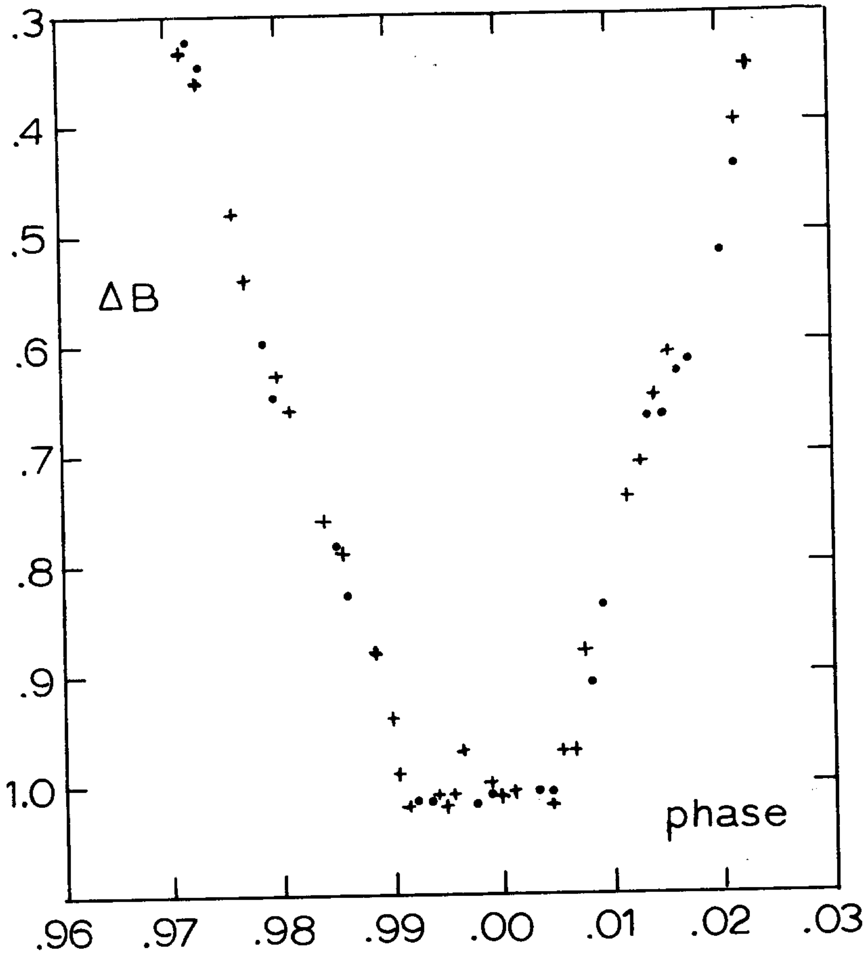

Figure 2. The same as Figure 1, in B.

There are several reasons why we do not believe the primary eclipse actually "became total" on these two nights in 1980 and 1981. According to light curve solutions given by Koch, Plavec, Wood (1970) and by Chambliss (1976), primary eclipse is partial by a wide margin: α_o = 0.8. Our primary eclipse depth, in both V and B, is equal to that found by Chambliss, to within a few hundredths of a magnitude; a total eclipse should have been several tenths of a magnitude deeper. The color change in our primary eclipse was less than $0^{m}_{.}1$, in excellent agreement with that of Chambliss; a total eclipse should have reddened by more than a half magnitude.

Although it is generally thought that primary eclipse in RZ Cas is in-eed partial (Nowak and Piotrowski 1982), there have been a few reports in the literature of a constant phase at minimum light: 14 minutes (Szafraniec 1960) and 13 minutes (Burke and Rolland 1966).

We frankly do not know how to interpret our apparent 22-minute constant phase. We make our observations public on the chance that they represent paradoxical behavior which requires explanation. Perhaps there is a relation between RZ Cas and other semi-detached, mass-transfering, Algol-type binaries which have total eclipses that on occassion appear partial: RW Persei (Hall 1969) and U Cephei (Hall and Keel 1977).

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Photoelectric Observations of HR 4047

HR 4047 (HD 89343, Sp. T. A7n, V = 5.80) was chosen as a comparison star for VY UMa in the American Association of Variable Star Observers (AAVSO) photoelectric photometry program. However, it was found in 1986 to be variable by a few hundredths of a magnitude by Don Pray (Cranston, Rhode Island), and this result was confirmed in 1987 by Howard J. Landis (Locust Grove, Georgia). The spectral type and amplitude of the star suggest that it is most likely a δ-Scuti star.

An observation program of HR 4047 was therefore undertaken in the summer of 1987 and May of 1988. HR 4215 (Sp. T. A1V, V = 6.39) was used as the comparison star. The use of HR 4021 as a check star was discontinued when the task of isolating it from a nearby star in the field proved difficult at best. Also included in the program were the stars HR 4026 and HR 4108 which, on the basis of their spectral types, might also be δ-Scuti stars but so far have been found to have little or no short-term variability.

The observations were taken differentially in the V filter only, with the University of Toronto's 0.4m reflector, located on the 16th floor of the McLennan Physical Laboratories in downtown Toronto. The DC photometer used an *EMI 6094* photomultiplier tube which was operated at 1300 volts supplied by a *Keithley Instrument 242 Regulated High Voltage Supply*. The signal from the photometer was amplified by a *Keithley Instruments DC Amplifier* and the output was fed into a *Vidar 240 Voltage to Frequency Converter*. The 10 second integrations were performed by a *NOVA* computer which also displayed the results on screen and printed them on paper.

In all, 22 observations on 5 nights were obtained in 1987 and 64 points on 5 nights in 1988. These will be deposited in the IAU Commission 27 Archive for Unpublished Photoelectric Photometry (Breger 1988). The precision of the observations is estimated at $\gtrsim 0.007$ magnitude. This value is the standard deviation of the HR 4026 and HR 4108 measurements taken on the night of HJD 2447307 and excludes 3 points which lie more than 4σ from the mean. Of course, in using the HR 4026 and HR 4108 data, we make the possibly false assumption that these two stars are non-variable. However, based upon the

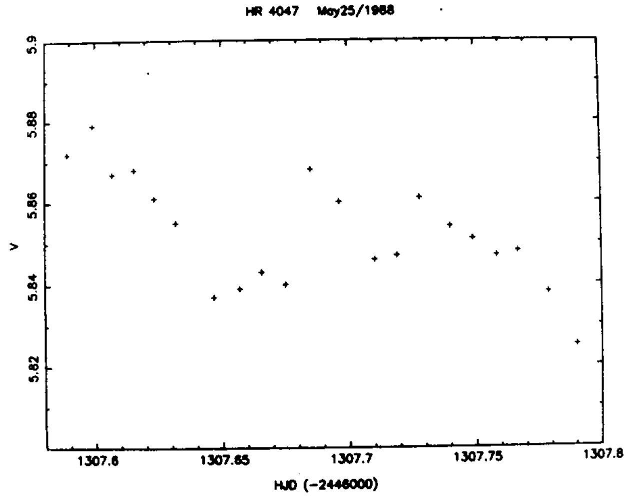

Figure 1. Light curve of HR 4047 for one night of data only.

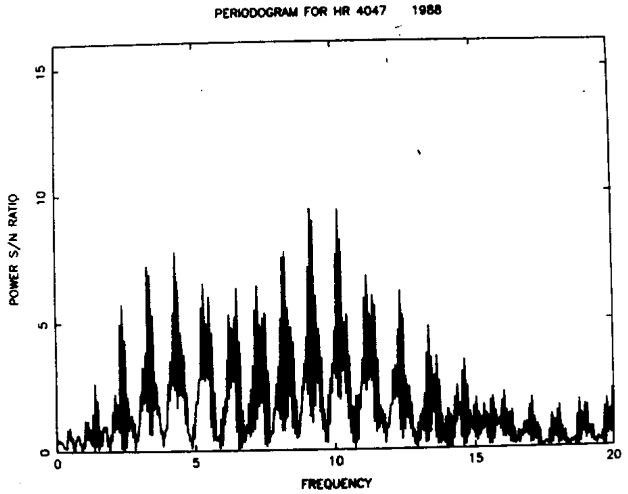

Figure 2. Power spectrum of HR 4047 utilizing all 64 points from 1988.

data so far received, this assumption appears reasonable. A value of ~ 0.007 magnitude is consistent with the precision obtained in other photometric programs using the same telescope.

Preliminary analysis of the light curve (*e. g.* figure 1) and the power spectrum (*e. g.* figure 2) of HR 4047 has yielded an amplitude of approximately 0.05 magnitude and a dominant period somewhere around 0.11 to 0.14 days. However, as can be seen in figure 2, the power spectrum is fairly complicated and seems to indicate the presence of at least two periods. The power spectrum was obtained using Scargle's method (Scargle 1982).

Power spectra of the comparison star have shown a maximum realistic signal to noise ratio of about 0.4 at a frequency of 12.24, negligible when compared to HR 4047's maximum peak of 9.416 at a frequency of 9.16 (see figure 2). A sine wave of frequency 12.24 was fit to the HR 4215 data by the method of least squares and has given an amplitude of 0.00459. This translates into a maximum variation of about 0.009 magnitude. Therefore, it appears that HR 4215 is not variable and any small peaks seen in its power spectrum can be attributed to noisy data.

Clearly there is a danger of over-interpreting the results obtained from so few points. It will probably take many closely-spaced nights of observations (preferably from observatories at widely-spaced longitudes) to disentangle the periods in this star.

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LIGHT VARIABILITY OF THE HELIUM-STRONG STAR HD 96446

HD 96446 [V = 6.68, B-V = -0.16, U-B = -0.87, sp. B1IVp - B2Vp (Hoffleit and Jaschek 1982)] was first recognized as a helium-strong star by Jaschek and Jaschek (1959). Its spectrum indicates that helium is roughly equal in number abundance to hydrogen and oxygen is deficient by a factor of ~13, while other metal abundances appear normal (Wolf 1973).

We had included HD 96446 in a list of 7 candidates to search for β Cephei variables among the He-strong stars (see Matthews and Bohlender 1988) during an observing run at the Las Campanas Observatory in March 1987. Because much of the observing time was instead devoted to studying the recently discovered SN 1987, and additional time was lost to nonphotometric weather, only HD 96446 was observed often enough to produce meaningful results. The presence of variations at β Cephei timescales cannot be established from our data alone. The observations *do*, however, clearly demonstrate that HD 96446 is a broadband light variable. We have used these data to address the question of this star's rotation period.

Measurements were obtained by J.M.M. during UT 19 - 22 March 1987 with the 0.6-m telescope of the University of Toronto located on Las Campanas, Chile, using a photometer equipped with an S25 phototube and UBV filter set. In addition to the programme star HD 96446, a comparison star [HR 4342: V = 6.87, B-V = -0.09, U-B = -0.44, sp. B7III] and a check star [HR 4361: V = 5.73, B-V = -0.12, U-B = -0.71, sp. B3] (Hoffleit and Jaschek 1982) were also monitored. The standard observing routine was: HD 96446, sky, HR 4342, sky, HD 96446, sky, HR 4361, sky, HD 96446, sky, (repeat). For each star, 30-second integrations through U, B, and V filters were recorded in sequence.

TABLE I.
Differential photometry of HD 96446

HJD (2446800+)	V	B	U
HD 96446 - HR 4342			
73.78011	-0.310	-	-0.784
73.78761	-0.319	-0.361	-0.801
73.79483	-0.319	-	-
73.80808	-0.312	-0.360	-
73.81650	-0.313	-0.365	-0.785
73.82267	-0.311	-0.347	-0.784
73.83525	-0.309	-0.350	-0.777
73.84744	-0.311	-	-0.772
73.85389	-0.314	-0.347	-0.775
73.85994	-0.310	-0.354	-0.779
73.86575	-0.313	-0.352	-0.779
73.87628	-0.311	-	-0.775
73.88273	-0.310	-0.354	-0.784
73.88833	-0.318	-0.343	-0.775
74.67382	-0.320	-0.364	-
74.68134	-0.319	-0.363	-
74.68764	-0.321	-0.367	-
74.70911	-0.320	-0.364	-0.793
74.71515	-0.315	-0.365	-0.799
74.72122	-0.313	-0.365	-0.797
74.75543	-0.316	-0.359	-0.791
74.76110	-0.320	-0.367	-0.804
74.76690	-0.315	-0.356	-0.798
74.78460	-0.321	-0.367	-0.801
74.79134	-0.316	-0.362	-0.796
74.79684	-0.315	-0.359	-0.797
74.80199	-0.314	-0.355	-0.790
74.80801	-0.317	-0.353	-0.789
75.77596	-0.307	-0.350	-0.792
75.77753	-0.307	-0.351	-0.790
75.78607	-0.305	-0.351	-0.790
75.79278	-0.309	-0.348	-0.783
75.80291	-0.309	-0.359	-0.791
75.80923	-0.305	-0.352	-0.786
75.81551	-0.306	-0.360	-0.791
75.82175	-0.299	-0.356	-0.786
75.83845	-0.298	-0.344	-0.772
75.84406	-0.296	-0.342	-0.778
75.85232	-0.301	-0.342	-0.778
75.85850	-0.303	-0.344	-0.776
75.87151	-0.295	-0.341	-0.772
75.87781	-0.298	-0.343	-0.785
76.80495	-0.297	-0.344	-0.780
76.81127	-0.293	-0.345	-0.773
76.81731	-0.292	-0.337	-0.776
76.82756	-0.296	-0.344	-0.783
76.84217	-0.293	-0.343	-0.760
76.84773	-0.290	-0.331	-0.762
76.85364	-0.296	-0.331	-0.767
76.85967	-0.295	-0.338	-0.775
76.86813	-0.290	-0.338	-
HR 4342 - HR 4361			
73.78398	1.188	1.161	-
73.81253	1.183	1.158	1.428
73.83818	1.189	1.165	1.421
73.85676	1.188	1.167	1.430
73.87946	1.192	1.165	1.430
74.67794	1.188	1.159	1.434
74.71204	1.186	1.166	1.424
74.75816	1.186	1.163	1.421
74.78831	1.185	1.163	1.424
74.80447	1.185	1.162	1.419
75.78131	1.188	1.166	1.428
75.80636	1.190	1.171	1.435
75.81875	1.182	1.169	1.425
75.83563	-	1.164	1.426
75.84918	1.184	1.163	-
75.87449	1.185	1.171	1.427
76.80851	1.186	1.171	1.429
76.82487	1.188	1.165	1.434
76.83862	1.186	1.163	1.426
76.85052	1.188	1.165	1.425
76.86431	1.185	1.165	1.431

Figure 1.

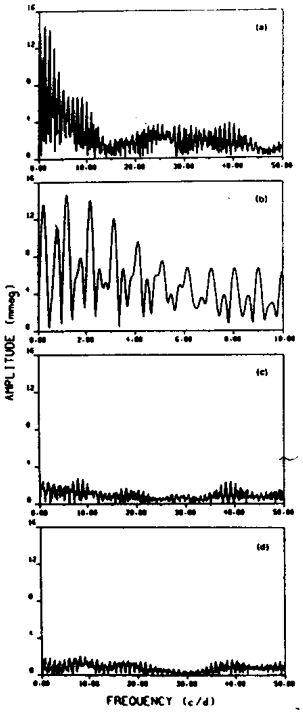


Figure 2.

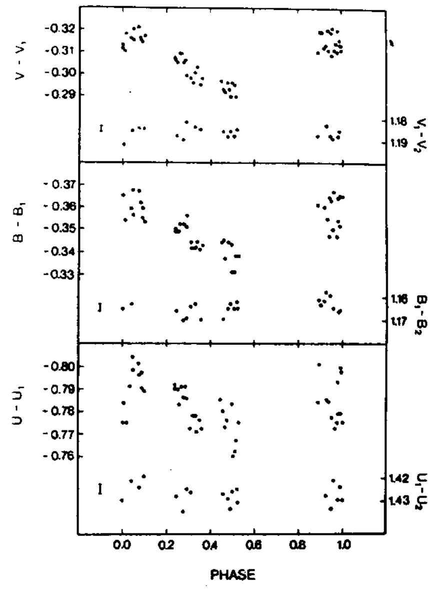
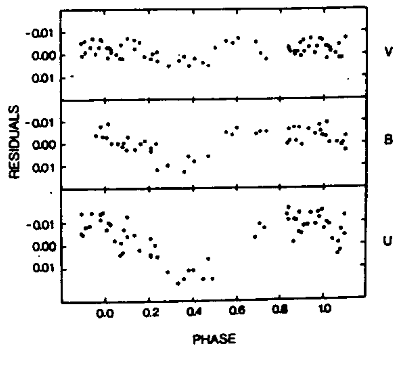


Figure 3.



The raw counts were corrected for coincidence-counting ("dead time") effects and sky background, and converted into instrumental magnitudes. The comparison and check star values were plotted against air mass to derive local extinction coefficients, which were then used to correct the magnitudes for mean air mass extinction. Finally, interpolated values of the comparison and check star magnitudes were determined to produce the differences (HD 96446 - HR 4342) and (HR 4342 - HR 4361) in the three bandpasses. These data are listed in Table I.

There is no indication of variability in HR 4342 or HR 4361; the standard deviations of the magnitude differences are $\sigma_V = 0\overset{m}{.}0025$, $\sigma_B = 0\overset{m}{.}0032$ and $\sigma_U = 0\overset{m}{.}0044$. The larger scatter in U is expected, since sky stability usually worsens at shorter wavelengths.

To search for periodicities in the data, the measurements of HD 96446 were analysed using a Fourier periodogram routine for unequally spaced time series (Matthews and Wehlau 1985). A Fourier amplitude spectrum of the differential V data, spanning the frequency range 0 - 50 d^{-1}, is shown in Figure 1*a*; the range 0 - 10 d^{-1} is reproduced at a larger scale in Figure 1*b*. The largest peak is centred at a frequency of $\nu_1 = 1.178 \pm 0.001$ d^{-1}, corresponding to a period of $P_1 = 0.8490 \pm 0.0007$ d. This peak is accompanied by an extended comb of 1 d^{-1} aliases, including alias peaks "reflected" about zero frequency.

The UBV measurements are displayed in Figure 2, folded at the 0.8490 d period. Both the programme-comparison and comparison-check differences are plotted. The variability of HD 96446 is obvious from these phase diagrams. When a sinusoid of period 0.8490 d and amplitude $0\overset{m}{.}011$ is removed from the V data of Figure 2*a*, the periodogram of the residuals (Figure 1*c*) shows no signs of additional variations with amplitudes much greater than the observational scatter. There are indications of power - suggested by 1 d^{-1} aliasing patterns just barely rising above the noise - at frequencies of 8.047 and 39.219 d^{-1}. We will return to these shortly. The ±1 d^{-1} aliases of the 0.8490-d periods (at periods of 5.6225 and 0.4592 d) are also possible solutions to the data, although the residual Fourier spectra and fits to the phase diagrams are noticeably worse.

Even though the 0.8490-d period accounts well for the V variations, it is apparent from Figures 2*b* and *c* that the scatter of the B and particularly the U measurements about such a sinusoid exceeds that indicated by the (comparison - check) star data. When a sinusoid of period 0.8490 d and amplitude $0^{\mathrm{m}}.012$ is subtracted from the U data, frequency analysis of the residuals shows evidence for periodicity with a timescale between roughly 0.25 - 0.35 d and a peak-to-peak amplitude in U of $0^{\mathrm{m}}.02$. A phase diagram of the best fit to the residuals, at a period of $P_2 = 0.2570$ d is shown in Figure 3. (We note that when a sinusoid of this period and an amplitude of only $0^{\mathrm{m}}.0025$ is filtered from the V residuals, the two possible aliasing patterns - centred near $P_2/2$ and $P_2/10$ - are no longer obvious in the periodogram (Figure 1*d*).)

We believe this may indicate variability in HD 96446 comparable to that seen in the β Cephei stars. Unfortunately, the strongest indicator of such short-term variations in our data is the U residual curve. Although the (comparison - check) U values are well-behaved, the U transparency of the atmosphere is notoriously unreliable even at good sites. Therefore, we must await more extensive photometric (and hopefully corroborating radial velocity measurements) to confirm if these variations are indeed real.

Many of the He-strong stars exhibit photometric variations which are believed to correspond to their rotation periods, in the context of the oblique rotator model. Well-determined periods are available for at least 9 He-strong stars (Hunger 1986; Bohlender *et al.* 1987), ranging from 0.90 to 9.53 d. The value of 0.849 d we propose for HD 96446 falls at the low end of this range; the alias period of 5.623 d is also consistent with this range. If this star is an oblique rotator, its spectroscopic variations (if any) should have the same period as the light variability.

Pedersen and Thomsen (1977) searched for periodic variability in the He I $\lambda4026$ line strength among several He-strong stars, including HD 96446. They obtained 21 observations of this star from which they derived a period of 23 ± 6 d. Their data show no correlation with either the 0.849107-d or the 5.623-d period, nor do any of the aliases of their period correspond to these values. It is possible that He line strength variations in this star are not linked to rotation as simply as in some other He-strong stars (Landstreet, private communication). Even so, we have some concerns about the reliability of their R index data for the purpose of period determination in the case of HD 96446. The changes they detected in this star were the smallest of any in their sample for which they claimed variability, and the amplitude was roughly the same as the standard error in each measurement.

If HD 96446 is rotating with a period of 0.849 d, we can use Wolf's (1973) estimate of the radius of the star (R = 3.6 ± 0.8 $R_{\odot}$) to derive an equatorial rotation velocity $v_{eq} \simeq 200 \pm 30$ km s^{-1}. This is consistent with the range of rotation rates determined for early BIV-V stars by Wolff *et al.* (1982). However, so too is the value $v_{eq} \simeq 33$ km s^{-1} which we find by using the 5.623-d period, if the star belongs to the subset of early B stars with slow rotation inferred by Wolff *et al.* On the other hand, Pedersen and Thomsen's period of 23 ± 6 d yields $v_{eq} \simeq 9 \pm 4$ km s^{-1}, which is exceptionally low for such a star.

Walborn (1983) has set an upper limit on the projected rotation velocity of HD 96446 at $v\sin i \leq 30$ km s^{-1}. Of the 9 He-strong stars with accurately-determined periods, six have periods less than 2 d; of these, the values of $v\sin i$ range from 170 to <30 km s^{-1}. The three remaining stars all have $v\sin i \leq 30$ km s^{-1}. Therefore, the existing sample is compatible with periods of 0.85 *or* 5.6 d and a $v\sin i$ of ≤ 30 km s^{-1}.

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PHOTOMETRY OF ALPHA Ori (BETELGEUSE), GAMMA Ori, AND PHI-2 Ori

We present photometry of Betelgeuse with respect to two comparison stars, Gamma Ori (V=1.64, B-V=-0.22) and Phi-2 Ori (V=4.09, B-V=0.95, Johnson et al. 1966, Table 9). Previous data has been published by Krisciunas (1986, and references therein). For V-band data reduction we adopted B-V=1.84 for Betelgeuse, as given by Johnson et al.

Data by Fisher, given in Table I, was obtained at Berwick, Ontario, Canada, using a 20 cm Celestron reflector and an Optec SSp-3 solid state photometer. Transformatiom to the UBV system (determining ϵ_V) was accomplished by differential measurements of 28 and 27 LMi (for which ΔV=0.378, Δ(B-V)=-1.03, Hall 1983). Differential magnitudes with respect to Phi-2 Ori were then added to the known V magnitude of Phi-2 Ori to obtain the V magnitude of Betelgeuse. Fisher's ϵ_V was typically -0.01. A value of V-band extinction of 0.30 mag/air mass was used in the data reduction.

Data by Krisciunas, given in Tables II and III, was obtained at the 2800 m level of Mauna Kea on the island of Hawaii. Krisciunas used a 15 cm f/5.82 Newtonian reflector, an uncooled RCA 931A photomultiplier tube, operated at -1050 V, and UBV filters by Estafilter. His transformation coefficients ϵ_V and μ were obtained from all - sky measurements of UBV standards, typically 9 observations on a given night, but on one occasion 26 observations of 15 stars. Typically ϵ_V ranged from -0.04 to -0.06 but on JD 7205 and 7222 ϵ_V was -0.092 and -0.081, respectively. The average value of μ was 0.940.

On JD 7242 Krisciunas found ϵ_V =-0.060 +/-0.004 from observations of 8 standards. That was followed by 10 differential measurements of 27 vs. 28 LMi, for which ϵ_V =-0.046 +/-0.006. From 6 differential measurements on the same pair on JD 7262 he found ϵ_V=-0.050 +/-0.007. On nights when ϵ_V and μ were not determined, recently determined values were adopted.

Krisciunas also measured the extinction and reddening as often as possible. From observations on 20 nights from September 1985 to April 1988 the median V-band extinction at the 2800-m level of Mauna Kea on nights without cirrus

Table I

Photometry of alpha Ori by Fisher (comp star phi-2 Ori)

Date	Julian Date	V
5/6 Jan 1986	2446436.54	0.666
13/14 Jan 1986	6444.69	0.610
12/13 Feb 1986	6474.54	0.442
29/30 Nov 1986	6764.62	0.542
30 Nov/1 Dec 1986	6765.65	0.539
6/7 Dec 1986	6771.64	0.555
16/17 Jan 1987	6812.60	0.536
25/26 Jan 1987	6821.55	0.531
4/5 Feb 1987	6831.63	0.491
9/10 Feb 1987	6836.61	0.446
14/15 Feb 1987	6841.54	0.465
24/25 Feb 1987	6851.55	0.466

Table II

Photometry of alpha Ori by Krisciunas (comp star gamma Ori)

Date	<UT>	Julian Date	V		B–V		n_V	n_{bv}
11/12 Oct 1986	1158	2446716.00	0.435	± 0.020			3	
29/30 Nov 1986	1047	6764.95	0.544	0.020			3	
21/22 Dec 1986	0839	6786.86	0.531	0.014			4	
27/28 Dec 1986	0830	6792.87	0.543	0.007			4	
21/22 Jan 1987	0932	6817.90	0.562	0.007	1.797	± 0.004	3	3
8/9 Feb 1987	0716	6835.80	0.523	0.014	1.795	0.017	3	3
29/30 Mar 1987	0707	6884.80	0.383	0.024	1.958	0.033	3	3
5/6 Apr 1987	0548	6891.74	0.428	0.011			5	
16/17 Apr 1987	0619	6902.76	0.451	0.010			2	
24/25 Oct 1987	1041	7093.95	0.555	0.005	1.923		3	1
12/13 Nov 1987	0929	7112.90	0.538	0.009	1.857		3	1
27/28 Dec 1987	0829	7157.85	0.610	0.007	1.857		3	1
23/24 Jan 1988	0708	7184.80	0.602	0.005	1.819	0.010	4	2
13/14 Feb 1988	0839	7205.86	0.478	0.021	1.809	0.025	3	3
1/2 Mar 1988	0710	7222.80	0.511	0.008	1.751		3	1
21/22 Mar 1988	0651	7242.79	0.402	0.010	1.869		3	1
10/11 Apr 1988	0614	7262.76	0.396	0.007			3	
16/17 Apr 1988	0625	7268.77	0.385	0.023			3	

Table III

Photometry of alpha Ori by Krisciunas (comp star phi-2 Ori)

Date	<UT>	Julian Date	V		B–V		n_v	n_{bv}
21/22 Dec 1986	0839	2446786.86	0.508	± 0.008			4	
27/28 Dec 1986	0830	6792.87	0.487	0.007			4	
21/22 Jan 1987	0932	6817.90	0.535	0.017	1.858	± 0.015	3	3
8/9 Feb 1987	0716	6835.80	0.443	0.005	1.871	0.009	3	3
29/30 Mar 1987	0707	6884.80	0.337	0.005	1.925	0.022	3	3
24/25 Oct 1987	1041	7093.95	0.505		1.989		1	1
12/13 Nov 1987	0929	7112.90	0.482		1.958		1	1
27/28 Dec 1987	0829	7157.85	0.609		1.853		1	1
23/24 Jan 1988	0708	7184.80	0.569	0.004	1.805	0.066	3	2
13/14 Feb 1988	0839	7205.86	0.488	0.009	1.856		3	1
1/2 Mar 1988	0710	7222.80	0.434	0.014	1.790		3	1
21/22 Mar 1988	0651	7242.79	0.408	0.013	1.822		2	1
10/11 Apr 1988	0614	7262.76	0.357	0.011			4	
16/17 Apr 1988	0625	7268.77	0.363	0.011			4	

Table IV

Differential photometry of gamma Ori vs. phi-2 Ori

Date	<UT>	Julian Date	ΔV		Δ(B–V)		n_v	n_{bv}
29/30 Nov 1986	0252	2446764.62	–2.519					
30 Nov/1 Dec 86	0336	6765.65	–2.475					
6/7 Dec 1986	0321	6771.64	–2.510					
Krisciunas data:								
21/22 Dec 1986	0841	6786.86	–2.486	± 0.008			4	
27/28 Dec 1986	0832	6792.86	–2.513	0.011			4	
21/22 Jan 1987	0927	6817.89	–2.464	0.013	–1.111	± 0.018	3	3
8/9 Feb 1987	0721	6835.81	–2.519	0.003	–1.097	0.010	3	3
29/30 Mar 1987	0712	6884.80	–2.516	0.016	–1.223	0.024	3	3
24/25 Oct 1987	1053	7093.95	–2.500		–1.109		1	1
12/13 Nov 1987	0943	7112.90	–2.520		–1.065		1	1
27/28 Dec 1987	0848	7157.87	–2.446		–1.173		1	1
23/24 Jan 1988	0723	7184.81	–2.470	0.011	–1.184	0.076	4	2
13/14 Feb 1988	0844	7205.86	–2.444	0.028	–1.092		3	1
1/2 Mar 1988	0710	7222.80	–2.505	0.023	–1.122		3	1
21/22 Mar 1988	0658	7242.79	–2.436	0.012	–1.239		2	1
10/11 Apr 1988	0612	7262.76	–2.484	0.009			3	
16/17 Apr 1988	0623	7268.77	–2.463	0.015			3	

Table V

Mean star color differences

Pair	$\langle\Delta(B-V)\rangle$	n_{bv}	Johnson et al. value
α Ori - γ Ori	2.061 ± 0.016	19	2.06
α Ori - ϕ^2 Ori	0.923 0.015	17	0.89
γ Ori - ϕ^2 Ori	-1.139 0.015	17	-1.17

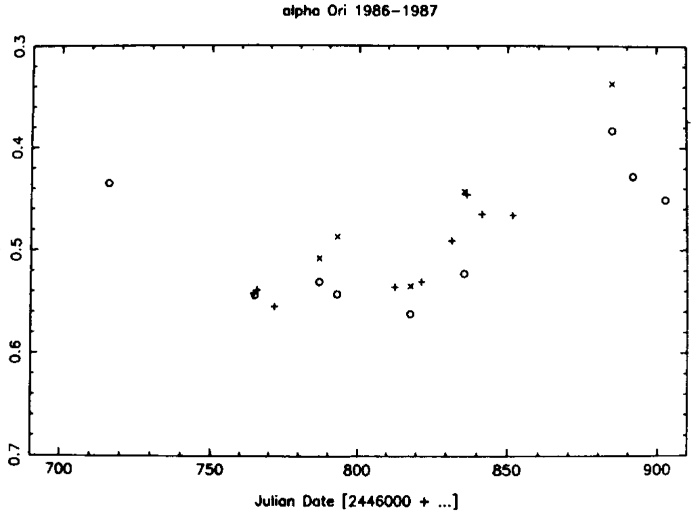

Figure 1. V magnitude of Alpha Ori vs. Julian Date for 1986-1987 observing season. Circles: Krisciunas data using Gamma Ori as comparison star. X's: Krisciunas data using Phi-2 Ori as comparison star. +'s: Fisher data using Phi-2 Ori as comparison star.

is 0.173 mag/air mass. It was assumed that $k''(v)$ was 0.00.

For the data presented here we used a value of $k(v)$ appropriate for the night. For all the B-V color determinations we used the mean coefficients of out-of-atmosphere reddening parameters of:

$k'(bv) = 0.10$;

$k''(bv) = -0.05$.

In Table II we give data on Betelgeuse by Krisciunas, reduced using Gamma Ori as comparison star. Given are the local date/UT date, the mean Universal Time, the geocentric Julian Date, the mean V magnitude, B-V color, and numbers of differential v and b-v observations made. Table III gives

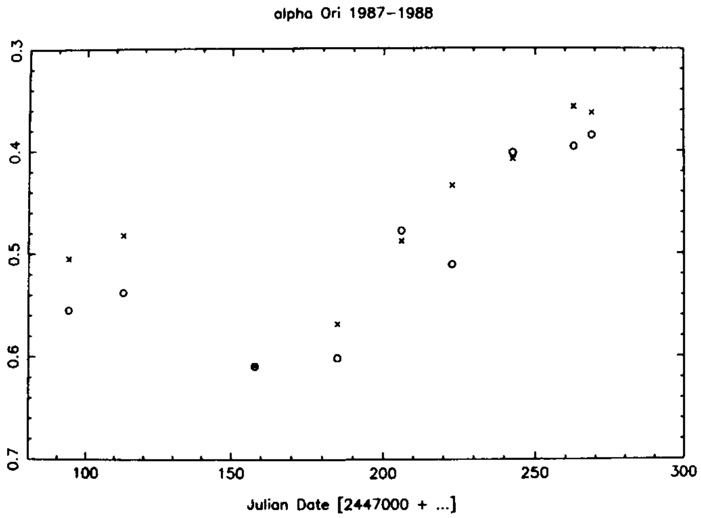

Figure 2: V magnitude of Alpha Ori vs. Julian Date for 1987-1988 observing season. Symbols same as in Figure 1.

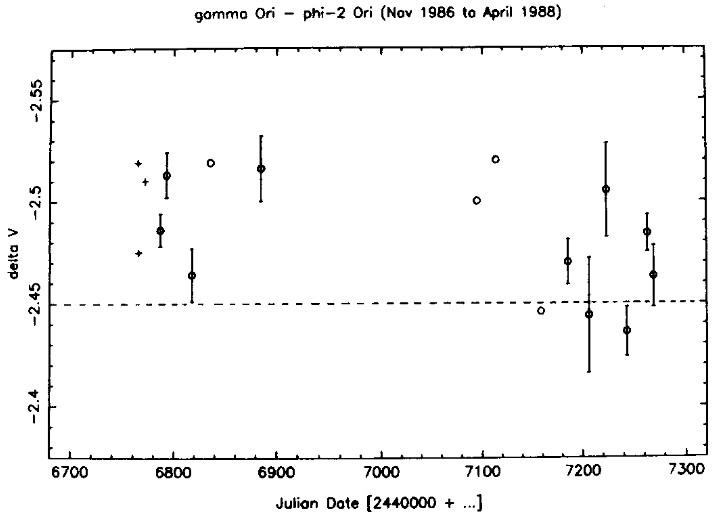

Figure 3: Differential V magnitude for Gamma Ori minus Phi-2 Ori, November 1986 to April 1988. +'s: Fisher data. Circles: Krisciunas data. The dotted line corresponds to data given by Johnson et al. (1966).

Betelgeuse data by Krisciunas, reduced using Phi-2 Orias comparison star. Table IV gives data by both authors on Gamma Ori minus Phi-2 Ori. In Tables II to V the errors quoted are the mean error of the mean, without the uncertainties of gain values, transformation coefficients, or atmospheric parameters folded (i.e., they are internal random errors).

Figure 1 is the V-band light curve of Betelgeuse in 1986-1987. Figure 2 is for Betelgeuse during 1987-1988. Figure 3 shows Gamma Ori minus Phi-2 Ori from November 1986 to April 1988.

Data obtained by Fisher in early 1986 for Betelgeuse is 0.153 magnitudes fainter than values interpolated from data previously published by Krisciunas. Fisher used Phi-2 Ori as the comp star, while Krisciunas used Gamma Ori. The most likely possible sources of error are:

1/ Saturation of Fisher's detector (he used the larger telescope).

2/ Systematic errors in the adopted values of ϵ_V.

3/ Wrong catalog value(s) for comparison star(s).

4/ Variability of comparison star(s).

5/ Systematic errors in adopted gain values for amplifier, given that observations by Krisciunas of Betelgeuse and comparison stars were made on different gains.

Krisciunas recalibrated his amplifier gain steps in the lab and double checked the values using observations of standard stars. If these same gain values were correct for the 1985-1986 observing season, that would make Krisciunas's previously published values from 1985-1986 fainter by 0.057 magnitudes.

We note that photometry of Alpha Ori vs. Phi-2 Ori by Fisher in January and February of 1987 is in excellent agreement with the two points of Krisciunas obtained in those months, using the same comparison star.

Consider the following facts:

1/ Alpha Ori vs. Phi-2 Ori in 1987-1988 shows a relatively smooth light curve.

2/ Alpha Ori vs. Gamma Ori in 1987-1988 shows a relatively ragged light curve.

3/ Gamma Ori vs. Phi-2 Ori from 1986-1988 is ragged.

4/ Other photometry by Stebbins (see Goldberg 1984) indicates that Alpha Ori usually varies smoothly.

This would seem to indicate that Gamma Ori is a "standard" star that is variable. Further, Krisciunas finds that all-sky photometry of Phi-2 Ori gives values not statistically significantly different than V=4.09, while Gamma Ori has shown standardized values up to 0.07 brighter than its catalog value. (However, Gamma Ori is usually the bluest star observed, and it is assumed that the V-band transformation is linear.)

Given our list of 5 sources of error above, we feel that numbers 1, 2, and 5 are under control. Gamma Ori, of spectral type B3 III, could be a Beta Cephei star, and seems variable. Phi-2 Ori, of spectral type K0 III, is not suspected to be variable.

Finally, a word about B-V colors. Table V gives mean color differences between pairs of stars, obtained from observations when the stars were high in the sky, so as to minimize the effect of the k" (bv) term. There is considerable scatter of the nightly means given in Tables II, III, and IV. We do not believe these variations are due to actual color variations versus time. The scatter comes from star centering, filter positioning, possible systematic errors in the adopted value of μ, and possible variations of k'(bv) and k"(bv).

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PHOTOMETRIC VARIABILITY OF HD81410 IN 1988*

The single - line chromospherically active spectroscopic binary HD 81410 has a relatively large orbital period P = 12.86833 days and its colors at the maximum light level correspond to a system with K0 III primary and F5 V secondary (Raveendran et al., 1982). Bidelman and MacConnel (1973) detected strong emissions in Ca II H and K. Eggen's (1973) photometric observations of HD 81410 during 1971 and 1972 showed light variability with an amplitude of 0.50 mag and he estimated the period to be 25.4 days. The 1981 photometry by Raveendran et al. (1982) and their subsequent analysis of the photometry and spectroscopy, available till then, showed that the system has an orbital period of 12.86833 days and 12.89 days periodicity in light variation. The shape and the amplitude of light curve in 1981 was entirely different from that of 1971 and 1972. These variations are caused by the rotational modulation of magnetically active regions, spots, that are cooler than the surrounding photosphere. Slee et al. (1984) detected radio emission from HD 81410 at 5 GHz and also they observed flux variability by a factor of 2 in 90 minutes during a major flare of 1983 August 2.

HD 81410 was observed with the 50 cm telescope at the European Southern Observatory, La Silla, on 18 nights; 7 nights through UBVRI filters and a cooled RCA 31034 photomultiplier tube and 11 nights through Stroemgren uvby filters and a cooled EMI 6256 tube. The measurements were made differentially with respect to the comparison star HD 81904. Sufficient numbers of UBVRI and uvby standard stars were observed for the conversion of the instrumental magnitudes to the standard system. The mean error in V is of the order of 0.006 mag and in y 0.007 mag. The Stroemgren y is nearly the same as the Johnson V, and in order to compare both sets of observations, the y magnitudes were converted to Johnson V values using the relation

$$V = y + 0.015\,(b-y) - 0.003 \quad \text{(Olsen, 1983)}.$$

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[*] Based on observations collected at the European Southern Observatory La Silla, Chile.

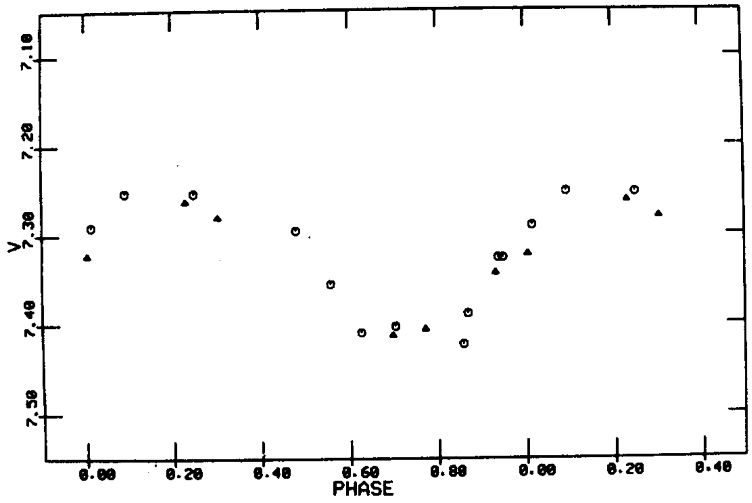

Figure 1

The orbital phases were calculated according to the ephemeris of Raveendran et al. (1982):

$$JD = 2441466.213 + 12\overset{d}{.}86833E$$

Figure 1 is a plot of V magnitudes. The rectangles represent V magnitudes of UBVRI photometry and open circles the calculated V values from Stroemgren y. The light curve is asymmetric with a flat minimum (0.60P to 0.85P) and has an amplitude of 0.16 mag. The magnitudes at the maximum and minimum are 7.25 mag and 7.41 mag respectively.

From the photometry of HD 81410 available in the literature, it is seen that the light curve during 1971/72 was quasi-sinusoidal with an amplitude of 0.45 mag, minimum at 0.70P and the maximum light level 7.50 mag. In 1981 the light curve had two minima and the maximum brightness.7.50 mag while the amplitude decreased to 0.15 mg. The unpublished observations obtained by Mekkaden during 1987 indicated that the light curve had two minima; the deeper minimum occurring at the same phase as that of the light curve in 1988. This means that the large spot group responsible for the deeper minimum in 1987 was present in 1988 while the small spot group of 1987 disappeared. The unchanged maximum light levels of these two seasons reveal that the activity on the less spotted hemisphere remained unchanged.

The changes in the light curve and the mean light level occur due to the formation and disintegration of active regions. Mekkaden and Geyer (1988) interpreted such types of activity due to the evolution of short lived spot groups in active zones on stellar photosphere and the cumulative effect of these spot groups cause changes in the activity in these stars.

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UBV(RI)c OBSERVATIONS OF SN 1987A[*]

SN 1987A was observed in 1987 from November 30 to December 14 with the 50 cm ESO Cassegrain reflector at La Silla. The telescope was equipped with a single-channel photon-counting cooled photometer using an RCA 31034 tube.

HD 39062 (=CP $-61^{\circ}517$ = SAO 243350) and HD 37297 (=CP $-64^{\circ}456$ = SAO 249309 = HR 1917) were used as comparison and check stars, respectively. The observations were corrected for atmospheric extinction and were transformed to the UBV(RI)c system by observing Cousins E-region standard stars (Vogt et al. , 1981). The following magnitudes were derived for the comparison and check stars, which showed no variability larger than 0.02 mag in any of the wavebands (the standard deviation in units of .001 mag. is given within parentheses):

Star	U	B	V	R	I
HD 39062	10.063(20)	8.685(11)	7.402(8)	6.754(12)	6.193(10)
HD 37297	7.239(13)	6.384(8)	5.350(6)	4.807(11)	4.326(9)

Table I

Nightly mean JDo, V magnitude and colors of SN 1987A. At the bottom of each column the typical standard deviation is reported in units of .001 mag.

JDo (2447000.+)	**V**	**U-B**	**B-V**	**V-R**	**V-I**
129.8058	5.881	1.574	1.273	1.162	1.642
130.7534	5.887	1.566	1.275	1.163	1.634
131.7469	5.902	1.558	1.275	1.158	1.632
132.7392	5.911	1.529	1.276	1.164	1.635
133.7037	5.925	1.540	1.268	1.168	1.634
134.7190	5.938	1.548	1.261	1.163	1.634
135.7974	5.947	1.532	1.259	1.160	1.633
136.7402	5.959	1.524	1.262	1.168	1.638
137.7905	5.964	1.522	1.260	1.161	1.627
138.7057	5.966	1.507	1.259	1.160	1.616
139.7656	5.973	1.500	1.254	1.154	1.620
140.7719	5.987	1.485	1.248	1.154	1.619
141.6943	5.997	1.490	1.238	1.158	1.626
142.7228	6.009	1.480	1.234	1.159	1.625
143.7636	6.012	1.478	1.237	1.157	1.617
	3	6	4	4	4

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[*] Based on observations obtained at the European Southern Observatory, La Silla, Chile

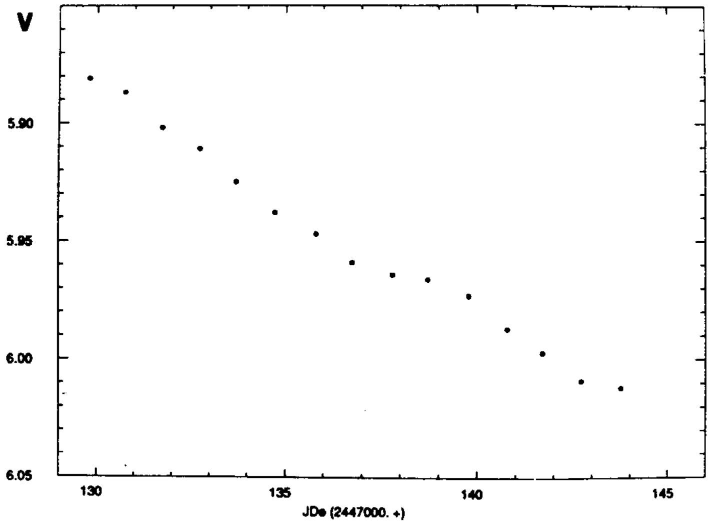

Figure 1: V observations of SN 1987A in 1987 from November 30 to December 14.

The magnitudes of HD 37297 and HD 39062 are in very good agreement with those reported by Rucinski (1983) and Gouiffes (private communication) respectively.

Figure 1 shows the V light curve. In Table I the mean JD⊙, the V magnitude and the U-B, B-V, V-R and V-I color indices are presented. Each value is the average of at least three different measurements (SN 1987A - HD 39062).

Comparing our results with those obtained by Whitelock et al. (1988), we note systematic shifts (present paper - Whitelock magnitudes) of the order of: +0.04 mag in U, +0.01 in B, +0.04 in V,+0.03 in R and +0.1 in I. Although the difference in the I band is quite high, the shifts between the two data sets could be simply due to differences in the zero point.

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22 August 1988
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1976 LIGHT CURVES OF BX ANDROMEDAE

BX And (SVS 995, HD 13078, BD +40° 442) is the brighter companion of the visual binary ADS 1671 (Σ 215). The GCVS (1985) lists its spectral class to be F2 V. Its variability was discovered by Soloviev (1945), who reported it to be of Algol type. Ashbrook (1951), by studying 200 Harvard patrol plates, confirmed the binary nature of BX And and stated it to be of ß-Lyrae type. Svolopoulos (1957) published normal points and began a Russell-Merrill (1952) analysis which he abandoned due to complications in the rectified light curve. Todoran (1965) completed the solution and determined preliminary orbital elements for the system. Additional light curves have been published by Castelaz (1979) and Rovithis and Rovithis-Livaniou (1984). Sets of light elements have been determined by Ashbrook (1951), Svolopoulos (1957), Chou (1959), and Castelaz (1979). Chou (1959) and Ahnert (1975) determined that BX And has undergone a major period change of about $0^s\!.25$. Using all available epochs of minimum light we have confirmed this. A least squares fit of the photoelectric data shows that this occurred in 1946.

The present observations were made on three nights in September and two nights in November, 1976 using the 41 cm Cassegrainian telescope of the Morgan-Monroe station of the Goethe Link Observatory of Indiana University. Standard U,B,V filters were used with a dry-ice-cooled 1P21 photomultiplier tube. The comparison and check stars were BD +39° 476 and BD +39° 480, respectively. Standard magnitudes were determined for the comparison and variable star. They are listed in Table I. Over 1000 observations in B and V wavelengths and over 900 observations in U were obtained.

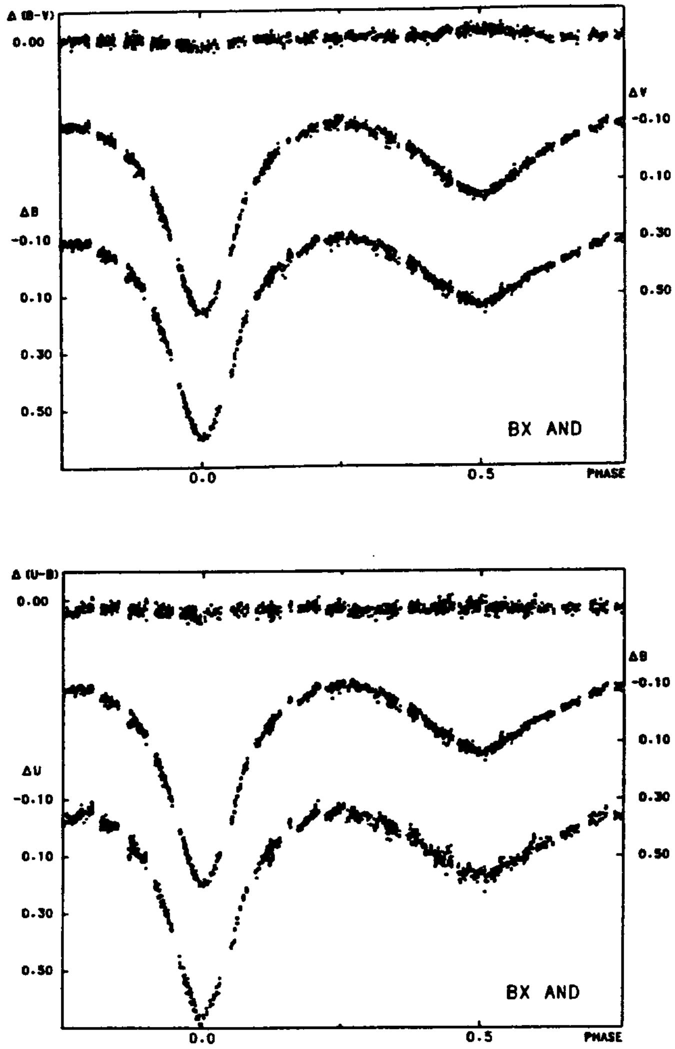

FIG. 1 - Light curves of BX And defined by the individual observations.

Table I

Standard Magnitudes of the Comparison Star and Variable

Star	V	B-V	U-B	Phase
Comparison	8.96	0.44	-0.01	----
BX And	8.65	0.45	0.04	0.25

Kaitchuck and Faulkner (1977) published four epochs of minimum light from these observations. The rather large O-C's obtained from these and other photoelectric epochs indicate that the system is very active and may be undergoing erratic and continuing minor period changes.

The U, B and V light curves of BX And defined by the individual observations are shown in Figure I as Δm versus phase. The analysis of the observations is underway.

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Cn 1-2 (=PK 326 -10^{0}1)

The emission line object Cn 1-2 is listed in the Catalogue of Galactic Planetary Nebulae by Perek and Kohoutek (1967) under the designation (326 -10^{0}1) but is actually a symbiotic star. It is misidentified on the finder chart in Perek and Kohoutek, but a correct identification is given in Allen's (1984) Catalogue of Symbiotic Stars. Cn 1-2 is also known as Henize 1242 andHe 2-177. Relatively few observations of Cn 1-2 have been made since its first description by Annie J. Cannon (1921). Webster (1966;1973) and Allen (1984) established its identity as a symbiotic star which is also confirmed by recent IUE observations (Feibelman 1988). The IUE spectrum is practically identical to that of V1016 Cyg and very similar to HM Sge, both of which had dramatic increases in brightness by about 5 magnitudes in 1965 and 1975, respectively. Webster (1973) gives an approximate V magnitude of 12.5 for Cn 1-2, with minor fluctuations in emission line strengths.

If Cn 1-2 experienced a brightening similar to that of V1016 Cyg and HM Sge prior to 1921, it would represent a southern counterpart to such objects and may form an important link to these unusual symbiotics. However, the apparent constancy in brightness of Cn 1-2 (though greatly under-observed during the past half century) may also signal a very long wait for major changes to occur in V1016 Cyg and HM Sge. Because of the importance of these objects to the understanding of stellar evolution and their spectral similarity to Cn 1-2, observations of Cn 1-2 over a wide range of wavelengths appears to be desirable in the hope of predicting the future development of symbiotics of this type.

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UBV(RI)c PHOTOMETRY OF AB Dor*

AB Dor = HD 36705 is a rapidly-rotating late-type star having strong Ca II emission lines (Bidelman and MacConnell, 1973). Almost certainly due to its very high v sin i (∼100km/s), this star has been variably classified as K1 IIIp, K2 IVp and K0 IV-V. Pakull (1981) discovered a photometric period of 0.51423 days and, because of variable optical and X-ray fluxes, classified AB Dor as an RS CVn system. There is no clear evidence, however, that the star is double and AB Dor has been successively classified as an FK Com (Collier 1982), a still contracting post T-Tau or a BY Dra star (Rucinski 1982). None of the interpretation of the evolutionary status of AB Dor is completely statisfactory. For further details see also Innis et al. (1985), Pallavicini et al. (1987), Collier Cameron et al. (1988), and the references therein.

AB Dor was observed at La Silla in 1985 by one of us (GC), from November 19 to 28, with the 50 cm ESO Cassegrain reflector equipped with a single-channel photon-counting, cooled photometer using an RCA 31034 tube. HD 37297 (=CP-64°456=SAO 249309=HR 1917) was used as comparison, while HD 35230 (=CP-68°347=SAO 249241) and HD 38616 (=CP-67°492=SAO 249336) served as check stars; they showed no significant variability during the period of the observations. The observations were corrected for atmospheric extinction and were transformed to the UBV(RI)c system by observing Cousins' E-region standard stars.

The following magnitudes were derived for the comparison and check stars (the standard deviation is about .01 mag, or less):

Star	U	B	V	R	I
HD 37297	7.22	6.39	5.35	4.79	4.33
HD 35230	8.92	8.46	7.58	7.09	6.66
HD 38616	6.89	7.01	7.03	7.01	7.04

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* Based on observations collected at the European Southern Observatory, La Silla, Chile

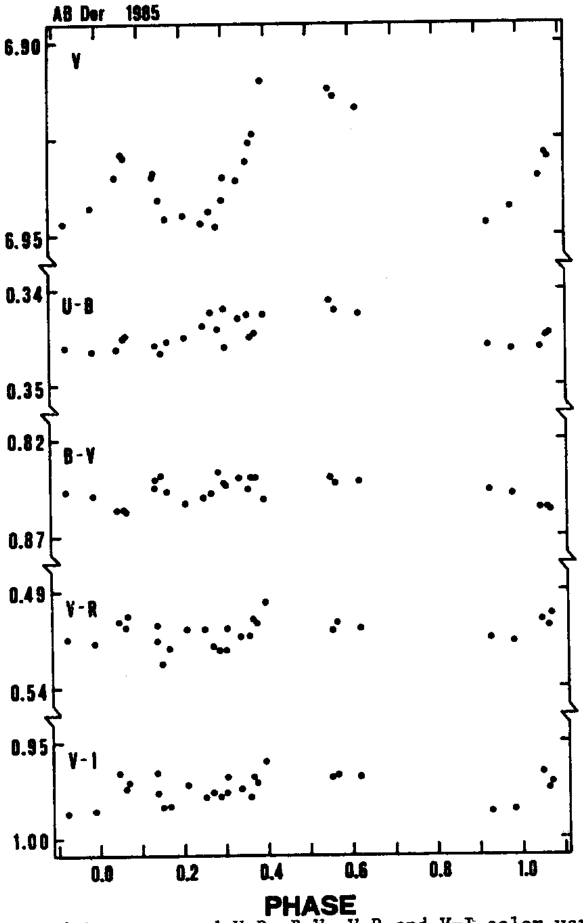

Figure 1: V light curve and U-B, B-V, V-R and V-I color variations of AB Dor in November 1985. The phases are computed using the ephemeris HJD=2444296.575+0.51423 x E given by Pakull (1981).

Figure 1 shows the V light curve and the U-B, B-V, V-R and V-I color variations. In Table I the heliocentric JD, the phase (computed using the ephemeris HJD= 2444296.575+0.51423 x E given by Pakull 1981), the V magnitude and the color indices are presented. The typical standard deviation is .005 mag for the V data and .007 for the color indices. The light curve, though incomplete, is clearly double-peaked with maxima at phase 0.45 (±.05) and 0.1 (±.025), respectively. The color variations are in agreement with the starspot hypothesis: the star appears redder at light minimum.

Table I

HJD (2446000.+)	Phase	V	U-B	B-V	V-R	V-I
389.8088	.6178	6.917	0.354	0.842	0.510	0.968
390.8090	.5629	6.914	0.352	0.843	0.507	0.967
391.8315	.5519	6.912	0.347	0.840	0.511	0.968
392.7598	.3564	6.931	0.354	0.846	0.514	0.978
.7681	.3726	6.924	0.364	0.840	0.507	0.971
393.6824	.1507	6.941	0.374	0.839	0.528	0.983
.6901	.1657	6.946	0.368	0.847	0.520	0.983
394.7719	.2694	6.944	0.353	0.848	0.519	0.976
.7878	.3003	6.941	0.351	0.843	0.521	0.976
.8058	.3347	6.936	0.356	0.840	0.514	0.974
.8208	.3643	6.926	0.366	0.840	0.505	0.968
.8358	.3936	6.910	0.354	0.851	0.496	0.960
395.6940	.0625	6.929	0.366	0.856	0.509	0.974
.7328	.1379	6.934	0.370	0.841	0.516	0.976
.7687	.2078	6.945	0.366	0.853	0.510	0.972
.8088	.2858	6.948	0.362	0.837	0.521	0.978
.8176	.3029	6.935	0.371	0.844	0.510	0.968
396.6805	.9809	6.943	0.373	0.849	0.517	0.985
.7145	.0469	6.935	0.372	0.856	0.506	0.966
.7603	.1362	6.935	0.370	0.845	0.508	0.966
.8194	.2511	6.947	0.360	0.850	0.510	0.978
397.6806	.9257	6.947	0.371	0.847	0.515	0.986
.7539	.0683	6.930	0.365	0.857	0.503	0.971

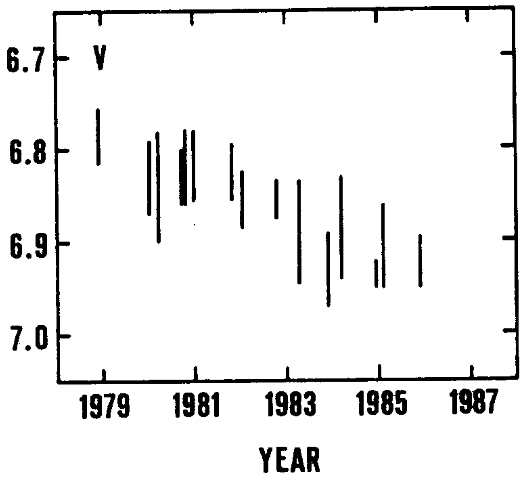

Figure 2: Collection of all published photometric data of AB Dor. The vertical bars indicate the peak-to-peak V amplitude of the light curves.

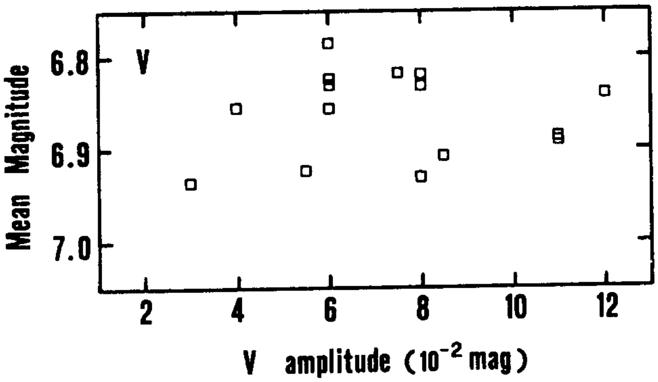

Figure 3: Mean V magnitude of AB Dor as a function of the corresponding peak-to-peak V amplitude.

In Figure 2 collection of all published photometric data of AB Dor is presented, with vertical bars indicating the peak-to-peak amplitude of the light curves. It is evident that the mean magnitude of AB Dor has been increasing during the last seven years. Clearly, the degree of spottedness has been increasing, but no systematic correlated change of the light curve amplitude is apparent. This is shown in Figure 3, where the peak-to-peak V amplitudes of the light curves and the corresponding mean magnitude are reported. The uncorrelated behaviour of the light curve amplitude and mean V magnitude suggests that the spot areas form at different longitudes and/or latitudes. In fact, spot surface distributions leading to the same mean magnitude and different amplitude or to the same amplitude and different mean magnitude appear to occur. We are developing a quantitative analysis of this behaviour in terms of differential rotation.

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A PERIOD DETERMINATION FOR THE ECLIPSING BINARY NSV 03005

In March 1988, NSV 03005 (BD +17° 1281, HD 258878, SAO 095781), +8.2 V, F2II, was discovered to be a probable long-period eclipsing binary with an amplitude of $1^{m}.8$ and eclipse duration of 12-14 days (Kaiser et al. 1988). I have now searched the Harvard Photographic Plate Collection for addition minima. The variable was estimated on 577 plates of the AC series, 1898-1952, and 177 plates of the Damon series, 1967-1988, using the B magnitudes of comparison stars previously reported (Table I, Kaiser et al. 1988). NSV 03005 appeared at maximum, +9.0 m_b, on almost all plates. Six plates showed the variable considerably fainter:

TABLE I.

JD 2400000+	m_b	E	Phase
15777.703	+10.3	0	-0.0013
18295.829	10.9	2	-0.0005
20815.817	10.0	4	+0.0017
22072.548	10.8	5	+0.0003
27106.639	10.5	9	+0.0002
27107.647	10.6	9	+0.0010

A period of $1258^{d}.56$ fits these observations and the minimum observed by Kaiser et al. (1988), JD 2447243.4. Times of primary minima are represented by the elements:

$$JD_{min} = 2415779.4 + 1258^{d}.56\ E$$

Epoch numbers and phases calculated from this ephemeris are noted in the Table. The next primary mid-eclipse is predicted for 2 September 1991.

One of the Damon plates was exposed just five days prior to the observed mid-eclipse date of 23 March 1988. No dimming of the variable was detected on this plate by visual inspection. The observations in the Table show that the variable is $>1^{m}.0$ fainter than maximum within two days of minimum. I concluded that plates within three days of mid-eclipse would clearly reveal minima. Within this $\pm 3^{d}$ range, plates showing the variable at maximum were found to eliminate all the sub-multiples of the derived period from 1/2 to 1/20 P.

The good agreement of faint observations with a constant period and the fact that the star is faint on less than 1% of the plates strongly support the classification of NSV 03005 as an eclipsing binary.

I wish to thank curator Martha Hazen for permission to use the Harvard Photographic Plate Collection and for her assistance, as well as Marvin Baldwin and David Williams for checking the results.

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FURTHER OBSERVATIONS, IMPROVED POSITION AND EPHEMERIS FOR THE EW TYPE SYSTEM V728 HERCULIS

(BAV Mitteilungen Nr. 51)

Recently, Nelson, Milone and Penfold (1988) reported on BVI photometry and spectroscopy of the short-period eclipsing binary V 728 Her (= SVS 2086). They noted that the period P = 0ᵈ446250 quoted by its discoverer (Kurochkin 1977), fails to represent the observations. However, the preliminary period of P = 0ᵈ471302 obtained by Nelson *et al.* was still inadequate to fit the observed times of minimum. Differential UBV photometry -albeit of very poor quality- of V 728 Her had already been secured by Ciardo *et al.* (1985) who also suggested a longer period (around 0ᵈ4747).

To derive an adequate ephemeris for V 728 Her, we have collected all available epochs of minima from the literature (Table 1). For the photographic observations, these are epochs of faint light on photographic plates. Application of a simple least-squares period search algorithm led to a period close to that found by Nelson *et al.* (1988). Both the periods quoted by Kurochkin and Ciardo *et al.* turned out to be spurious periods caused by interference with the sidereal day and a gap of one month between successive observational series, respectively. The time span covered by photoelectric observations proved adequate to define the period with an accuracy sufficient to bridge the gap of 11 years to Kurochkin's estimates on plates obtained with the 40cm astrograph at the Krim station of the Sternberg Intitute, and, subsequently, even 80 years backward in time, to the old plate collection ("S" series) of Moscow Observatory (cf. Kurochkin, 1977).

To test the new ephemeris, we reobserved V 728 Her with the automatic photoelectric telescope at F. Agerer's private observatory (for a description see Agerer 1988a). The telescope used was a 0.35 m Schmidt-Cassegrain. The photometer was equipped with an EMI 9781B tube and Schott filters BG12 (1mm) + GG385(2mm) for the B and GG495(1mm) for the V colour, the size of the diaphragm was 32". The differential instrumental magnitudes have been transformed to the international UBV system. The light curve, reduced with the new period, is shown in Fig.1. The amplitudes in B and V are 0ᵐ39(0ᵐ38) resp. 0ᵐ36(0ᵐ35); the values given in parentheses apply to minimum II which

Table 1. Observed times of minima for V 728 Her, epochs and residuals computed with respect to the ephemeris (1) and (2) derived in this paper

No.	JD helioc.	Min	Type*	Epoch	(O-C)1	(O-C)2	Observer	Source
1	2417796.394	II	P:	-61860	+0.024		N.E.Kurochkin	PZP 3.212
2	40361.509	II	P	-13980	+0.003			
3	40809.460	I	P	-13029	-0.002			
4	40810.405	I	P	-13027	+0.000			
5	40827.372	I	P	-12991	+0.001			
6	41062.573	I	P::	-12492	+0.031			
7	41533.337	I	P:	-11493	-0.019			
8	41567.287	I	P	-11421	-0.002			
9	41571.292	II	P	-11413	-0.003			
10	41957.241	II	P::	-10594	-0.036			
11	45882.375	I	E:	- 2265	-0.001	+0.0024	Ciardo *et al.*	ASS 111.123
12	46257.7518	II	E	- 1469	-0.003	-0.0006	D.R.Faulkner	PASP 98.691
13	46612.868	I	E	- 715	+0.000	+0.0011	Nelson *et al.*	IBVS 3201
14	46613.809	I	E	- 713	-0.002	-0.0005		
15	46949.835	I	E	0	-0.002	-0.0019		
16	47304.469	II	E::	752	-0.010	-0.0111	R.Diethelm	BBSAG 88
17	47353.4937 B	II	E	856	+0.001	-0.0002	F.Agerer	this paper
	.4937 V				+0.001	-0.0002		
18	47365.5121 B	I	E	882	+0.002	+0.0003		
	.5128 V				+0.003	+0.0010		
19	47366.4537 B	I	E	884	+0.001	-0.0006		
	.4565 V				+0.004	+0.0022		
20	47378.4726 B	II	E	909	+0.002	+0.0004		
	.4733 V				+0.003	+0.0011		

*) P denotes pg plate min. (weight 2 or 1), E photoelectric min. (weight 100 or 25). Minima marked ":" received reduced weight, while those marked "::" were discarded. as outliers. The epoch given by Diethelm (1988) is based on a very small number of measurements and was therefore considered unreliable.

is only marginally shallower. Four epochs of minima derived from our observations are listed in Table 1; these were used to further refine the orbital period of V728 Her by the method of least squares. We give as best overall linear ephemeris, covering an interval of eighty years,

$$\mathrm{Min\ I} = 2446949.837 + 0^{d}4712852 * E \qquad (1906\text{-}1988). \qquad (1)$$

Instantaneous elements, computed from photoelectric minima only, are

$$\mathrm{Min\ I} = \underset{\pm 4}{2446949.8370} + \underset{\pm 4}{0^{d}4712868} * E \qquad (1984\text{-}1988). \qquad (2)$$

It seems that the period has been constant within $2 \cdot 10^{-5}$ days during the last 80 years. Contrary to the suggestion of Nelson *et al.* (1988), there is no need to include a quadratic term in the ephemeris formula.

Although the variable is correctly identified on the chart provided by Kurochkin (1977), the position quoted in that paper (and in the GCVS) pertains to another star, much fainter and about 3 arc minutes south of V 728 Her. From a Palomar Sky Survey print (PSS E-1135, +42° 17h 00m) we have re-

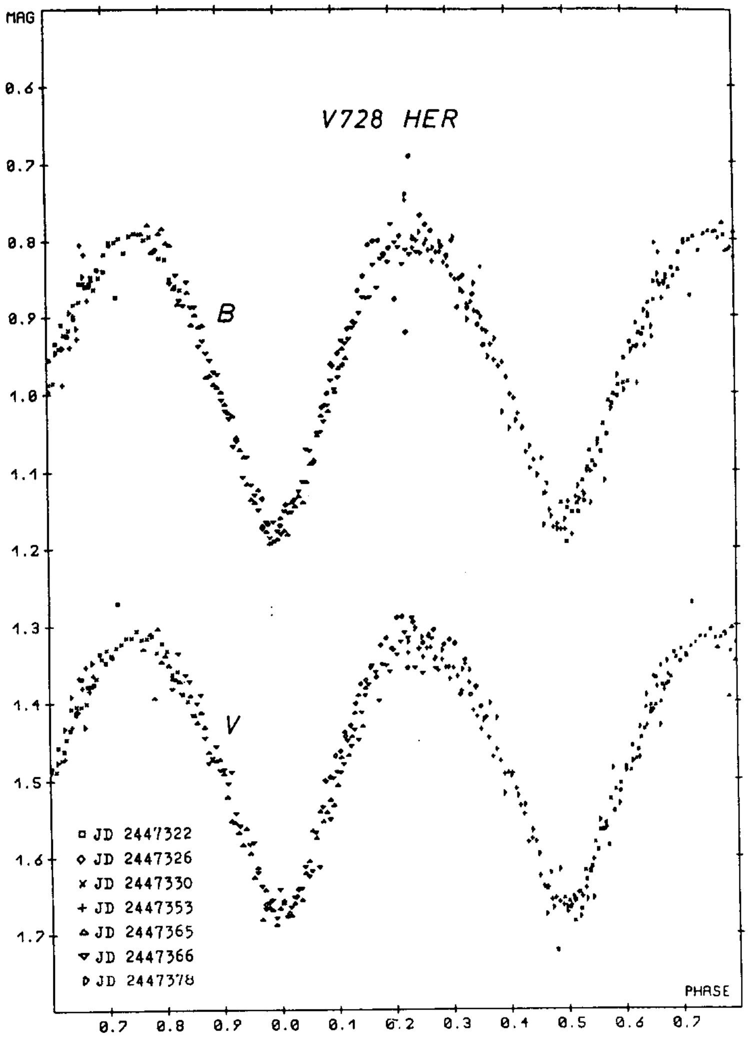
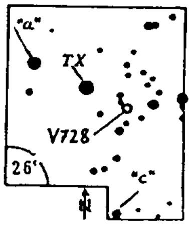


Figure 1. Differential B and V light curves of V 728 Her.
The comparison star is the star marked "a" in Fig. 2

Figure 2. Comparison star chart, after Kurochkin (1977)



determined the position of the variable through differential measurements against 11 AGK3 stars distributed within a field of 1°×1° around V 728 as

$$\alpha_{1950} = 17^{h}16^{m}30^{s} \qquad \delta_{1950} = +41^{\circ}53'.8\ .$$

Subsequently V 728 Her could also be identified among the stars contained in the *Cat. Photogr. du Ciel*, *Zone de Helsingfors*, on Clichés 723 (No.206), 726 (No.100) and 730 (No.18). For each plate we performed a standard astrometric plate reduction using reference stars taken from the AGK3 (some 30 stars per plate) and the published x,y coordinate measurements. From the measured coordinates of V728 Her we then deduced as mean position

$$\alpha_{1900} = 17^{h}14^{m}54.^{s}76 \qquad \delta_{1900} = +41^{\circ}56'58''.5\ ,$$
$$\pm 2 \qquad\qquad\qquad\qquad \pm 2$$
$$\alpha_{1950} = 17^{h}16^{m}29.^{s}52 \qquad \delta_{1950} = +41^{\circ}53'46''.0\ .$$

This is consistent with the above given approximate PSS coordinates. The epoch of the *CdC* position is 1892.7, that of the PSS plate is 1954.5.

The tables containing the individual observations in B and V will be published separately (Agerer 1988b).

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VARIABILITY IN THE HIGH LATITUDE Be STAR JL212 (=CPD-56°154)

Star number 212 in the survey by Jaidee & Lynga (1969) has Strömgren photometry by Kilkenny (1984) which indicates it to be of spectral type near B2. An analysis by Keenan, Dufton & McKeith (1982) found JL212 to have normal abundances for a population I star although it apparently lies at z = -3.2 kpc from the galactic plane. They also noted that differences between surface gravity determinations using spectroscopic measurements of Hε and photometry of the Hβ line suggested that JL212 might be an emission line star. Subsequently, spectroscopy by Kilkenny & Muller (1988) showed that JL212 did indeed have Hβ in emission. Keenan et al (1982) found (T_{eff}, log g, V sin i) = (19200, 3.7, 219) from high dispersion spectroscopy; using moderate dispersion (30 A/mm) Kilkenny (1989) obtains (17500, 3.5, 225) with a distance from the galactic plane z = -3.3 kpc, which is in good agreement with the Keenan et al (1982) result and is also extremely unusual for a Be star.

A very similar star, SB357 (=CD-37°316) at z = -6 kpc has recently been shown by Kilkenny (1988) to be a variable star with no obvious short-term (~ hours) variation but clear variability on a time scale of a few days or longer. It therefore seemed worthwhile to examine the SAAO 'archive' photometry of JL212 in a search for possible variability. The uvby and $UBV(RI)_C$ data are summarised in Tables 1 and 2 where the second row of figures for each date are the standard deviations of the mean values in units of 0.001 mag. All data were corrected to observations of the nearby star CPD-56°153 for which we find:

		s.d	n			s.d	n
V	= 9.802 ±	0.009	44	y =	9.805 ±	0.004	15
(B-V)	= +0.895 ±	0.005	44	(b-y)=	+0.546 ±	0.005	15
(U-B)	= +0.494 ±	0.007	44	m_1 =	+0.258 ±	0.007	15
$(V-R)_C$	= +0.480 ±	0.004	17	c_1 =	+0.439 ±	0.014	15
$(V-I)_C$	= +0.951 ±	0.005	17				

Table 1 Strömgren photometry of JL212 (=CPD-56°154)

HJD	V	(b-y)	m_1	c_1	n
2444109.51	10.320	-0.062	+0.076	+0.291	2
	2	1	4	2	
4119.54	10.345	-0.067	+0.089	+0.277	5
	5	3	5	8	
4120.58	10.340	-0.065	+0.080	+0.281	2
	2	1	2	7	
5251.43	10.313	-0.060	+0.087	+0.261	1
5252.45	10.318	-0.065	+0.085	+0.278	1

Although CPD-56°153 is not an ideal comparison star for JL212, being much redder (early K by colour) it is of similar brightness and is only ~ arcminutes away from JL212. CPD-56°153 was always reduced to the usual 'all-sky' standards for UBV$(RI)_C$ (Menzies, Banfield & Laing 1980) and uvby photometry (Crawford & Barnes 1970) and appears to be of constant brightness.

For JL212 there is only one reasonably long sequence of monitoring, that on HJD 2447005, which shows no variation bigger than about 0.01 mag over ~2.5 hours. From night to night comparison, it seems quite clear that JL212 is variable with an observed range of ~0.04 mag. The data obtained are from 1979, 1981 and 1982 (uvby) and 1987 (UBVRI) and show no sign of the much larger scale variations (~0.2 mag) seen in SB357.

Table 2 UBV(RI)$_c$ photometry of JL212

HJD	V	(B-V)	(U-B)	(V-R)	(V-I)	n
2447005.51	10.329	-0.158	-0.646			28
	3	3	3			
7006.62	10.330	-0.155	-0.653			6
	1	3	3			
7007.62	10.341	-0.160	-0.656	-0.070	-0.163	1
7009.61	10.323	-0.158	-0.652			11
	4	4	4			
7011.58	10.326	-0.165	-0.654			7
	3	5	4			
7013.55	10.343	-0.154	-0.651			4
	2	4	3			
7021.62	10.321	-0.157	-0.651			18
	5	6	3			
7023.59	10.316	-0.152	-0.661	-0.061	-0.142	2
	4	1	4	10	4	
7025.62	10.351	-0.158	-0.656	-0.063	-0.145	8
	2	5	2	5	9	
7068.49	10.356	-0.155	-0.650	-0.065	-0.150	2
	2	1	1	8	9	
7070.52	10.347	-0.157	-0.647	-0.071	-0.149	2
	1	1	1	1	9	
7071.47	10.351	-0.164	-0.646	-0.068	-0.156	2
	2	2	1	2	4	
7078.43	10.309	-0.161	-0.654	-0.061	-0.139	2
	6	6	2	3	8	

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SEARCH FOR SHORT TIME SCALE LIGHT VARIATION IN HD 183339 AND HD 184927

Two Bp stars, the He-weak HD 183339 and the He-rich HD 184927 was investigated for rapid light microvariability at Piszkéstető Observatory. Rapid light variation is a common phenomenon at late Ap stars, but Kurtz (1988) reported only negative results in searching for microvariability in stars, earlier than the blue edge of the delta Scuti instability strip.
On the contrary, Panov (1984) found rapid light variation in two peculiar B stars: ET And (B9p He-weak, Si) and HD 183339 (B8p He-weak Si) on a time scale of a few minutes and with a range of 1-2 mmag.

The investigation reported in this note was an experiment with the 1m telescope and the new UBVRI, cooled, photon counting photometer to test its accuracy and ability for such measurements.

HD 183339

The B8 He-weak, Si star is spectrum and magnetic field variable (Glagolevskij 1984) with a supposed rotation period of 6-8 days. Panov (1984) found possible periods of 15.5 min, 12.6 min, 10.7 min and 8.5 min for rapid light variations in U and B colours, with an amplitude of 2 mmag.

The star was observed on the night May 8/9, 1988, with a coverage of three hours in UBV colors. The comparison star was HD 184240. Five second integration was used in each colour in the sequence C-B-P-C-B-..., where C, B and P notes comparison, background and program star. The magnitude differences show 0.015 mag noise, but the light curve did not show periodicity. In the power spectra of the magnitude differences peaks appeared at 4.5 min, 13 min in U, and at 4.2 min, 11.5 min and 20 min in B colour (see Figures 1 and 2) with an amplitude of 2-3 mmag. In V there were no peaks higher than 1 mmag.

Because of the high noise level the separate analysis for the programme and comparison star could not be carried out. The results are similar to those of Panov but this confirmation is not too strong.

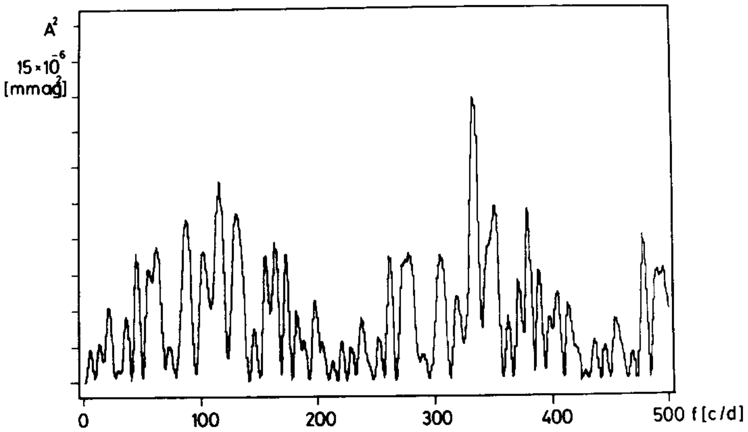

Figure 1

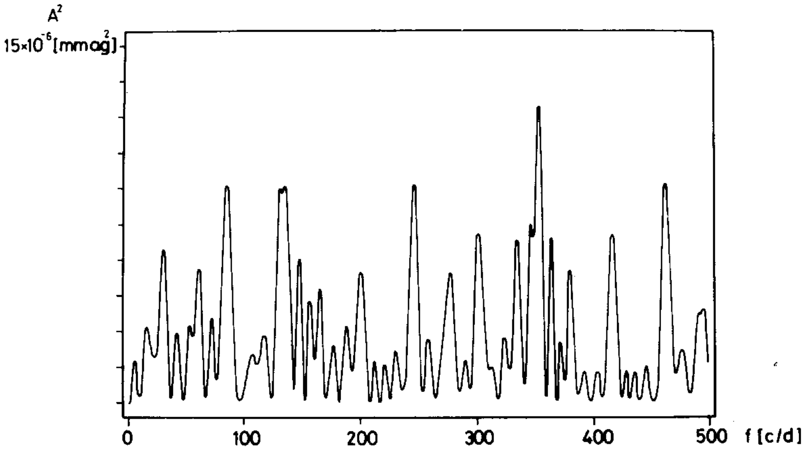

Figure 2

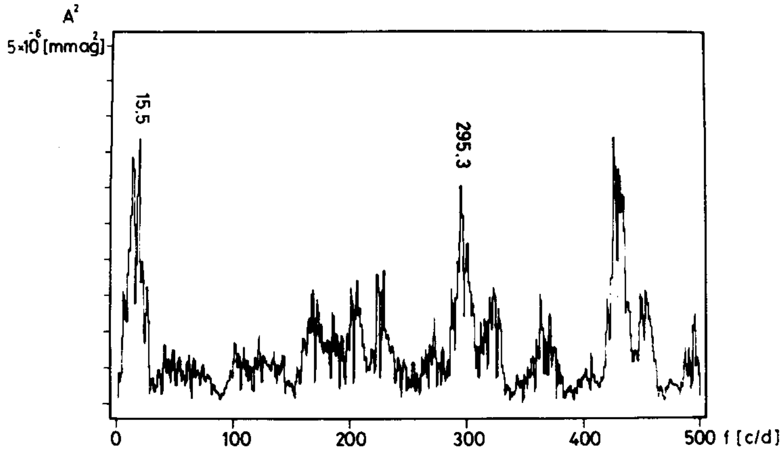

Figure 3

HD 184927

The star is a well known B2p He-rich star with a rotation period of 9.53 days. Photometric, spectroscopic and magnetic field changes coexist with the same period (Levato and Malaroda, 1979).

The investigation for rapid light variation was carried out on July 28/29 1988, for two and a half hours with two comparison stars. On other two nights, on July 31/August 1 and August 14/15 the star was measured with only one comparison star, C2, for one and half hours. The comparison stars were HD 185224 as C1, and HD 185174 as C2. The observations were only limited to the U colour of the UBV photometric system. Ten second integration was used in the sequences C1-C2-B-P-C1-C2-B-...,C2-B-P-C2-B... on the first and the two other nights, respectively.

The fluctuation of the magnitude differences usually reached 15-20 mmag, on the individual nights but the light curve did not look periodic. The results of the Fourier analysis (see Figure 3) show only noise on the night of July 28/29. On the two other nights the power spectra contain peaks at 4.2 min, 8 min and 1 hour. On the basis of the analysis it is possible that none of the investigated programme and comparison stars has a light variation larger than 3 mmag.

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THE FIRST PHOTOELECTRIC LIGHT CURVE OF V 456 OPHIUCHI

The detached eclipsing binary V 456 Oph (=BD+08°3814) seems to be observed first photographically by Kapko in 1949 (see the 1958 and 1969 editions of the General Catalogue of Variable Stars). Kapko found that the photographic light curve is of Algol type with partial eclipses (d=0), and the range of light variation being $m_{ph}=10^{m}.2-10^{m}.7$ at the primary minimum and $10^{m}.2-10^{m}.5$ at the secondary minimum. The GCVS 1958, 1969 gave the light elements as

Min I = Hel. J.D. 2428422.341 + $1^{d}.015986$ E.

No other observations of this neglected binary system have appeared in the literature until 1973 when one of us (O.D.) observed the primary and secondary eclipses of the system in BV filters (c.f. Kizilirmak and Pohl, 1974, 1975). The minimum times were delayed, with respect to the given ephemeris, by about four hours. Times of eclipse minima were determined as

Prim. Min. = Hel. J.D. 2441897.534 and 2441951.383
Sec. Min. = Hel. J.D. 2442239.410

Such a big delay in the eclipse minima suggests an increase in the orbital period of the system. The new period is estimated roughly as P=$1^{d}.0159989$. Such a delay in the eclipse minima could also be caused by the probable errors in the light elements given by Kapko, because his photographic observations could not be as accurate as the present observations. However, Diethelm (1981) reported the new light elements as

Min I = Hel. J.D. 2441897.532 + $1^{d}.0159996$ E

which were determined by using mostly our observations. The GCVS 1985 cited Diethelm's light elements for V 456 Oph, and noted a variable period.

We included V 456 Oph in our program and observed it in BV filters on twelve night between May 20 and July 19, 1988. Thus, we secured the first whole photoelectric light curves of the system in two colours. The differential observations were made with respect to the comparison star BD+08°3824 by checking against the nearby check stars BD+08°3813 and BD+08°3809. The compa-

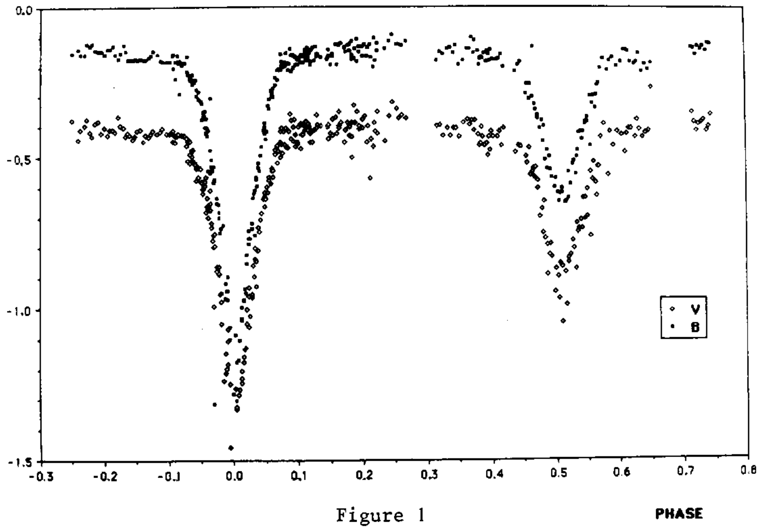

Figure 1

rison was found to be constant during the observations. The observations were made by using an EMI 9789 photomultiplier attached to the Maksutov telescope of the Ankara University Observatory. 365 differential observations have been secured in each colour. The observations were corrected for differential extinction and are shown in Figure 1. The phases were calculated by using the above cited Diethelm's light elements.

We thank to G. Kahraman, for the generous help during the observations. The period and light curve analysis of the system is in progress and will be published elsewhere in the future.

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FAST CHANGES IN THE SHAPE OF THE LIGHT CURVE OF THE OLD NOVA V603 Aql

V603 Aql (Nova 1918) is a relatively little studied object despite being the brightest old nova. In particular it was only in 1985 that it was found that its photometric and spectroscopic periods differ by several percent (Häfner and Metz 1985). In this short communique we report preliminary results of 9 white light photometric runs obtained in July/August 1988 and spanning 29 days altogether (Table 1). With the double beam photometers we observed simultaneously V603 Aql and the comparison star BD+0°4026. On all occasions 20 seconds integration times were used. In order to remove effects of atmospheric extinction we divided variable star counts by comparison star counts.

In Figure 1 samples of our results are presented. In particular we would like to draw attention to substantial changes in the shape and amplitude of light curves obtained on consecutive nights. On the one hand presence of such changes interferes with the study of the photometric period, to the extent of it being indetectable on some occasions (Slovak 1981). Thus one of our motivations to reobserve this star was to confirm Häfner and Metz findings. On the other hand presence of the changes and difference of the two periods point to some mechanism of light variation independent of orbital motion. Were the mechanism related in one or other way to accretion, modulation of the light curve by changes in the accretion rate would arise in a natural way.

Apart from the periodic variations some light curves exhibit violent flickering. Any effects of the instrumental origin are less than 0.01 mag in amplitude as may be appreciated by looking on the uncorrected for extinction comparison star light curve obtained simultaneously and presented also in Figure 1.

The observations were obtained with the twin 60-cm telescopes of High Pedagogical School (WSP) in Cracow and Warsaw University Observatories located respectively at Mt. Suhora 70 km south of Cracow and at Ostrowik near Warsaw. At Mt. Suhora we used a double beam photometer donated by the European South-

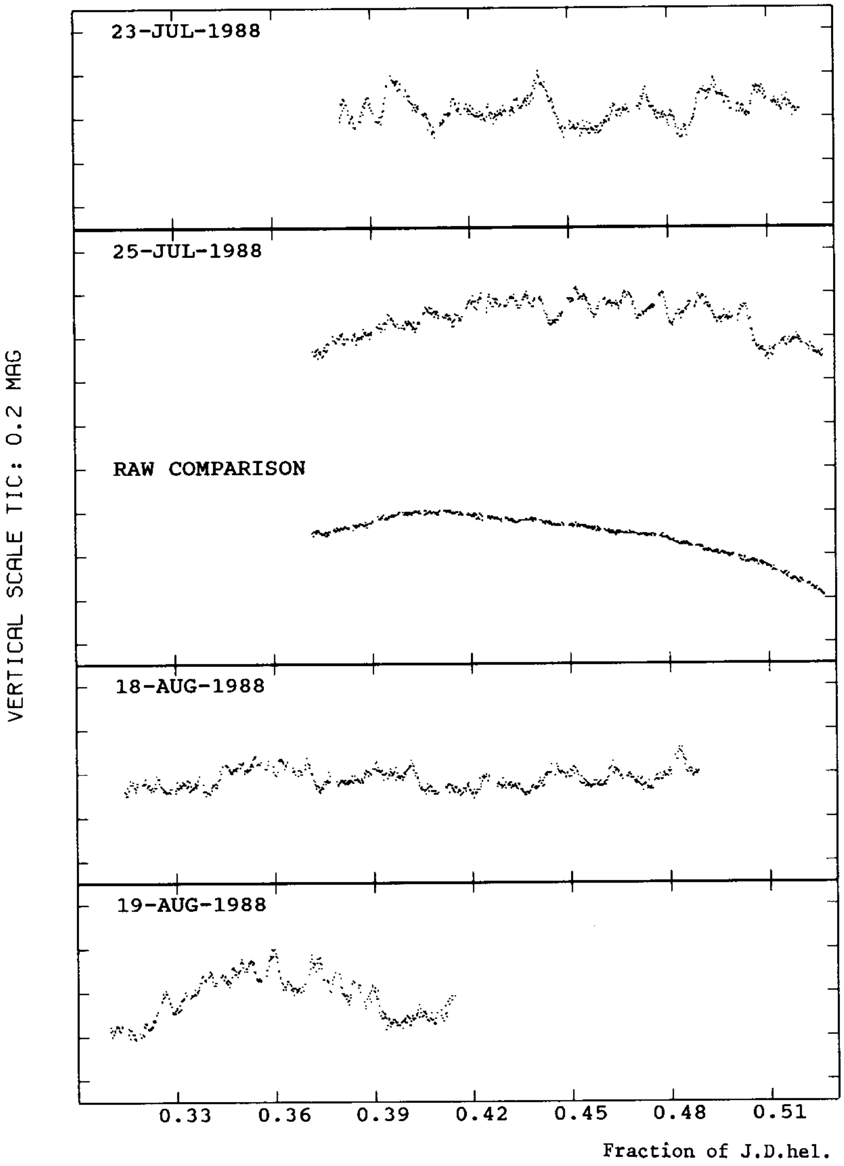
23-JUL-1988
25-JUL-1988
RAW COMPARISON
18-AUG-1988
19-AUG-1988
VERTICAL SCALE TIC: 0.2 MAG
0.33
0.36
0.39
0.42
0.45
0.48
0.51
Fraction of J.D.hel.

Figure 1

Table 1. Journal of the Observations.

No.	Date	Run Start (J.D.hel.–2447300)	Duration (day)	Telescope
1	1988–07–23	66.381	0.139	Mt. Suhora
2	1988–07–25	68.372	0.155	Ostrowik
3	1988–07–26	69.358	0.171	Ostrowik
4	1988–08–14	88.339	0.161	Ostrowik
5	1988–08–17	91.318	0.019	Mt. Suhora
6	1988–08–18	92.315	0.173	Mt. Suhora
7	1988–08–19	93.310	0.104	Mt. Suhora
8	1988–08–20	94.311	0.154	Mt. Suhora
9	1988–08–21	95.324	0.147	Mt. Suhora

ern Observatory to Warsaw Observatory following the initiative and through the action of Prof. Edward H. Geyer. The Ostrowik double beam photometer and the data acquisition systems for both telescopes were developed in Warsaw University Observatory (Szymański and Udalski 1988). Observations at Mt. Suhora were possible thanks to the invitation to collaboration by the Director of the new observatory, Prof. Jerzy M. Kreiner. Support from grant CPBP 164 is gratefully acknowledged.

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PHOTOMETRY OF CATACLYSMIC VARIABLES.
III. PHOTOMETRY OF SU UMa DURING NORMAL OUTBURST

SU UMa is a prototype of a subclass of dwarf novae. Beside normal outbursts, stars of this group undergo longer and brighter eruptions called superoutbursts. During a superoutburst periodic light variations (superhumps) appear in the light curve. They usually have an amplitude up to 0.3 mag and a period several percent longer than the orbital one.

Although SU UMa is a relatively bright dwarf nova ($V \approx 14.5$ mag at quiescence, $V \approx 12$ mag in normal outburst and $V \approx 11.3$ mag at superoutburst) very few photometric observations can be found in the literature. In particular no superhumps – one of the main properties of the SU UMa type stars – have been detected in SU UMa itself until now.

The new photometry of SU UMa was carried out on 12 December 1987 during normal outburst of the star. More than 7 hours photometric run was collected using double channel photometric system attached to the 60-cm telescope of Ostrowik Station of the Warsaw University Observatory. 11-th mag. star located 42^sE and 14'S from SU UMa served as a comparison star monitored simultaneously in the second channel. Its constancy was checked by comparison with BD 63°769 several times during the night. No variations of comparison star greater than 0.015 mag were found. Observations were obtained in white light with 20 seconds integration time.

The results were reduced in the standard way: net counts of SU UMa were divided by averaged net counts of the comparison star. Then they were crudely corrected for differential extinction and left in arbitrary units. Several measurements of SU UMa in the V filter carried out at the beginning of the observations yielded $V \approx 12.2$ mag.

Figure 1 shows the light curve of SU UMa. As it can be noted obervations were done after the maximum of brightness; the mean light level was fading with the rate of about 0.03 mag/hour. Beside that variation, brightness changes with an amplitude up to 0.2 mag and time scale of several minutes are visible. To find possible periodicities we performed Fourier analysis of the data. The computed power spectrum (in arbitrary units) is presented in Figure 2.

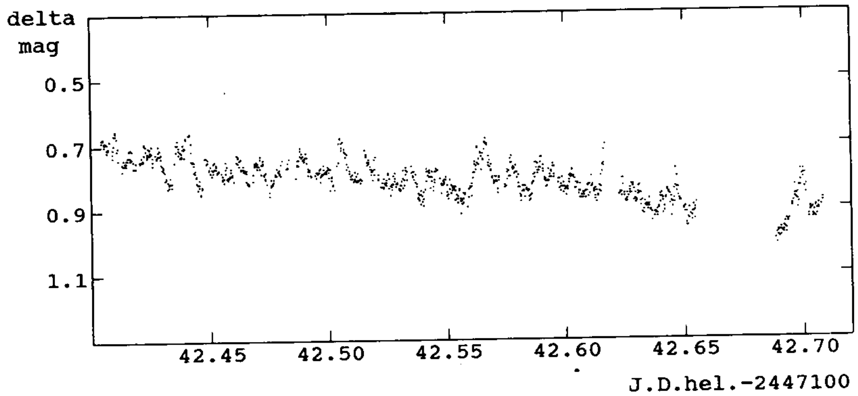

Figure 1

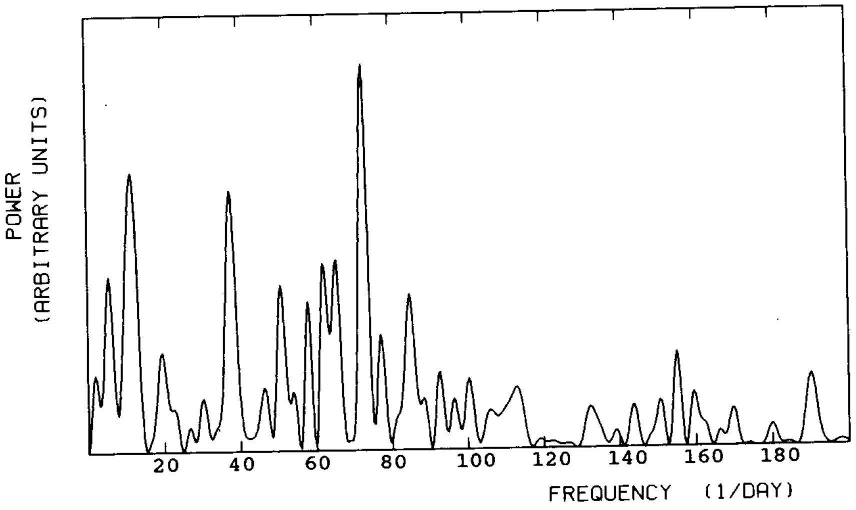

Figure 2

Period analysis can be summarized as follows:

- the nearest peak to the suspected orbital period of SU UMa (110 min – Thorstensen *et al.* 1986) corresponds to the period 124 min. Although Barwig and Schömbs (1981) found similar period (120 min ± 10%) we do not refer these variations to the orbital period. Probably moderate orbital inclination (≈ 45° Thorstensen *et al.* 1986) prevents any variations of light with the orbital period.

- the most prominent peaks in the power spectrum correspond to periods equal to 19.5 and 38 min. Short time scale variations in SU UMa light curves were previously reported by Mumford (1964) (in quiescence state) and Barwig and Schömbs (1981) (in quiescence and during rise to superoutburst). Barwig and Schömbs detected period equal to 13 min, Mumford mentioned variability with the period of about 10 ÷ 20 min. Present observations suggest P=38 min as a fundamental one; 19.5 min period might be interpreted as its first harmonic and the period found by Barwig and Schömbs as 1/3 P.

Among cataclysmic variables the intermediate polars reveal similar to SU UMa minutes periodicities (eg. TV Col – 32 min, AO Psc – 13 min). In these stars minutes periods are interpreted as a rotational period of the white dwarf primary. By the analogy, 38 min period of SU UMa could represent the white dwarf rotation period and the star might be classified as an intermediate polar. Relatively strong X-ray emission observed by Cordova and Mason (1983) may support this interpretation to some extend.

Although 'classic' intermediate polars do not undergo outbursts and superoutbursts, at least one object – SW UMa – shares characteristics of both intermediate polars and SU UMa type stars (Robinson *et al.* 1987). SU UMa could be the second object of such type.

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THE VARIABLE STAR 42 PERSEI

Following the suggestion of Batten (1987), we have made photometric and spectroscopic observations of the photometrically variable single-lined spectroscopic binary 42 Persei = HR1177 = HD23848 = V467 Persei.

Differential V-filter photometry was carried out on ten nights between January and March, 1988, using the 0.5-m telescope at the Devon Astronomical Observatory. HR1164 was used as the comparison star.

A total of nine spectroscopic observations were made during five nights in February, 1988, using the Reticon detector and the Cassegrain spectrograph (reciprocal dispersion = 1.5 nm.mm^{-1}) on the 1.85-m telescope at the Dominion Astrophysical Observatory, Victoria. Radial velocities have been determined using a cross-correlation technique. (Additional spectroscopic observations were made in August, 1988, but those data have not been reduced as yet).

Analyses of both our new photometric and spectroscopic data sets support Batten's conclusion that the $1\overset{\mathrm{d}}{.}765346$ spectroscopic orbital period found by Morbey and Brosterhus (1974) is correct and that it does fit the light, as well as the radial velocity, variations.

The raw -- not transformed to the standard UBV system -- v magnitude differences in the sense HR1164 - HR1177 are plotted in Figure 1. The Δv values have been phased from periastron passage, T = JD2437640.03, using $p = 1\overset{\mathrm{d}}{.}765346$ as given by Morbey and Brosterhus, and have been averaged over phase intervals of 0.05 P. Minimum light occurs between phases 0.5 and 0.6 which, within the uncertainties of this limited data set, coincides with primary conjunction in the spectroscopic orbit. The large scatter in the plotted data is due, in large measure, to the observations having been made at large zenith distances near the end of the observing season.

Our new spectroscopic data suggest the need for a very small correction of $+0\overset{\mathrm{d}}{.}000005$ to the orbital period, but no other significant changes to the previously published orbital elements.

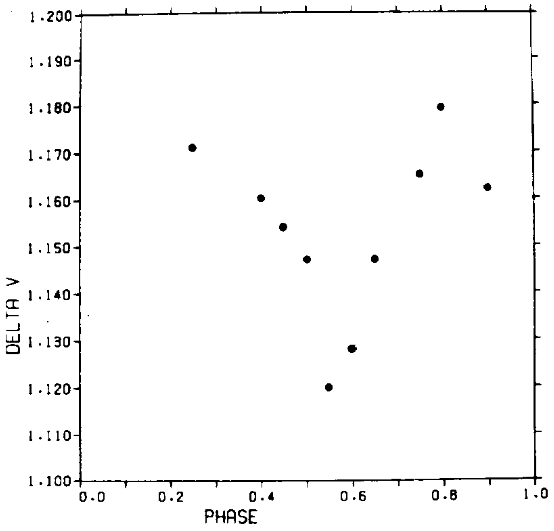

Figure 1. Visual magnitude differences between HR1164 and 42 Per.

Our results are consistent with Batten's conclusion that 42 Per is probably an ellipsoidal variable. During the coming observing season we intend to obtain complete, multi-colour light curves in collaboration with R. Wasson, Sunset Hills Observatory, California, and with W.S. Barksdale, Florida. A more detailed analysis and discussion of the combined spectroscopy and photometry will be published elsewhere.

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ON THE ASSOCIATION MEMBERSHIP OF THE CEPHEID IR Cep

Although the Cepheid variable IR Cephei (HD 208 960 = BD + 60° 2321 = HBV 476) is rather bright (its mean brightness is $7\overset{m}{.}8$ in V), it has been neglected by the observers. The available observational material consists of three series: one set of photographic maxima (Klawitter, 1971), and two series of photoelectric UBV data (Wachmann, 1976; Szabados, 1977). No radial velocity or other detailed spectroscopic observation has been made as yet. This short period ($P = 2\overset{d}{.}114$) Cepheid variable, however, deserves special attention on account of two facts.

1. IR Cephei is located in the region of the Cepheus OB2 association, as was first pointed out by Antonello and Poretti (1986).

2. This star belongs to the group of the small amplitude Cepheids but unlike most s-Cepheids, IR Cep has a non-sinusoidal light curve. Its light curve resembles that of the normal (large amplitude) classical Cepheids but with a reduced amplitude. Such an effect can be expected if the variable star has a bright companion.

Since Antonello and Poretti (1986) did not perform the distance determination but only guessed the distance of IR Cep based on the possible reddening, it is worth calculating it.

The interstellar reddening in the region of IR Cep was studied by Kun (1982). A small subset of this absorption study is shown in Figure 1, where the colour excess is plotted against the distance modulus (uncorrected for reddening), taking into account the stars within one degree from IR Cep. It is clearly seen from this figure that all the stars in this direction farther away than 400 pc have nearly the same E_{B-V} colour excess, roughly $0\overset{m}{.}3 - 0\overset{m}{.}4$.

In order to estimate the distance of IR Cephei we used two widely accepted forms of the period - luminosity relationship:

$$\langle M_V \rangle = -3.80 \log P + 2.7(\langle B \rangle_o - \langle V \rangle_o) - 2.27 \qquad (1)$$

(Martin et al., 1979, with the zero-point taken from Feast and Walker, 1987), and

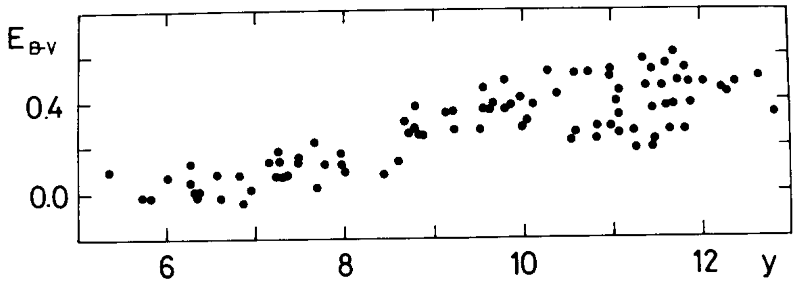

Figure 1. E_{B-V} colour excess vs. $V-M_V$ distance modulus for the stars around IR Cep

$$\langle M_V\rangle = -3.53\ \log P + 2.13(\langle B\rangle_o - \langle V\rangle_o) - 2.13 \qquad (2)$$

(Caldwell and Coulson, 1986, with the zero-point taken from Feast and Walker, 1987).

The following values could be determined from the observations:
mean visual brightness: $7^m.79$,
mean B-V colour index: $0^m.79$.

Assuming an E_{B-V} colour excess of $0^m.35$ (see above), the $\langle B-V\rangle_o$ colour index corrected for the reddening is $0^m.44$. The difference between this value and the value of $\langle B\rangle_o - \langle V\rangle_o$ is negligible as compared with the uncertainty of the colour excess. If we use $R = 3.0$ for the ratio of total to selective absorption, the distance of IR Cep is 630 and 650 pc when substituting into equations (1) and (2), respectively.

Recently Böhm-Vitense (1988) proposed that the short period Cepheids are all first overtone pulsators. Taking into account the difference $\log P_1 - \log P_o \approx -0.131$ (Iben and Tuggle, 1975), the distance of IR Cep would be 790 and 810 pc as derived from equations (1) and (2), respectively. Taking into account the $0^m.1$ uncertainty in the colour excess, and the possible deviation from the uniform $R = 3.0$ law, the estimated error of these distances is about ±40 pc.

The average distance of the Cep OB2 association was determined by Simonson (1968). He obtained about 800 pc for the distance of the centre of the association but the extent of the association is very large along the line of sight: the stars are spread over the range from 590 and 1100 pc.

In any case IR Cep is situated inside the boundary of Cep OB2 association. The apparent position in space, however, is not enough to make any statement whether IR Cep belongs to the association or not. Let us consider another criterion, viz. the age of the objects.

The age of the Cep OB2 association is in contradiction with the expected age of the Cepheid variables. Cep OB2 consists of two subgroups of different ages, and IR Cep is situated in the older subsystem which is about 6-7 million years old (Simonson, 1968), while according to the period - age relationship of the Cepheids (Kippenhahn and Smith, 1969) IR Cep is as old as about 90 million years. Based on this age criterion alone, it is impossible that IR Cephei is a physical member of Cep OB2.

Although, owing to this latter fact, it is improbable that IR Cep belongs to the Cep OB2 association, spectroscopic measurements are still necessary. There are only two rough estimations for the spectral type of IR Cep in the literature: Buscombe (1984) gives G0II with a comment that this value is somewhat uncertain, while Kun (1982) determined a spectral type of F8 from an objective prism spectroscopic survey. This latter value is in a better agreement with the spectral types of other low amplitude Cepheids than that of Buscombe. The spectroscopic data (including radial velocities) would give us important information about the possible companion to this variable that might cause the low-amplitude, non-sinusoidal light curve.

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OPTICAL BEHAVIOUR OF THE POLAR ST LEONIS MINORIS=CW 1103+254 IN THE SEASON 1988

In linking to the sequence of comparison stars given in the IBVS No. 2735 the star was measured on 17 blue-sensitive plates (ORWO-ZU21+GG13+BG12) from 11 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 14 February 1988 and 12 May 1988. The individual observations are listed in Table I. The "fainter than" observations marked by > are from plates on which the star is invisible.

Table I

J.D.hel. 244...	m_B	J.D.hel. 244...	m_B	J.D.hel. 244...	m_B
7206.590	16.95	7263.497	>16.57	7268.370	17.48
7206.608	>17.10	7265.473	>16.57	7271.368	>17.10
7207.558	>17.10	7265.494	>16.57	7271.386	>16.88
7262.474	16.59	7266.394	>16.88	7293.369	>17.10
7262.493	>17.10	7267.385	17.09	7294.373	17.08
7263.476	>17.10	7267.406	16.95		

As can be seen from Table I, the star is in its low brightness state.

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DO CEP FLARE MONITORING IN THE 1987-1988 SEASON

In a continuation of the University of Delaware program of photoelectric monitoring of flare stars from Mt. Cuba Observatory, we have returned this season to the initial star in that program, DO Cephei. In 1968 when we observed the first flares to be photoelectrically recorded for that star (Herr and Brcich, 1969), it was surprisingly active. Ten flares were then observed within 27.8 hours of monitoring of the unresolved Kruger 60 AB system through a Johnson U filter. In 1987-1988, only five flares were seen in 30.5 hours, the largest producing only a 0.72 magnitude change in the system. The change, of course, would be larger if the flaring star could be observed alone. In a combination of observations from Mt. Cuba totaling 57.4 hours during the 1970 and 1972-73 seasons, Nicastro (1975) reported 22 flares. The flaring rate and the character of the flares agreed well with the 1969 data. The same EMI 6256S photomultiplier tube, UV filter and 0.6-m telescope were used for all of the above observations.

Table 1. Flares of DO Cep

No.	1987-8 mo da	UT max h m	t_b min	t_a min	Δm mag	P min	Air Mass	JD 244 0000+
1	Oct 26	03:13.9	0.3	0.8	0.21	0.09	1.12	7094.6347
2	Nov 16	04:06.2	0.9	3.8	0.24	0.41	1.38	7115.6710
3	Dec 13	04:47.9	0.4	3.3	0.72	0.65	2.15	7142.6999
4	Dec 14	02:03.5	0.8	3.0	0.35	0.56	1.35	7143.5858
5:	Jan 12	02 06.2	0.9:	2:	0.19	0.39	1.84	7172.5876

: Flare 5 uncertain; see text.

Times, including estimated minutes before and after the maximum, and the magnitude change were measured directly from the original charts. P is the flare's equivalent duration (in minutes of quiescent flux).

Table 1 contains the characteristics of the five flares, and Figure 1 shows plots of their light curves. These plots have been smoothed of high frequency noise using the procedure described in IBVS 3069 (Herr & Opie, 1987) where the relationship of such plots to the actual photometer chart is shown in detail. Only one of the present flares (#3) shows a sharp peak; and, even there, its rate of rise is undramatic. Moreover, No. 5 is of dubious reality, representing only a small, irregular enhancement in a noisy signal.

We thank Conrad Brink for his contributions to this project and the Mt. Cuba Observatory for granting us use of the 61-cm Cassegrain.

Figure 1. Light curves of the five minor flares (see Table 1) normalized to the same scale (1 = UV flux of the comparison star). The average quiescent flux, based on data in Table 3, is 0.78 (0.04 std. dev.) in units of the flux of the comparison star. Vertical error bars indicate the peak-to-peak higher frequency noise (to 1 Hz) present in the original signal.

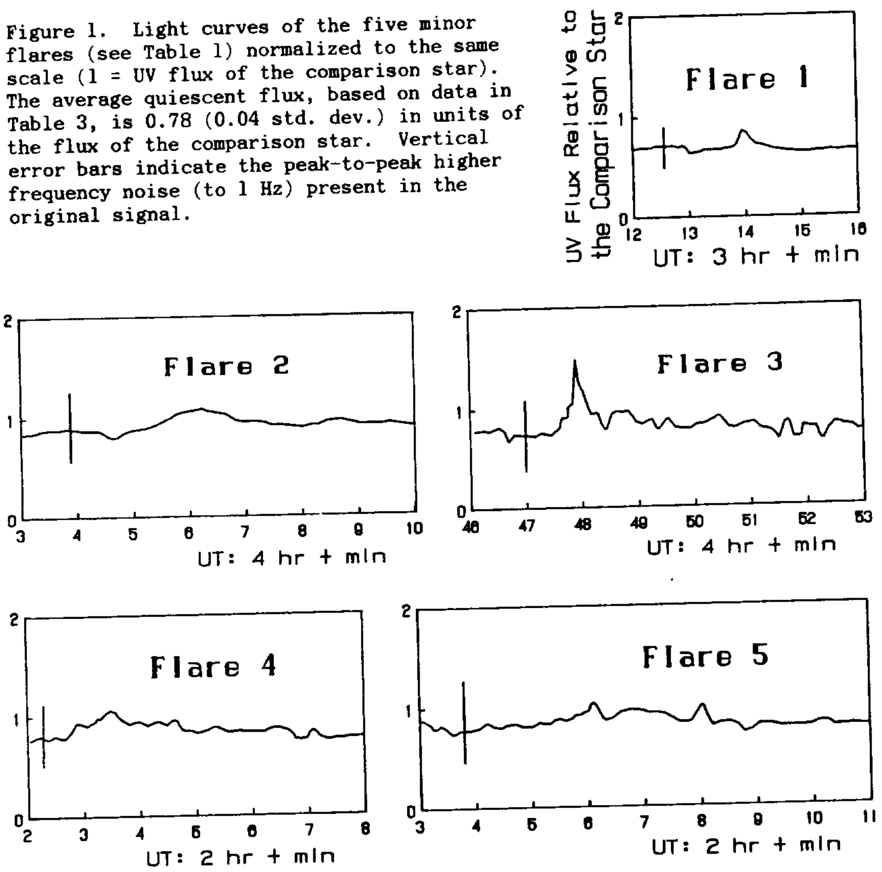

Table 2. Monitoring Coverage in 1987-1988

Date	U.T. in hours and minutes		
Sep. 29	4:05.0- 4:16.0,	4:24.3- 4:36.5,	4:49.6- 4:56.8,
JD 2447067	5:00.3- 5:11.4,	5:24.6- 5:38.1,	5:45.7- 5:58.9,
	6:01.5- 6:13.3.		
Oct. 26	0:28.1- 0:31.7,	0:38.3- 0:49.1,	0:54.3- 1:05.9,
JD 2447094	1:11.2- 1:13.2,	1:18.3- 1:31.0,	1:35.4- 1:36.0,
	1:36.8- 1:48.1,	2:32.8- 2:45.1,	2:52.7- 3:02.8,
	3:07.8- 3:19.6,	3:23.9- 3:36.0,	3:40.1- 3:51.5,
	3:55.3- 4:08.0,	4:11.8- 4:24.0,	4:28.0- 4:40.0,
	4:43.2- 4:57.6.		
Oct. 27	0:48.2- 0:58.2,	0:59.9- 1:09.0,	1:13.9- 1:25.6,
JD 2447095	1:55.0- 2:04.7,	2:21.1- 2:33.5,	2:54.0- 3:05.8,
	3:09.7- 3:24.0,	3:25.1- 3:39.6,	3:41.5- 4:00.0,
	4:05.7- 4:20.3,	4:21.5- 4:35.6,	4:39.1- 4:55.3,
	4:56.5- 5:09.4,	5:12.8- 5:29.0,	5:30.3- 5:35.0,
	5:54.4- 6:06.7,	6:08.2- 6:22.6,	6:26.0- 6:33.7,
	6:35.4- 6:47.0,	6:50.5- 7:13.0,	7:14.8- 7:25.0,
	7:26.7- 7:42.0.		
Oct. 29	0:09.0- 0:21.9,	0:27.8- 0:42.4,	0:43.8- 0:55.7,
JD 2447097	1:00.3- 1:12.0,	1:13.8- 1:25.2,	1:26.5- 1:32.6,
	2:17.9- 2:29.9,	2:35.8- 2:47.8,	2:49.2- 3:02.0,
	3:05.4- 3:08.6,	3:09.5- 3:17.5,	3:19.1- 3:33.9,
	3:35.5- 3:46.9,	3:50.7- 4:04.1,	4:05.5- 4:19.7,
	4:24.2- 4:34.3,	4:35.5- 4:47.0,	4:50.3- 5:04.8,
	5:06.1- 5:19.0.		
Nov. 16	2:31.7- 2:40.9,	2:47.2- 3:00.0,	3:01.5- 3:18.8,
JD 2447115	3:23.9- 3:36.2,	3:37.5- 3:52.0,	3:56.7- 4:10.0,
	4:11.3- 4:24.6,	4:28.0- 4:38.4,	4:39.5- 4:55.5,
	4:59.0- 5:18.0,	5:21.6- 5:34.2,	5:35.4- 5:47.9,
	5:51.0- 6:07.0,	6:08.3- 6:24.0.	
Nov. 21/22	23:41.8-23:54.0,	0:33.4- 0:47.0,	0:51.0- 1:04.0,
JD 2447121	1:06.3- 1:24.0,	1:25.3- 1:41.6,	1:45.8- 1:58.7,
	1:59.8- 2:19.2,	2:25.2- 2:37.6,	2:38.9- 2:53.0,
	2:56.6- 3:08.2,	3:09.4- 3:23.0,	3:26.3- 3:36.7,
	3:46.8- 4:00.3,	4:01.8- 4:13.3.	
Nov. 23	3:46.8- 4:00.1,	4:01.1- 4:13.7,	4:18.4- 4:31.4,
JD 2447122	4:32.3- 4:46.3,	4:51.3- 5:05.8,	5:06.9- 5:21.9,
	5:25.2- 5:39.6,	5:40.7- 5:56.5.	
Dec. 13	1:37.8- 1:47.0,	1:54.0- 2:09.0,	2:10.5- 2:26.0,
JD 2447142	2:30.0- 2:44.4,	2:46.3- 3:02.4,	3:06.1- 3:22.0,
	3:25.0- 3:32.8,	3:46.0- 3:48.1,	3:49.1- 3:51.8,
	3:53.0- 4:00.9,	4:14.5- 4:19.0,	4:20.2- 4:33.3,
	4:38.7- 4:54.0,	4:54.6- 4:55.6,	5:00.2- 5:07.2,
	5:17.7- 5:19.0,	5:35.4- 5:42.4.	
Dec. 13/14	23:46.9-24:00.0,	0:04.5- 0:20.0,	0:21.0- 0:36.9,
JD 2447143	0:39.7- 0:54.3,	0:56.0- 1:10.8,	1:14.6- 1:28.0,
	1:34.8- 1:52.1,	1:53.8- 2:11.0.	
Jan. 11	0:10.8- 0:21.6,	0:26.5- 0:42.3,	0:45.4- 1:04.2,
JD 2447171	1:12.4- 1:27.8,	1:29.4- 1:44.0,	1:57.8- 2:10.9,
	2:21.0- 2:34.0,	2:40.0- 2:57.0,	3:05.2- 3:05.9,
	3:09.5- 3:26.5,	3:28.0- 3:36.4,	3:36.8- 3:46.4.
Jan. 11/12	23:42.7-24:00.0,	0:04.6- 0:24.0,	0:25.0- 0:48.0,
JD 2447172	1:01.2- 1:14.0,	1:19.6- 1:35.0,	1:36.2- 1:52.0,
	1:55.0- 2:13.0,	2:14.8- 2:29.1,	2:31.9- 2:47.2,
	2:48.4- 2:50.0.		

Table III. Ultraviolet magnitude differences (v = DO Cep = BD +56°2783, c = BD +56°2777, k = BD +56°2788) and signal/noise estimates.

JD 2440000+	$m_c - m_v$	$m_c - m_k$	$\frac{I_o}{\sigma}$	Air Mass
7067.6799	-0.28		11.2	1.08
7067.6826	-0.27	-0.41		1.08
7067.7000	-0.30			1.10
7067.7067	-0.24			1.12
7067.7229	-0.26	-0.39		1.14
7067.7368	-0.29		11.1	1.17
7067.7618	-0.24			1.24
7094.5257	-0.33			1.06
7094.5361	-0.27	-0.41	11.4	1.05
7094.5528	-0.28			1.05
7094.5653	-0.23			1.05
7094.6056	-0.24			1.08
7094.6188	-0.27	-0.48	9.7	1.09
7094.6292	-0.22			1.11
7094.6403	-0.39			1.12
7094.6521	-0.28			1.15
7094.6625	-0.36			1.17
7094.6743	-0.28			1.20
7094.6851	-0.29			1.23
7094.6958	-0.41			1.26
7094.7076	-0.18	-0.43	7.5	1.30
7095.5500	-0.34		3.6	1.05
7095.5632	-0.44	-0.52		1.05
7095.5753	-0.14	-0.34		1.06
7095.6080	-0.15	-0.35	6.3	1.08
7095.6306	-0.24			1.11
7095.6681	-0.30	-0.46		1.19
7095.6931	-0.32			1.26
7095.7163	-0.32		6.2	1.34
7095.7431	-0.47			1.47
7095.7674	-0.23	-0.33		1.61
7095.7833	-0.25		4.7	1.72
7097.5184	-0.36	-0.46	7.0	1.06
7097.5406	-0.30			1.05
7097.5649	-0.19	-0.42	7.4	1.06
7097.6052	-0.29	-0.45		1.09
7097.6278	-0.23		7.5	1.12
7097.6594	-0.30			1.18
7097.6823	-0.33	-0.50		1.24
7097.7007	-0.30		7.6	1.30
7097.7243	-0.18	-0.38		1.40
7115.6139	-0.27	-0.36	6.9	1.19
7115.6406	-0.27			1.27
7115.6632	-0.22	-0.44		1.35
7115.6858	-0.17		6.6	1.45
7115.7069	-0.27			1.57
7115.7222	-0.17			1.68
7115.7431	-0.23			1.84
7115.7688	-0.29	-0.43	3.6	2.09
7121.5000	-0.34	-0.49	10.6	1.06
7121.5722	-0.26			1.13
7121.5986	-0.20	-0.44	7.5	1.19
7121.6219	-0.27			1.26
7121.6424	-0.26			1.33
7121.6785	-0.27	-0.42	6.8	1.50
7122.6597	-0.30	-0.52	6.4	1.42
7122.6781	-0.30			1.52
7122.7014	-0.22	-0.31	6.2	1.66
7122.7243	-0.32			1.84
7122.7465	-0.31	-0.44	5.5	2.06
7142.5771	-0.30	-0.43	7.2	1.30
7142.6031	-0.27			1.41
7142.6281	-0.25		6.6	1.54
7142.6417	-0.23			1.63
7142.6913	-0.28	-0.31		2.05
7142.7069	-0.31			2.24
7142.7333	-0.28			2.61
7142.7382	-0.22	-0.32	3.9	2.69
7143.5014	-0.23	-0.37	7.3	1.12
7143.5267	-0.30			1.16
7143.5507	-0.30			1.23
7143.5625	-0.28	-0.43	6.8	1.26
7171.5188	-0.30	-0.37	4.2	1.39
7171.5479	-0.21			1.54
7171.5948	-0.25	-0.41	3.3	1.88
7171.6271	-0.31			2.23
7171.6611	-0.17	-0.28	2.0	2.73
7172.5014	-0.25	-0.42	5.5	1.33
7172.5528	-0.21	-0.93	6.2	1.58
7172.5785	-0.22			1.77
7172.6049	-0.29		4.0	2.01

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THE MECHANICAL ENERGY BUDGET IN STELLAR FLARES

Flares on the Sun and on dKe-dMe stars are now widely believed to be basically similar in their origin and development. This is in spite of the fact that stellar flares are normally at least 10^3 and often 10^5 times more energetic than even the largest of their solar counterparts. In general, both phenomena are believed to arise from the rupture of a stressed magnetic structure, commonly termed a magnetic loop, which by magnetic buoyancy is forced upwards through the photosphere into the corona/transition region, where reconnection of the magnetic field occurs followed by a considerable release of energy. Initially this energy is believed to be carried by fast particles, such as electrons or protons, which, collimated by the magnetic field, move down towards the surface of the star where they bombard denser material and give rise to local heating and chromospheric evaporation (e.g. Doyle et al., 1985).

The major objective of this international corroborative project (involving Armagh Observatory, the Institute for Astronomy at the University of Catania, Goddard Space Flight Center, the Joint Institute for Laboratory Astrophysics of the University of Colorado, the Rutherford-Appleton Laboratory, the Laboratoire de Physique Stellaire et Planetaire du CNRS and the Institute of Astrophysics at Oslo) is to collect multiwavelength, i.e. optical, ultraviolet and X-ray; and in particular to obtain spectral and temporal resolution data of the higher Balmer lines in order to look for doppler motions. Evidence for such mass motions has been seen in low resolution spectroscopy (Doyle et al., 1988, Phillips et al., 1988). Such data will enable us to form some estimate of the mechanical energy budget from doppler shifts in spectral lines and compare with the X-ray energy. For this program, two ESA IUE 8 hr. shifts and one GINGA (i.e. the Japanese X-ray satellite) 24 hr. shift has been allocated. In addition we have requested three European Southern Telescopes and the Anglo-Australian Telescope to do high resolution spectroscopy (covering the higher Balmer lines, i.e. $H\gamma$, $H\delta$ etc., with a spectral resolution of ≈ 1Å and the time resolution of ≈ 1 min.) and to monitor the overall activity of the star in UBVRI and K bands. VLA time has also being requested.

We welcome the participation of any observer who can contribute either photometric or spectroscopic observations. Interested observers are requested to contact the undersigned and to notify us of their telephone and telex numbers and/or their electronic mail address.

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PHOTOMETRIC EVIDENCE OF THE END OF THE ACTIVE PHASE OF CH Cyg

The recent phase of activity of the symbiotic star CH Cyg began in May 1977 (Fehrenbach, 1977). Photometrically it was characterized by an intensity increase of the blue continuum (e.g. Luud et al., 1982) and by rapid changes of the U, B, V magnitudes (e.g. Slovak and Africano, 1978).The radiation of CH Cyg was significantly affected by the blue continuum in the whole optical spectral region, $\lambda \leq 550$ nm, (Ipatov and Yudin, 1983), which completely obscured the variations of the cool component. The next increase of the star's brightness began in June to November 1981 (e.g. Kaler et al., 1983). The magnitude in the U, B, V filters fluctuated approximately between 5^m and 6^m. CH Cyg retained this brightness until August 1984, when a sudden decrease of $1\overset{m}{.}0$-$1\overset{m}{.}5$ in the V-filter was observed (Panov et al., 1985a). In 1985, a minimum was observed in the U-light curve. It was interpreted as the eclipse of the hot component of CH Cyg by its cool component (Mikolajewski et al., 1987). During this period, no rapid changes in brightness were observed (e.g. Mikolajewski et al., 1987). They were indicated again immediately after the eclipse, mainly in the U-filter, at the end of 1985 and at the beginning of 1986 (Tomov et al., 1986, Skopal, 1987).

New photometric U, B, V observations were carried out at the Observatory Skalnaté Pleso from JD 2 446 700 (Figure 1). The star HD 184 786 was used for the comparison and HD 184 960 for the check. The integration time of one measurement was 10 s. The average values of the U and V- magnitudes during one night are shown in Figure 1.

The period after the eclipse of the hot component was characterized by a gradual decrease of the brightness in the U-filter, although, an increase by about $0\overset{m}{.}5$ was observed in October 1987. Recent observations made in 1988 again indicate its decrease to the value $\sim 10\overset{m}{.}5$, which is comparable with the values in the quiescent phase of CH Cyg, observed in 1970-1977 (Luud et al., 1982). It is interesting that CH Cyg was brighter by about 1^m in the U-filter during the 1985 total eclipse than in 1988. This fact indicates a decrease of the blue continuum source, which still contributed to the short wavelength region during the eclipse.

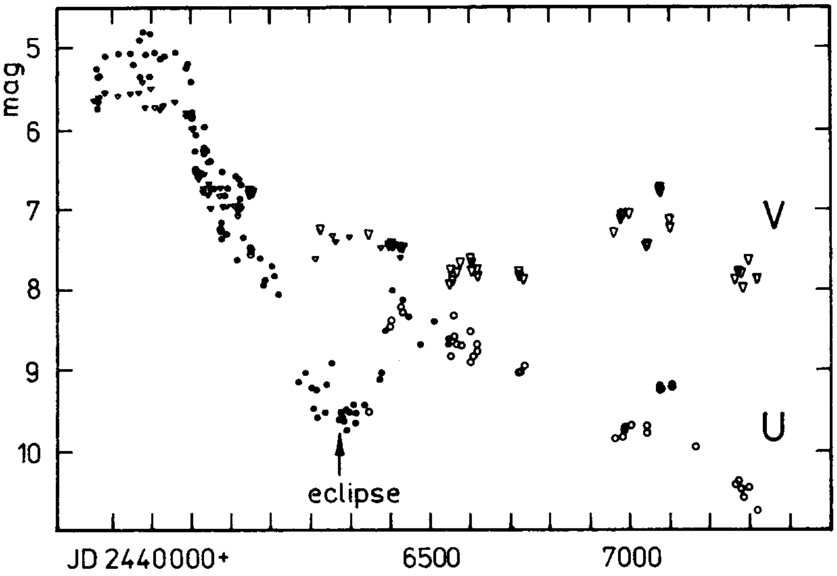

Figure 1. The U and V-light curve of CH Cyg in November 1983 to June 1988. References: ●-U,▼-V light curve according to data published by Vennik et al. (1987), Mikolajewski et al. (1987), Milone et al. (1986), Mikolajewski and Mikolajewska (1985), Mikolajewski and Wikierski (1986), Panov et al. (1985a,b). o,▽ - Observations carried out at the Observatory Skalnate Pleso: Skopal (1987) and from JD 2 446 700 this paper.

The star's brightness in the V-filter changed approximately between $6^{m}.7$ and $7^{m}.9$ from the end of 1984 till the recent observations in 1988. The brightness values were close to the visual magnitude measurements until 1960 (Gusev, 1976) and to the V-magnitude of the quiescent phase of CH Cyg in 1970 - 1977 (Luud et al., 1982). Their changes are independent of the changes in the U-filter. A significant difference in the U and V-magnitude values has been observed ever since the beginning of the eclipse, in May 1985. In 1987 - 1988 this difference reached $2^{m}.5$. The cool component of CH Cyg was thus revealed by the decrease of the blue continuum.

The amplitudes of the rapid changes of the U, B, V photometry decreased during the whole period after the eclipse. In 1987 - 1988, the brightness of CH Cyg in these filters was practically constant during one night ($\Delta m<0^{m}.1$), although the difference of amplitudes in the U and V-filter was obvious ($\Delta U>\Delta V$). In the spring of 1986 $\Delta U\sim 0^{m}.3$, but $\Delta V\sim 0^{m}.1$ (Skopal, 1987, Figure 6), in contradiction to the maximum of activity, when $\Delta U\sim\Delta V$ (e.g. Reshetnikov and Khudyakova, 1984).

If the accretion material around the hot component of CH Cyg is the source of the star's rapid brightness variations and of the blue continuum, the photometric measurements carried out in 1985 - 1988 showed that the size of the accretion complex decreased and confirmed the end of the active phase of CH Cyg.

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RADIAL VELOCITIES OF THE BINARY STAR HD 37020 (ϑ^1 Ori A)

HD 37020 was discovered as an eclipsing binary by Lohsen (1975). Baldwin (1976) and Franz (1977) estimated its period P=65.4325 days. A tentative spectroscopic orbit was determined by Lohsen (1976) using the radial velocity data available in the literature and Baldwin's period.

Systematic observations of HD 37020 were made at the Brera-Merate Observatory, using the 137 cm Ruths telescope and the B&C spectrograph mod. 31523.

The average of 13 photographic spectra taken in the range 3700-4700 A allowed a re-classification of HD 37020 as a B3 III-IV star. Spectra were also taken in the sub-range 4050-4450 A using a Reticon device (Bonanno et al., 1984);in both cases the reciprocal dispersion was 35A/mm. Nebular lines were adopted as a reference for radial velocities;at last, photographic and Reticon results are perfectly compatible.

Orbital elements (Table I) and a velocity curve (Figure 1) were obtained, assuming the light minimum as phase zero and a period of 65.4325 days. Radial velocities are listed in Table II.

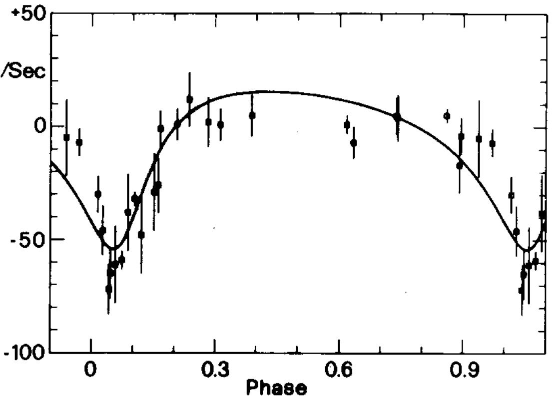

Figure 1

Table I

$a_1 \sin i = 0.184$ A.U.
$e = 0.476$
$\omega = 201^{\circ}.7$
$V_o = 3.9$ km/sec $+ V_n$ (*)
$T_o =$ J.D. 2444201.623
(*) V_n is the radial velocity of the Orion Nebula

Table II

Julian Date	Velocity		Error	Julian Date	Velocity		Error
2446819.41	-26	+/-	12	2447184.33	5	+/-	8
822.39	1		7	192.28	5		3
824.28	12		12	194.27	-17		12
827.28	2		11	197.36	-5		17
829.29	1		7	203.26	-46		11
834.29	5		9	204.27	-72		11
849.32	1		4	205.27	-61		17
850.31	-7		7	206.30	-59		4
857.31	4		10	207.30	-38		17
867.33	-4		8	208.28	-32		3
872.29	-7		6	209.30	-48		17
875.30	-30		8	211.31	-29		17
877.32	-65		11	212.29	-1		8

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A NEW RAPIDLY OSCILLATING Ap STAR IN THE NORTHERN HEMISPHERE

We monitored the star HD 176232 (HR 7167; 10 Aqr), classified as an F0p, photometrically for a total of ~ 29 hours over a period of 8 days during July 1988. We detected a low amplitude light variation with a period of approximately 11.5 minutes. This is equivalent, within the errors, of the period detected in July 1987 (Heller and Kramer 1988) and confirms the suspected variability. There are also indications that other frequencies may be present.

We obtained high speed photometric observations of HD 176232 using the one-meter telescope and single channel photometer of the Mount Laguna Observatory (MLO), jointly operated by San Diego State University and the University of Illinois. A series of continuous 20-second integrations were taken through a Johnson B filter and 40 arc sec diaphragm; interrupted only for occasional sky measurements and recentering at irregular intervals. The equipment and reduction of the data are described in Heller and Kramer (1988). We computed the amplitude spectrum using Deeming's (1975) algorithm along with the time saving schemes of Kurtz (1985), and O'Donoghue and Warner (1982). All amplitudes reported are semi-amplitudes.

Figure 1 shows an amplitude spectrum of the combined one-meter data. A peak rising above the noise level at approximately 1.45 mHz dominates the periodogram with an amplitude of 0.42 mmag. An excess of power at nearby frequencies can be seen in the figure and may indicate the presence of other variations in HD 176232.

We are currently reducing an additional ~90 hours of photometric data taken with the 61-cm telescope at MLO in June and July 1988. The full data set spans some 60 days. Unfortunately, because of the smaller mirror diameter of the 61-cm telescope, the scintillation noise is significantly larger than with the 1-meter.

We feel there is strong evidence for rapid light variation in HD 176232. While the presence of other frequencies are suggestive by the preliminary investigation, a full analysis of the entire data set is necessary before this can be stated with confidence. Further analysis of the data is currently in progress.

We acknowledge Steven Kawaler for reviewing this manuscript.

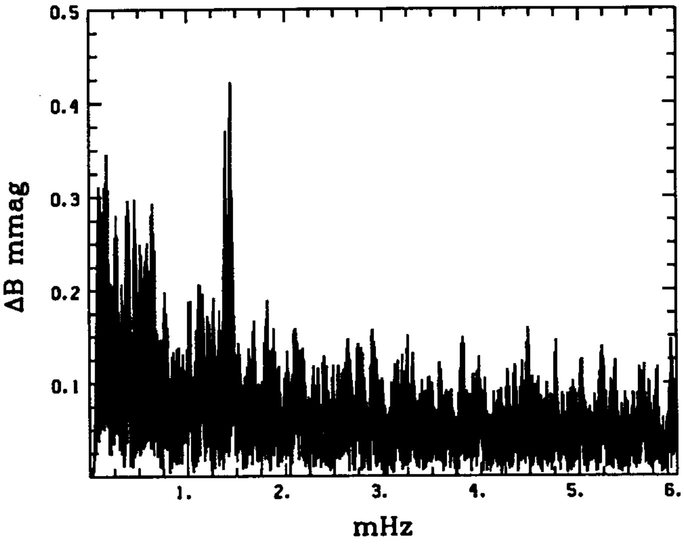

Figure 1: An amplitude spectrum of data taken between JD2447351 and JD2447359 for HD 176232. The highest peak is at 1.45 mHz (11.5 min) and has a semi-amplitude of 0.42 mmag.

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MICRO-FLARING OF dMe STARS : A CONNECTION BETWEEN X-RAY LUMINOSITIES AND "TIME SIGNATURES" OF ULTRAVIOLET FLUCTUATIONS ?

The recent developments of a modified auto-correlation (MAC) technique which utilizes least-square successive differences (Andrews 1988a) have been applied to 1-second U-band monitoring data of the flare star, Gliese 735 (= V1285 Aql). The MAC parameter is examined in the frequency domain to detect significant peaks indicative of quasi-periodicities which have been termed "time signatures". The interpretation of the time signature is that of a characteristic time-scale of fluctuations of dMe flare stars outside large flares. The fractional contribution of micro-flaring to the total energy of the flaring mechanism is difficult to estimate. Attempts have been made in the past to assess their contribution from the form of the cumulative distribution function of the number of flares above a certain threshold. Also, the U-magnitude of a flare star at the beginning of a night's monitoring has been utilized to estimate the "level" of micro-flaring each night (Kunkel 1967). The present work does not yet lead us to a quantitative measure of micro-flaring but an interesting result has emerged which appears to tie-in with our concepts of the flaring mechanism as a grand solar-type scenario. Simultaneous optical spectroscopy and X-ray monitoring of stellar and solar flares shows that a well-defined linear relation exists between the integrated $H\gamma$ and soft X-ray fluxes that extends over four orders of magnitude (Butler, Rodono and Foing 1988). The U-band contains the higher Balmer lines which will contribute a sizable emission component during micro-flares,

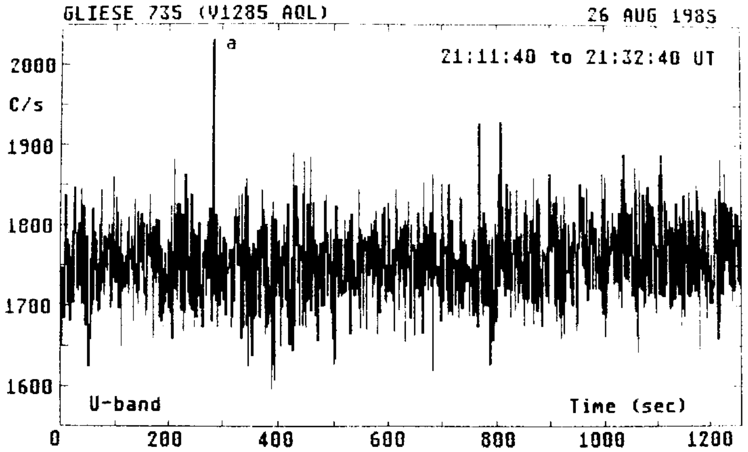

Fig.2. Photometric data for Gliese 735 on 26 August 1985 utilized in the MAC analysis consisting of ultraviolet pulse-counts per second. Letter "a" indicates a spike flare of duration 2 seconds

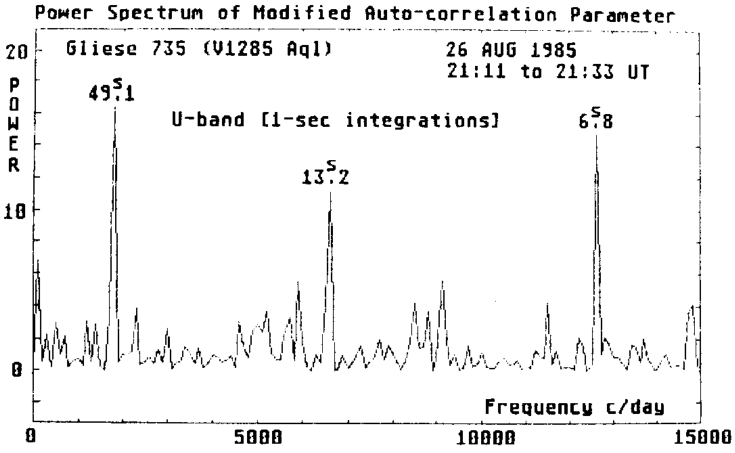

Fig.1. Power spectrum of MAC parameter for Gliese 735 showing three time signatures

and it appears reasonable that any measure of the fluctuations in the U-magnitude of a flare star (outside detected flares) should be related to the "quiescent" X-ray flux of the star.

There is now information on the time signatures of five flare stars obtained using remarkably short segments of U-band monitoring mostly at 1-second time resolution (Gliese 803 being the exception, at 5-second resolution). The results are given in Table 1, together with the logarithm of the X-ray luminosities from Bookbinder (1985) and Pallavicini (1988). An unpublished result recently obtained for G735 suggests that there are at least three distinct time signatures for this star less than 1 minute (Fig.1). The data for G735 is shown in Fig.2 for a monitoring run at 1-second resolution over an interval of 21 minutes. A spike flare occurred at 21:16:23 UT lasting only two seconds (marked "a" in Fig.2). We note that when this spike was removed from the data the MAC analysis showed no discernible change, i.e. the spike did not contribute exceptionally to produce any of the three peaks in Fig.1.

The flare stars in Table 1 have been arranged in order of increasing X-ray luminosity. We note that when the time signatures are assigned, admittedly in a biassed manner, to three different columns, TS_1,TS_2 and TS_3, that each TS increases with increasing $logL_X$, with the exception of G799AB. Also, for G803 there is no high time-resolution data for the detection of a possible TS_3. For G551 there is a weak peak near 11.4 sec (Andrews 1988c). The fact that the optical and X-ray data are not simultaneous and only one data set was examined for each star means that changes in the time signature with stellar activity cycles cannot yet be discussed. It is, however, an important aspect of micro-flaring deserving further investigation. Utilizing such short segments of U-band data, the MAC technique certainly promises to be an interesting line of investigation. Higher time-resolutions with larger instruments, to at least 0.1-second, would be worthwhile to detect the full range of possible time signatures. Furthermore, we are planning high time-resolution spectroscopy to examine this phenomenon in detail.

TABLE 1

Time signatures (secs) and X-ray luminosities of five flare stars

Identification	TS_1	TS_2	TS_3	$logL_X$	Refs
G644AB (V1054 Oph)	24.7	8.9	5.8	26.8	1,3
G551 (V645 Cen)	31.3	11.4	6.3	27.0	1,4
G735 (V1285 Aql)	49.1	13.2	6.8	28.9	2,5
G799AB (B = AT Mic)		12.8	7.8	29.2	1,6
G803 (AU Mic)	54	25.4		29.9	1,3

Refs: (1) Bookbinder (1985) (2) Pallavicini 1988 (3) Andrews (1988b) (4) Andrews (1988c) (5) Andrews (present work) (6) Andrews (unpublished)

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1988 BV PHOTOMETRIC OBSERVATIONS OF CG Cyg

There are several observed light curves of CG Cyg (BD+34°4217) reported in the literature. From his visual light curve Williams (1922) suggested irregularities outside the eclipse. It is among the eclipsing binaries with unequal light curve maxima studied by O'Connell (1951). This star fulfills Hall's (1976) three criteria for being a short-period RS CVn - type star. First the period is less than one day long, ($0^{\mathrm{d}}.631141$) although it has been shown by Milone and Ziebarth (1974) to be variable.

Second, Naftilan and Milone (1979) studied the system spectroscopically and found CaII H and K emission lines, and third, the two stars were classified as G9.5V (the hotter component) and K3 IV-V (the cooler one).

Castle et al. (1977), Milone et al. (1979), Jassur (1980) and Naftilan and Milone (1985) and finally Sowell et al. (1987) have also presented photometric observations for this star.

The object, an eclipsing binary, was observed from 30 August through 4 September 1988 with the 1.2 m Kryonerion Telescope and a single channel photon counting photometer described by Dapergolas and Korakitis (1987). The photometer employs a high gain 9789 QB phototube and BV conventional filters. Its output is fed directly to a microcomputer enabling rapid data access.

The data reduction method is the standard one. The comparison and check stars are the stars a and b, respectively named by Yü (1923). The data were obtained with an accuracy of ±0.015 mag.

Table I lists the dates of observations and phases covered whereas Figures 1 and 2 summarise the results for B and V colours.

Table I

Date	Phase	
30-8-88	.46	.77
31-8-88	.98	.38
1-9-88	.69	.85
2-9-88	.19	.50
3-9-88	.83	.96
4-9-88	.33	.74

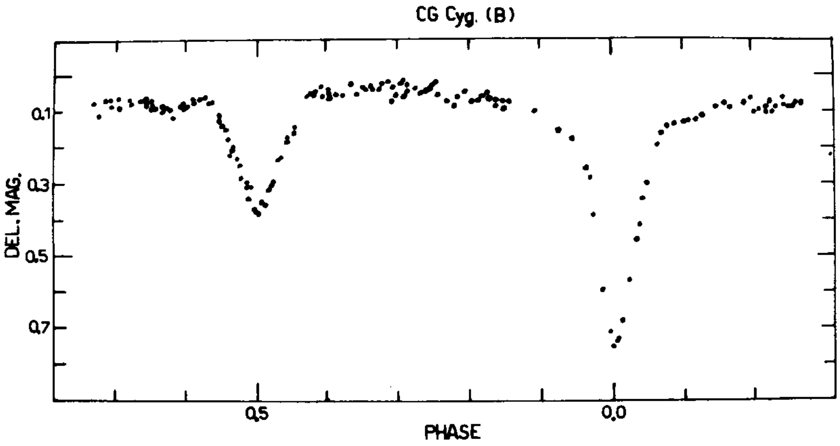

Figure I

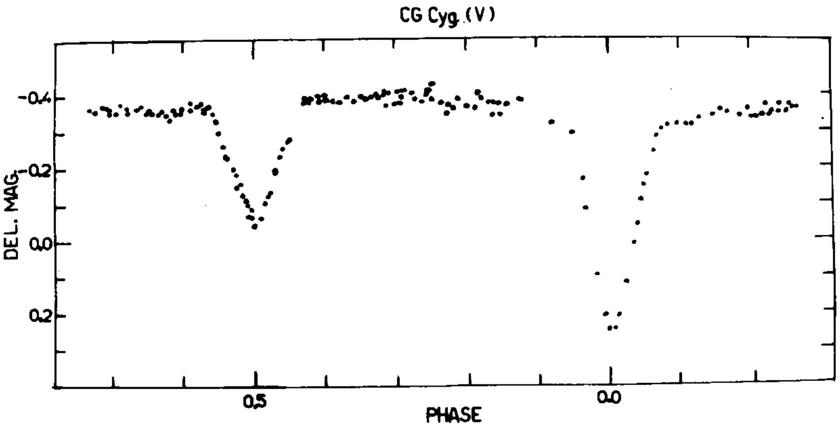

Figure 2

Previously reported light curves show remarkable similarities and the most notable event is the significant difference in depth between the primary and secondary minima (~0.3 mag).
Our data confirm these results and, in addition, we noticed that the intrinsic scatter of the magnitudes seems larger outside the eclipse than during them.

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X-RAY/OPTICAL FLARES ON RS CVn STARS

Previous observers (e.g. Chambliss et al., 1978) have noted the lack of a corresponding optical flare for quite large ultraviolet and micro-wave flares on RS CVn stars. This has been generally interpreted as a contrast effect, since the non-flare continuum is more intense in these stars than, for instance, in the dMe or flare stars where optical flares are common. An alternative explanation may be that the flare loop lengths and electron densities on RS CVn stars are much larger than those on either the sun or dMe stars, resulting in an increased column density along the loop. Assuming, as in the sun, that we have a flare model where we have an instability at the loop apex leading to the generation of a high energy beam of hard X-ray electrons which move down the loop legs to the chromosphere, theoretical calculations from Emslie (1983) imply that all electrons with energy less than 50 keV are stopped before they reach the chromosphere. Hence in this model, most of the heating from this beam goes to heating the transition region/corona with a substantially less amount going to heat the lower atmosphere than in solar-type stars and dMe stars.

Simultaneous optical (covering the high Balmer lines) and X-ray data should help in distinguishing between these two suggestions, i.e. contrast effect or increased loop length and density, since the X-ray observations will give an estimate for the flare size and density. Simultaneous ultraviolet data will provide (through line ratio techniques), an estimate of the electron density in the transition region. A good target for such a campaign is II Peg (=HD 224085). This star has a very high X-ray luminosity, e.g. $4 \cdot 10^{31}$ erg/s was observed by Walter et al. (1980) in the 0.2 - 4 keV range and $5 \cdot 10^{30}$ erg/s by Schwarz et al. (1981) in the 2 - 10 keV range. It is a single-line spectroscopic binary of spectral type K2 IV-V with an orbital period of approximately 6.7 days with photometric variations, of the type usually interpreted as due to cool surface spots. This star has a very high rate of flaring in the ultraviolet region, e.g. see Doyle et al. (1988). Ultraviolet flares so-far observed have had typical decay times of 10 to 15 hours with a total radiative power output of 10^{36} erg. These long flare decay times will mean that a high resolution (compared to the flare life-time) is possible. Two 24 hr. shifts on the Japanese X-ray satellite GINGA has been awarded. An application for ESA and NASA I IUE shifts have been submitted, in addition, we have requested spectroscopy and photometric coverage from La Palma and Mauna Kea (Hawaii). The requested dates of observations are the 15 and 16 August 1989. Involved in this international corroborative project is Armagh Observatory, the Institute for Astronomy at the University of Catania, Goddard Space Flight Center, the Joint Institute for Laboratory Astrophysics of the University of Colorado, the Rutherford-Appleton Laboratory, the Laboratoire de Physique Stellaire et Planetaire du CNRS and the University of Leicester.

We welcome the participation of any observer who can contribute either photometric or spectroscopic observations. Interested observers are requested to contact the undersigned and to notify us of their telephone and telex numbers and/or their electronic mail address.

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NEW ELEMENTS OF CK Boo

The star CK Boo (HD 128141, BD$+9^{\circ}2916$) is a W UMa-type eclipsing binary discovered by Bond (1975). Its light curve varies form night to night. Aslan and Derman (1986) suggested these long-term changes to be due to a starspot cycle with a period of about 7 years.

New photoelectric observations were obtained during May 1988 at Mt. Suhora Observatory (1000 m above sea level, $\phi=+49^{\circ}35'$, $\lambda=-1^{h}20^{m}22^{s}$) of the Pedagogical University (Cracow) using the 60 cm Cassegrain telescope equipped with a one-channel photometer. An uncooled EMI 9865B photomultiplier as well as blue and yellow filters close to UBV Johnson-Morgan system were used. The data logging was controlled automatically by a Commodore-64 microcomputer.

The observations allowed us to determine the following times of minima by parabolic fitting:

JDhel	Filter	Minimum type
2447290.4153 ± 0.0007	V	II
47290.4146 ± 0.0007	B	II
47291.4796 ± 0.0003	V	II
47292.3699 ± 0.0005	V	I
47298.4072 ± 0.0002	V	I

Adding these times of minima to those available in the literature (see e.g. Aslan and Derman 1986, Demircan 1987) we could improve the elements of the system. The new elements are as follows:

$$\mathrm{JDhel(min)} = \underset{\pm 1}{2446183.5876} + \underset{\pm 2}{0^{d}.35515102}\ E$$

The O-C residuals calculated using the above elements are plotted in Figure 1.

The new elements are more precise than those given by Aslan (1978) (see O-C's in Figure 2 according to Aslan's elements).

A complete discussion and light curve analysis of the system will be published soon.

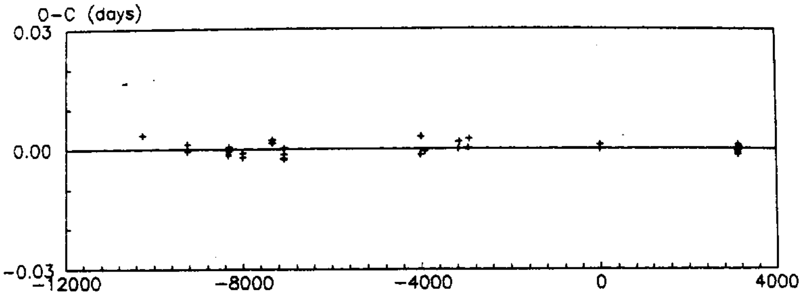

Figure 1

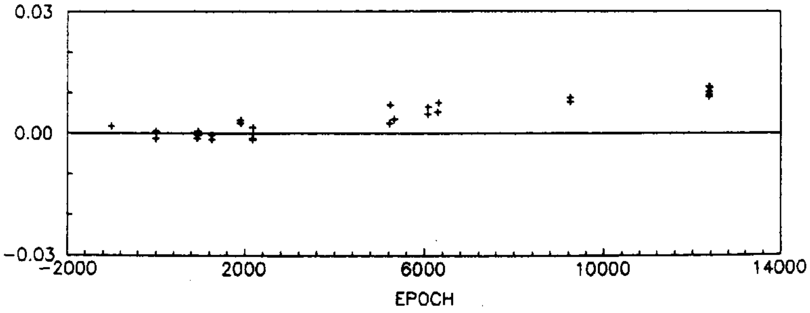

Figure 2

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SLOW VARIABILITY OF V1500 Cyg

Regular photometric observations of Nova Cygni 1975 (V1500 Cyg) have been continued in the Crimean Observatory from 1975 up to now. The 0.5 meter meniscus telescope equipped with a TV system is used to get estimates of the brightness close to the V photometric band. The large amount of data obtained so far (2150 points) makes it possible to use statistical methods for searching for possible regularities in the light curve of V1500 Cyg in addition to the well-known main period $P_0=0^d.13961325$ (the corresponding phase dispersion spectrum is displayed in Figure 1).

We used the classical method of least squares approximation to obtain parameter estimates for polynomial trend (taking into account the fading of Nova) and harmonic components of the main period. After that we computed O-C residuals from the estimated model. In Figure 2 low resolution phase dispersion spectrum of residuals is plotted against frequency. The strongest minimum in the region under study (P=5-20 days) corresponds to $P_1=7^d.70$. However, the refined spectrum for the region around P_1 (Figure 3) shows several peaks ($P_1=7^d.7019$, $P_2=7^d.7352$, $P_3=7^d.7731$ etc.) and consequently we cannot speak about the feature around $P=7^d.70$ as the strict period.

G. Schmidt and H.S. Stockman (IAU Circ. No.4458) studied the polarization of V1500 Cyg and found that polarization is variable with the period of $P_{pol}=0^d.1376$. Within the range of permissible errors the following near equality holds:

$$P_{pol}^{-1}=P_0^{-1}+P_1^{-1}$$

and it cannot be ruled out that P_1 is the "beat" period between P_{pol} and P_0.

If P_{pol} is the period of rotation for the white dwarf (as was conjectured by G. Schmidt and H.S. Stockman) and P_0 is the period of its revolution in the system, then P_{pol} must synchronize with P_0 in the future and the period P_1 must change as well. Then the appearance of fine phase dispersion spectra can be attributed to the interplay between the changing nature of P_1 and random distribution of observations in time.

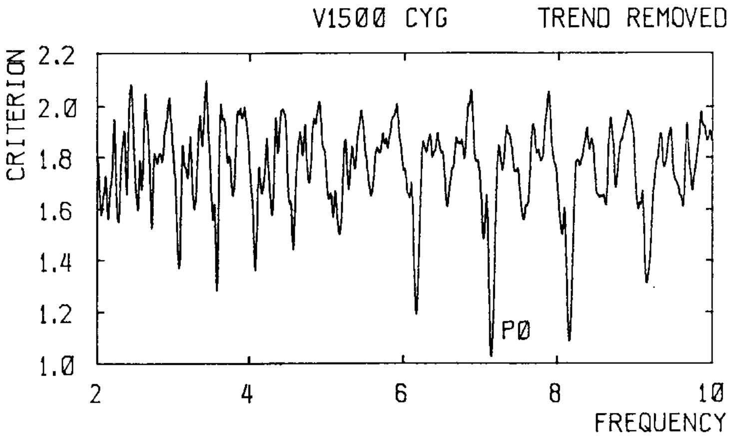

Figure 1: Crude PDM spectrum for detrended data.

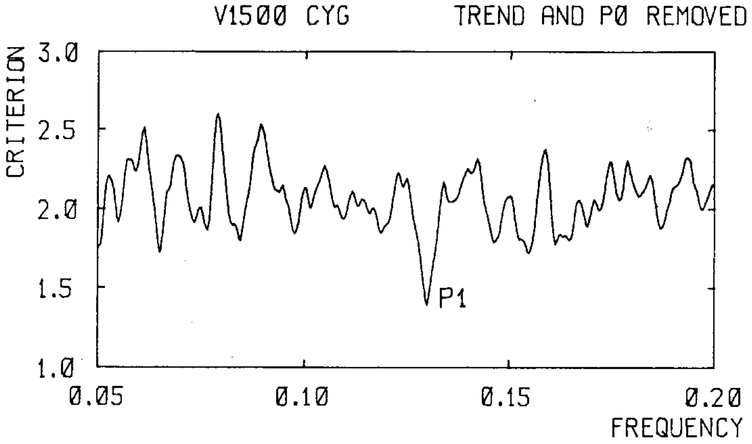

Figure 2: Crude PDM spectrum for O–C residuals.

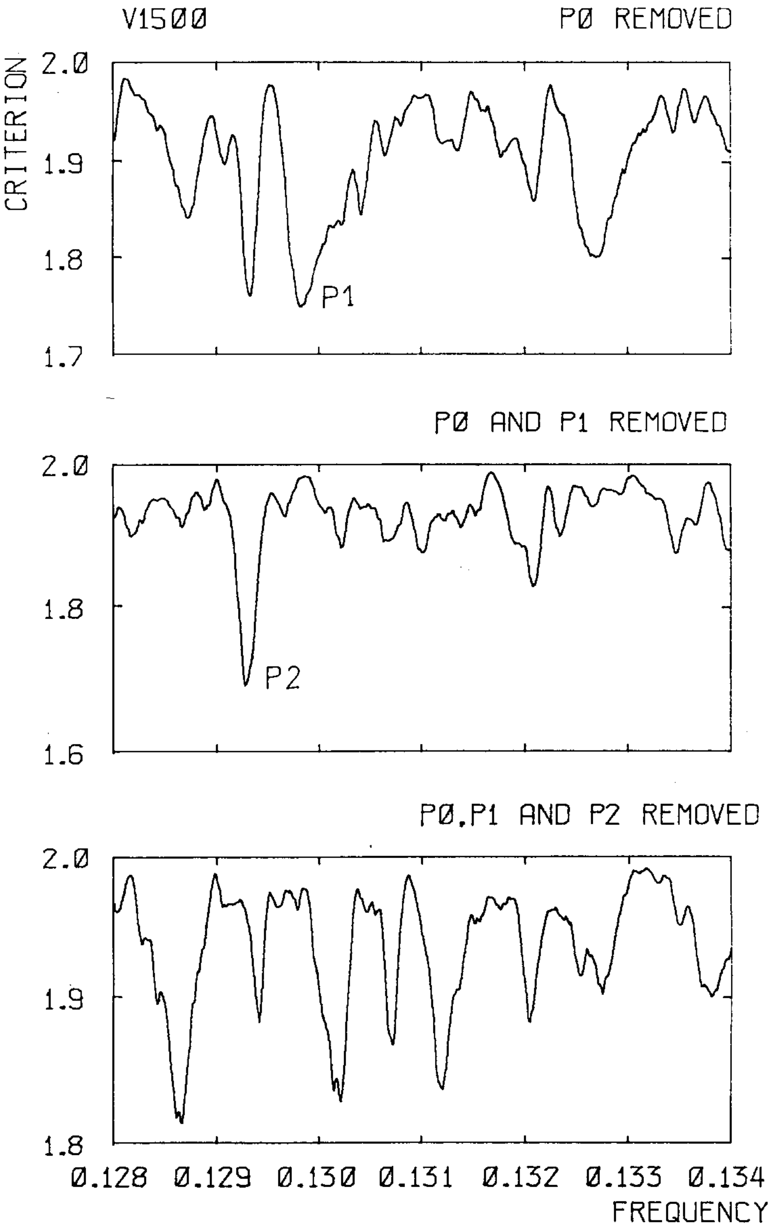

Figure 3: Refined PDM spectra for O-C residuals, sequential analysis

Evaluation of statistical significance for the obtained results is rather cumbersome because of the complex nature of V1500 Cyg variability. The development of appropriate statistical techniques is currently under way at Tartu Astrophysical Observatory.

Further photometric and polarimetric observations with substantial time base can reveal more exactly the nature of slow variability of this interesting object.

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1987 PHOTOMETRY OF XY URSAE MAJORIS

XY UMa [= +55° 1317, SAO 27143, #69 in the catalog of Strassmeier et al., 1988] is the most active member of the short-period RS CVn group (Budding and Zeilik, 1986). Geyer (1980) has observed the system since 1955; he attributes its photometric distortion wave to starspot activity on the primary star.

Aside from Geyer's persistent scrutiny, few complete light curves are available to track the magnetic activity cycles of this system. Zeilik et al. (1983) observed XY UMa in Jan-Feb 1982; Jassur (1986) in March 1979; Lorenzi and Scaltriti (1977) present Oct-Dec 1975 observations, but in general, their coverage is incomplete.

We conducted observations on 27 and 28 Feb 1987 and 29 Mar and 2 Apr 1987 (U.T.) to complete the light curve. We used the 61-cm telescope operated by San Diego State University on Mt. Laguna, California. The photoelectric photometer uses an EMI 6256 phototube operated at 1300 volts and cooled to -23 C. The photometer was fitted with an OG-515 filter for V-band. Each observation consisted of three separate 60-second observations through a 19 arcsec aperture. Phases were calculated from the ephemeris given in Strassmeier et al. (1988). The comparison star for all observations was SAO 27139 (Geyer's comparison star) and the check star was SAO 27151. Figure 1 shows the light curves in the instrumental V-band system, in the sense of comparison star-variable.

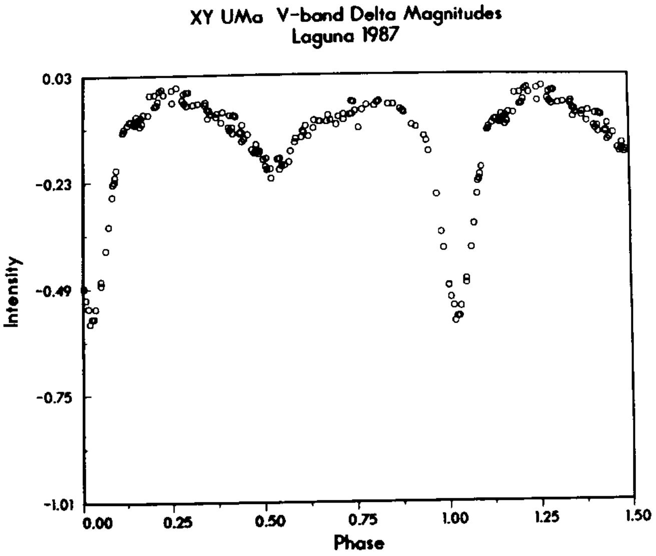

Figure 1

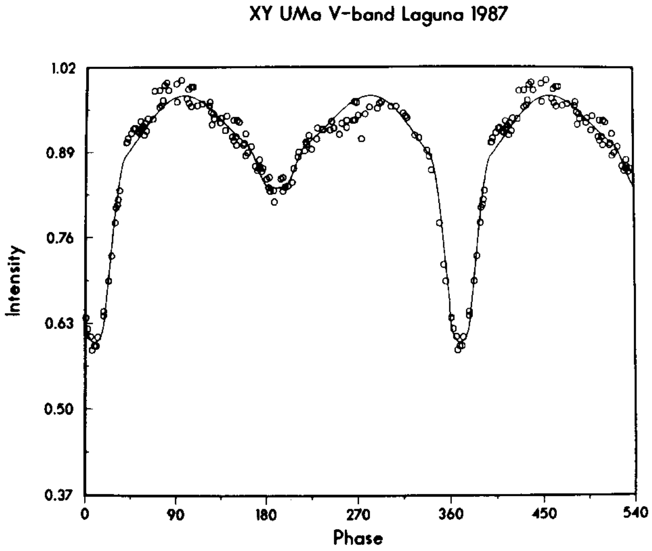

Figure 2

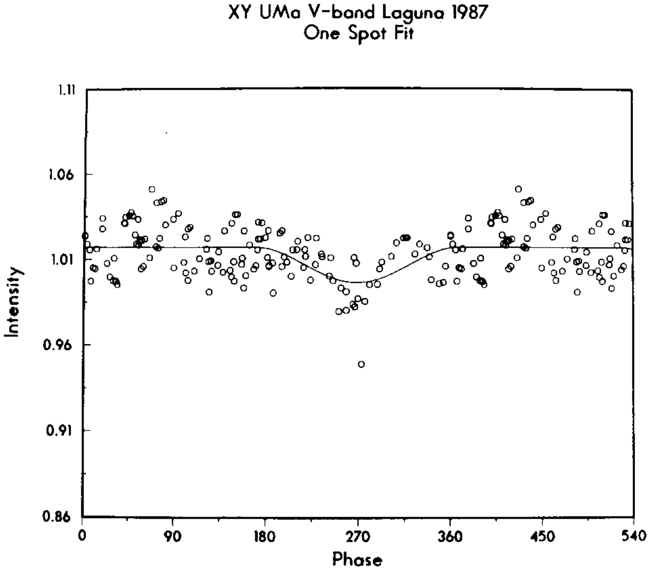

Figure 3

We analyzed the light curve by the technique of Budding and Zeilik (1987), in which we parameterize starspot indices by fitting a dark, circular spot to the distortion wave. We assumed a spot temperature = 0 K (completely black), a choice that minimizes the effective area. Figure 2 shows the observed points (open circles) compared to the theoretical light curve (solid line) for an unspotted system. The delta magnitudes have been converted to relative intensity units, normalized so that the shoulders of the light curves have a value ~1.0. Figure 3 has the distortion wave (circles) extracted from Figure 1 and shows the starspot fit (solid line). We assume that the primary star is the active one. We optimized a fit with a single spot group located at longitude 269° ±#6°, latitude = 40° ±#36° with a radius of 9.2° ±#4.0°. Note the large correlated error in the latitude, which also affects the value of the radius. The longitude, though, is well-determined and further confirms the notion that the active regions tend to appear at quadrature in the short-period RS CVn systems. Budding and Zeilik (1987) find two spots at longitude 81.4° ±3.2° and 13.0° ±0.3° at a fixed latitude of 45°. Since 1982, the two spots have merged (or one has disappeared). The total spotted area has also decreased significantly.

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VARIABLE B IN M33: A BINARY STAR?

Variable B is one of the classical Hubble-Sandage variables in M 33 (Hubble and Sandage 1953). Photographic and UBV(R) photometry or light curves were published by Hubble and Sandage (1953), Humphreys (1975), Humphreys et al. (1984), Rosino and Bianchini (1973), Sharov (1973, 1981) and van den Bergh et al. (1975).

Variable B was observed with the 60/90/180 cm Schmidt-telescope of Konkoly Observatory at Piszkesteto between 1965 and 1987, for details see Lovas and Zsoldos (1988). The magnitudes are given in Table I and the light curve is plotted in Figure 1. After the last large maximum at 1963.5 (Rosino and Bianchini 1973) the star probably had two small ones at 1982.0 and at 1986.5 with amplitudes of about 0.6 mag. These small maxima are similar to those at 1927.5 and 1934.9, observed by Hubble and Sandage (1953).

There is a marked difference between the forms of the light curves of the Hubble-Sandage stars in M 33 (see e.g. Figure 6 of Hubble and Sandage (1953)). The light curve of Variable B - though not in contradiction with the standard interpretation of Hubble-Sandage variables (Lamers 1987), - may strengthen the case for the binary hypothesis of some of these stars. Figure 2 shows the amplitudes of the maxima as a function of time elapsed since the last maximum (data from Rosino and Bianchini (1973) and from Figure 1). It indicates that after a larger maximum it takes usually more time to reach the next one. Bath (1977) pointed out that the Hubble-Sandage stars might be similar to cataclysmic binaries though on a larger scale.

Table I

Photographic observations of Variable B

J.D.	m_{pg}	J.D.	m_{pg}	J.D.	m_{pg}
2400000+		2400000+		2400000+	
39090.51	14.8	41714.34	16.7	44136.58	16.6
39498.38	15.3	41903.53	16.7	44167.47	16.6
39529.30	16.0	41921.55	16.8	44256.30	16.7
39711.55	15.6	42008.55	16.8	44554.47	16.5
39766.41	15.8	42066.40	16.8	44912.59	16.1
39796.44	16.0	42095.30	16.8	44989.29	16.1
39827.53	16.1	42278.44	16.7	45018.31	16.2
40073.56	16.0	42397.36	16.6	45197.53	16.1
40092.48	15.6	42473.31	16.7	45230.43	16.5
40144.49	15.5:	42695.46	16.8	45261.46	16.7
40157.49	16.3	42725.47	16.8	45347.26	16.6
40183.42	16.8	42754.44	16.8	45593.50	16.3
40203.38	16.6	42756.50	16.7	45615.46	16.3
40230.24	16.7	43013.52	16.7	45647.49	16.5
40654.32	16.4	43072.49	16.7	45940.56	16.1
40798.54	16.5	43191.30	16.7	46026.43	16.2
40837.56	16.8	43344.57	16.6	46030.28	16.1
40916.47	16.6	43399.43	16.7	46321.43	16.0
41164.53	16.7	43430.50	16.5	46355.55	16.0
41183.50	16.7	43464.50	16.8	46441.35	15.9
41213.45	16.4	43489.29	16.6	46468.36	16.0
41518.55	16.5	43720.55	16.5	46677.57	15.9
41520.51	16.5	43756.43	16.6	46706.41	15.8
41625.46	16.7	43757.56	16.7	46738.50	16.1
41679.26	16.8	43787.54	16.7	46763.46	16.3
41687.38	16.8	43809.56	16.7	47060.48	16.2
41689.28	16.6	43815.28	16.6		

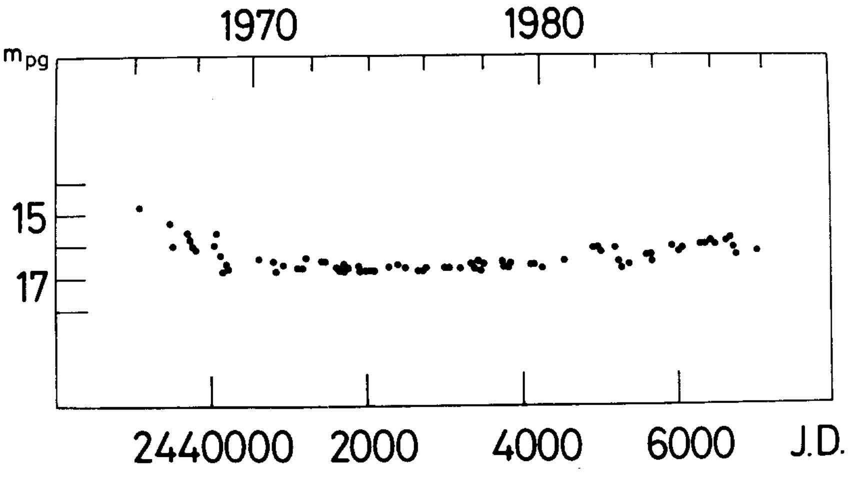

Figure 1

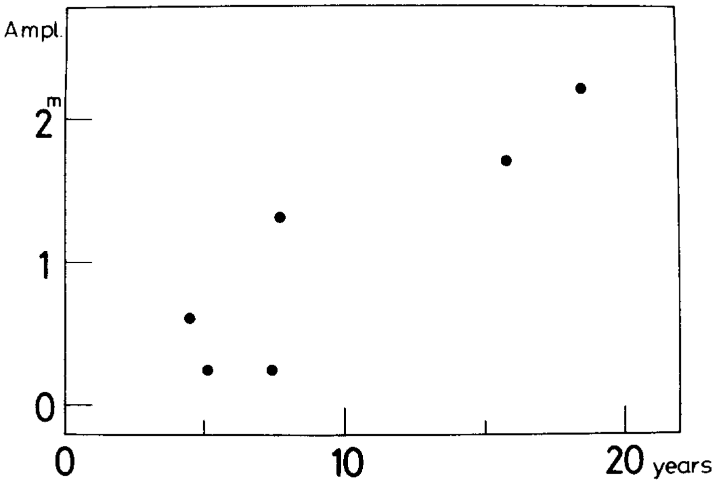

Figure 2

Kenyon and Gallagher (1985) also favoured the binary nature of some of these variables. Assuming that Variable B is really a binary star, Figure 2 then corresponds to the outburst period-energy relation observed in cataclysmic variables (Bath and van Paradijs 1983).

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KX TrA = Cn 1–2 = PK 326 – 10°1

Feibelman (1988) recently drew attention to the symbiotic star KX TrA, which he referred to as Cn 1–2, noting its spectral similarity to some of the (very slow) symbiotic novae such as V1016 Cyg and HM Sge. He also claimed that the finding chart in Perek and Kohoutek (1967) is erroneous while that in my catalogue of symbiotic stars (Allen 1984) is correct.

Those planning to observe KX TrA should note that, in fact, the error occurs in my catalogue and the correct identification is that given by Perek and Kohoutek. Nonetheless, from his decription of the ultraviolet spectrum, I infer that Feibelman observed the symbiotic star. KX TrA is the SW of a pair of stars of about 12th magnitude.

Feibelman encouraged observations of KX TrA on the basis that it might be a slow nova that had erupted prior to the first observation in 1921. Roughly 150 symbiotic stars are now known; about half of them broadly resemble KX TrA. It has long been recognised that many of these may have undergone nova-like eruptions before observations of them began. All deserve greater study.

If a comparison with other symbiotic novae is made then it should perhaps be with V1329 Cyg and AG Peg, since those systems involve a stable M giant and not a Mira variable, in common with KX TrA and unlike the symbiotic novae Feibelman mentioned.

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FLARE OBSERVED FOR A HIGH VELOCITY STAR

During the night of March 12/13, 1988 a relatively strong flare was observed for the high proper motion star G64-34 (=LTT5465) at the San Pedro Martir Observatory, Baja California, Mexico, using the Danish 6-channel uvbyβ photometer that has been in operation there since 1983. This star was observed as part of an ongoing extensive uvbyβ photometric survey of high-velocity and metal-poor stars (Schuster and Nissen, 1988). G64-34 has been selected from Table II of Fouts and Sandage (1986) who give V=11.98 and B-V=1.01 on the system of Johnson and a radial velocity of +25.7 km/sec; these values are based on only one photometric observation and only one radial velocity measurement .

The observations of the flare were made simultaneously in the bands u, v, b, and y of the Strömgren photometric system. A few Hβ observations were also obtained. The uvby instrumental magnitudes are plotted in Figure 1 corrected only for sky brightness and for changes in atmospheric extinction between the beginning and end of the flare. Small vertical error bars to the left in the figure show the errors expected only from the photon statistics, and a small horizontal bar near the top, center shows the integration time of 20 seconds. The interruption in the uvby observations before the peak of the flare corresponds to the time during which we measured Hβ and the moved off the star to measure the sky. The break immediately after the peak corresponds to the time of confusion produced in the observer by the flare itself - time during which the equipment and the identification of the star were checked.

Our observations include the peak of the flare and the sharp rise immediately preceding. However, due to the length of our integrations (20 seconds) detail has been lost. Nevertheless, the mean rates of brightening preceding the peak are at least $0^{\rm m}.021$/sec, $0^{\rm m}.013$/sec, $0^{\rm m}.008$/sec, and $0^{\rm m}.005$/sec in the filters u, v, b, and y, respectively. According to the criterion of Haro (1968), $0^{\rm m}.005$/sec, these rates classify G64-34 as a flare star. Also the shape of the lightcurve in Figure 1 is that of a type I flare as defined by Gurzadyan (1980).

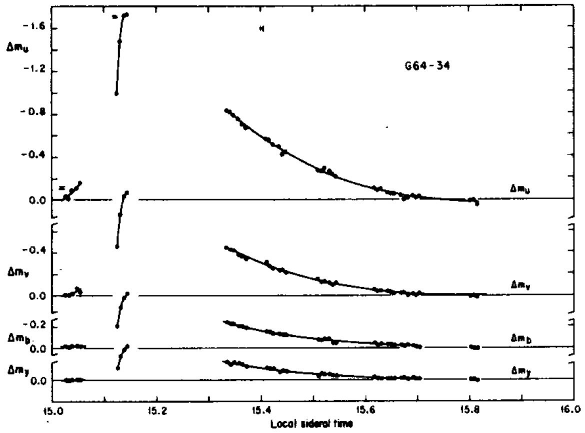

Figure 1.: The observed lightcurves of the flare of G64-34 from the night of 12/13 March 1988. The vertical coordinates are the instrumental magnitudes in u, v, b, and y, and the horizontal coordinate is the local sidereal time (in hours) for the San Pedro Martir observing site.

In Figure 1 it is quite obvious that the flare began in the u band, and perhaps also in the v band, prior to any brightness changes in the b and y bands. There is also marginal evidence that after the flare the star was returning to a brightness level slightly fainter than before the flare. This is clearest for the b band where the brightness levels before and after the flare are well defined. If we assume that the difference in brightness is due strictly to atmospheric extinction, we calculate k_b=0.367 which is unrealistically large for the San Pedro Martir observing site (Schuster, 1982).

For G64-34 the photometric data of Sandage and Kowal (1986) give δ (U-B)= +0.18, a blanketing corrected (B-V) of +1.19, M_V=7.602, and a distance D=75 pc. Using the Lowell and Luyten proper motions and the radial velocity measurement by Fouts and Sandage (1986), Sandage and Fouts (1987) calculate (U, V, W)= =(+65.9 km/sec, -65.2km/sec, +52.9km/sec) and S=106.7km/sec, where (U, V, W) are the usual galactic velocity components and S is the total space motion relative to the Sun. We estimate photometrically a spectral type of K5-K6 for the star (Johnson, 1966). For comparison, if we assume that G64-34 lies on the Population I ZAMS, its B-V=1.01 implies M_V=6.75 (Allen 1973), D=110 pc, (U, V, W)=(+103.0, -92.4, +67.9), S=154.1 km/sec, and a photometrically estimated spectral type of K2-K3. However, the resulting kinematics are not Population I, but they do give us an upper limit for possible velocities of G64-34 in the Galaxy. Another possibility is that G64-34 is a Population II subdwarf.

Then the value B-V=1.01 gives $M_V=7.95$ (Allen, 1973), D=64 pc, (U, V, W)= =(+54.3, -56.7, +48.2), and S=92.1 km/sec.

The range of kinematic parameters calculated above for G64-34 place it in the velocity space where the old thin disk, thick disk and halo populations overlap. The W component of approximately +50 km/sec means that G64-34 will move the approximately 800 pc above the galactic plane (Eggen, Lynden-Bell, and Sandage, 1962), suggesting that it is a member of the thick disk or halo populations. If the motion of G64-34 is not due to some sort of dynamical expulsion from a cluster or multiple system, then its age must be in the range 2×10^9 to 18×10^9 years, similar to those of stars in the old disk or halo populations. Other fairly old flare stars are known. For example, Wolf 630 is a flare star with an age similar to that of the old disk cluster M67 (Kunkel, 1970; Eggen, 1969). Other flare stars which probably belong to the old disk population are Wolf 359 and 40 Eri C (Kunkel, 1970), but none of these have kinematics as extreme as G64-34. Wolf 630 has (U, V, W)=(-26, -33, +12) (Eggen, 1969).

G64-34 is unusual in another sense. According to the discussion of Gurzadyan (Chapter 1, 1980) most UV Ceti-type (field) flare stars are of spectral class M with absolute visual magnitudes greater than 8.0. Only about 7% belong to the K spectral classes. For G64-34 we have estimated a spectral class of K5-K6 and $M_V \cong 7^m.6-8^m.0$, and we observed flare amplitudes of approximately $1^m.73$, $0^m.96$, $0^m.52$, and $0^m.32$ in the u, v, b, and y bands, respectively. According to Gurzadyan (1980), a flare with this amplitude for a field star with $M_V \cong 8.0$ should be very infrequent. Only in fairly young clusters or associations, such as the Pleiades, are flare amplitudes in the ultraviolet greater than $1^m.6$ detected with any frequency for the mid-K spectral types. However, on the Palomar prints we see that G64-34 is not now a member of any cluster or association.

On the night of June 10/11, 1988, we re-observed G64-34 with the same instrument, monitoring it for three and a half hours without detecting any further flare activity. According to Gurzadyan (1980), the average flare frequency for G64-34 should be approximately 1 flare each 4.2 hours, for all flares with $\Delta U > 0^m.1$. More monitoring of this star is strongly encouraged.

In conclusion, on the night of March 12/13, 1988 we observed an unambiguous flare event for the high-velocity star G64-34. The kinematics, photometrically estimated spectral type, and absolute visual magnitude of G64-34 are not typical for a field flare star. The kinematics suggest that the star is a runaway star or that it belongs to the thick disk or halo populations. In the latter case, we conclude that flare activity continues over a significantly large portion of the main-sequence lifetime of a metal-poor late-type star.

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ROTATION OF THE MAGNETIC Ap STAR 56 Ari

The magnetic Ap star 56 Ari was investigated in the UBV system by several authors: Provin (1953), Rakosch (1963), Hardie and Schroeder (1963), Blanco and Catalano (1970) and Hildebrandt et al. (1985). Additional measurements were made in the U band at the Bialkow Station of the Astronomical Institute of the Wroclaw University. All the data cover the interval J.D. 2434322 - 2447176 and span 17660 rotational cycles. These data yield the mean rotational period P_o=0.72789761 days. Then trigonometric polynomials of the second order were fitted to the individual data sets, by the least squares method:

$$m = m_o + \Sigma A_k \cdot \cos(2\pi \cdot ((JD-JD_o) \cdot k \cdot f_o - \Phi_k)). \qquad (k=1,2) \qquad (1)$$

The frequency $f_o=1/P_o=1.3738196$ and the starting epoch $JD_o=2437667.728$ were adopted in the calculations. Calculated phases of minimum brightness of the first and second order components (Φ_1 and Φ_2) vs. Julian Date together with the least squares fits of parabolas to these phases are exhibited in Figures 1 and 2. The fits indicate a decrease in the frequency. Calculated coefficients of the parabolas yield the following mean relationship between the frequency and JD:

$$f = 1.3739186 - 2.42 \cdot 10^{-9} \cdot (JD-2400000). \qquad (2)$$

Such decrease of frequency corresponds to an increase in the rotational period of 4 seconds per 100 years.

Magnetic braking may be the reason for the increase of rotational period. The calculated time for the e-folding loss of angular momentum is equal to $1.6 \cdot 10^6$ years. This result is an accord with calculations of hydromagnetic deceleration made by Fleck (1981). He gives estimate of the braking time equal to 10^6 years for "perpendicular rotators". From the model of Borra and Landstreet (1980) follows, that 56 Ari is a "perpendicular rotator" i.e. the magnetic field axis is nearly perpendicular to the rotational axis ($\beta=80^o$).

Another result is presented in Figure 3, which exhibits phases of maximum β index obtained in four observational runs vs. Julian Date. For comparison the calculated phases of minimum light in the U band are also exhibited. The

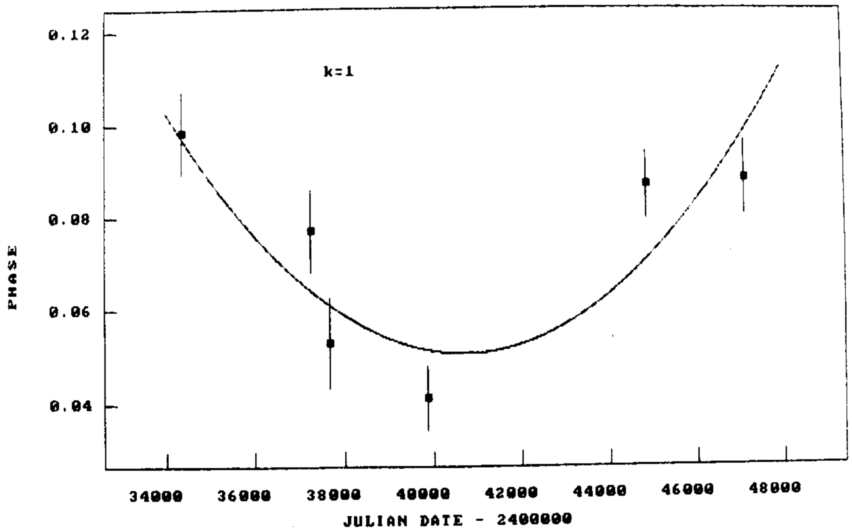

Figure 1. The phases of minimum brightness of the first order component vs. Julian Date.

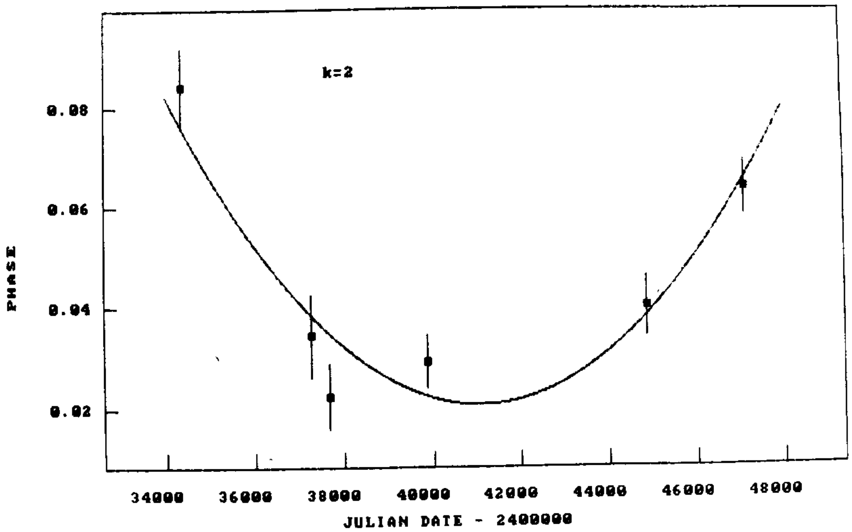

Figure 2. The phases of minimum brightness of the second order component vs. Julian Date.

The JD_o and f_o remain the same as those used for calculation of the data presented in Figures 1 and 2. The β indices for the time interval J.D. 2446307-2446746 were published by Musielok (1986), and by Musielok and Madej (1988). Additional measurements were made between J.D. 2447028 and 2447239. The increase of phases of maximum β index in Figure 3 is steeper than the calculated increase of phase of minimum light in U. This implies that the period of β variations is larger than the period of light variations in the U band. The period calculated from β measurements is equal to $0\overset{d}{.}7279534$, whereas the period of light variations in U calculated from equation 2 for the corresponding Julian Date is equal to $0\overset{d}{.}7279048$.

Musielok and Madej (1988) suggest that nonhomogeneities of the β index over the surface of 56 Ari are a consequence of Lorenz forces, which arise from interaction between macroscopic electric currents, which flow in the atmosphere and the large scale dipole magnetic field measured by Borra and Landstreet (1980). Variations of the β index reflect variations of the visibility of regions, where the Lorenz forces are most effective - "β-spot", during the rotational period. On the other hand, light variations reflect variations of visibility of the chemical spot. The positions of the photometric spot and the "β-spot" on the surface of 56 Ari are not the same because we

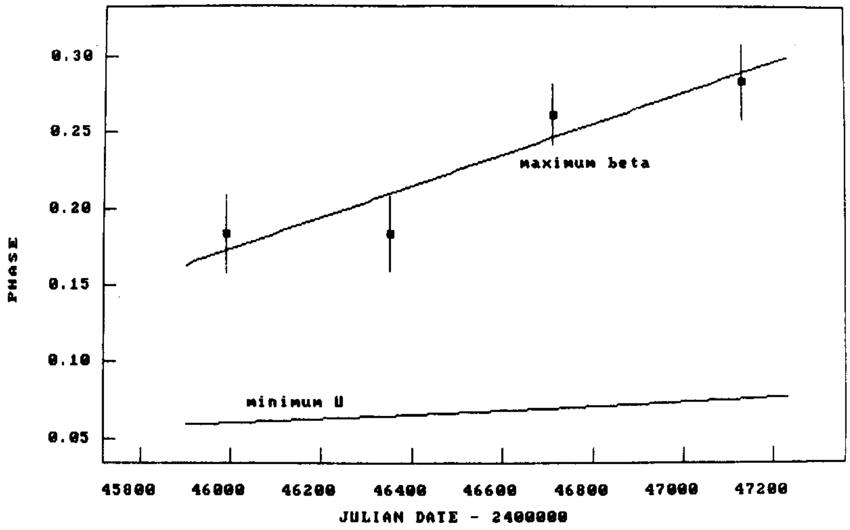

Figure 3. The phases of maximum beta index vs. Julian Date.

observe a shift between the phases of maximum β and photometric minimum (cf. Figure 3). The difference of both rotational periods could be interpreted as a result of relative migration of these features on the surface of 56 Ari.

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U B V OBSERVATIONS OF VW CEPHEI

UBV photoelectric observations of the W Ursae Majoris type system VW Cephei (BD +75°0752) were carried out at the Mount Laguna Observatory during three consecutive nights 5/6, 6/7 and 7/8 July, 1988. The 24-inch Smith f/20 telescope was used with the standard U,B,V filters and thermo-electrically cooled EMI 6256 photomultiplier. BD +75°0765 was used as a comparison star and approximately 500 measurements were obtained through each filter.

Three sets of data of the light curves and fifteen times of minimum light were determined from the observations of VW Cep .The data reduction and standardization program for differential photometry (Guinan et al., 1986) and a version of the Kordylewski's "tracing - paper" method (see Szafraniec,1948) adopted to the IBM-PC computer graphics (Guinan et al. 1987) were employed.The times of primary (I) and secondary (II) minimum light of the VW Cephei for each filter are given in Table I.

The differential U, B, V observations of VW Cephei are plotted against phase in Figure 1. The working ephemeris were used :

JD Hel Min I = 244 4176.6161 + 0.2783136 E.

Table I.: Times of minima of VW Ceph

J.D. hel. 244 0000+	m.e.	type	filter
7348.8079	±.0002	I	V
7348.8074	±.0002	I	B
7348.8063	±.0004	I	U
7348.9476	±.0003	II	V
7348.9459	±.0006	II	B
7348.9456	±.0008	II	U
7349.9215	±.0003	I	V
7349.9215	±.0001	I	B
7349.9217	±.0003	I	U
7350.7554	±.0003	I	V
7350.7553	±.0001	I	B
7350.7547	±.0002	I	U
7350.8944	±.0001	II	V
7350.8947	±.0001	II	B
7350.8946	±.0002	II	U

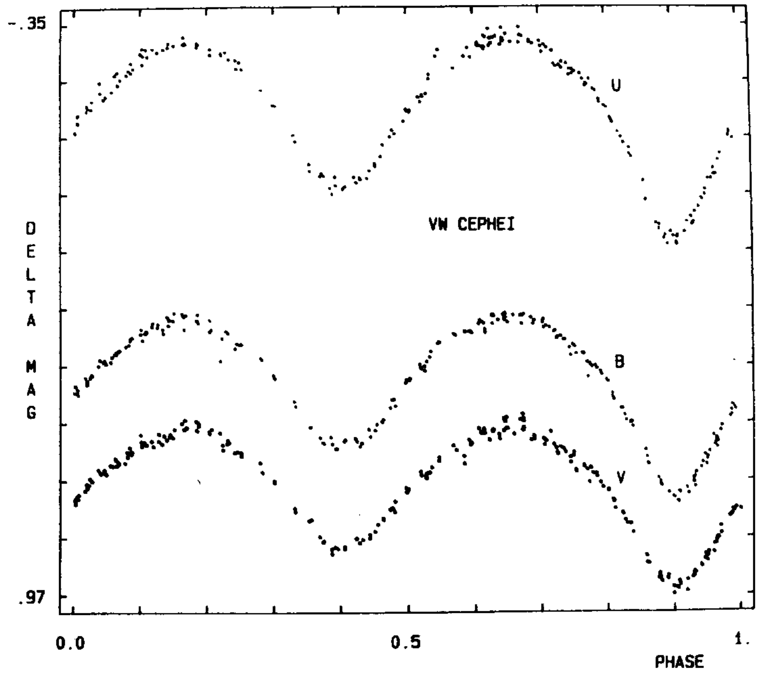

Figure 1.: The differential U, B, V observations of VW Cephei plotted in phase.

These light curves are almost symmetric and both the maxima in B, V band pass are nearly equal . In the past the light curves showed large assymmetries most noticeble in the differences of heights of maxima (Kotarska and Glownia ,1983). The relative depth of primary minimum in U band pass is significantly deeper than in B and V due in part of small differencies of stars temperatures and gravity darkening effects.In the U light curve the maximum following secondary minimum is slightly brighter by the order of 0.02 mag than the corresponding maximum that follows the primary minimum.

The analysis of the observations is underway.

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RS Boo. THE PECULIARITIES OF BLAZHKO EFFECT MANIFESTATION

The variability of RS Boo was discovered by Flemming (Pickering, 1907). Oosterhoff published a detailed investigation on the basis of 2418 photographic observations obtained in Leiden wherein he showed that the pulsation period and the star's light curve shape varied with a secondary period equal to 537 days. Kanyó (1980) confirmed the presence of the secondary period as long as 533 days and supposed a shorter secondary period $\Pi \sim 58-62$ days on the basis of photoelectric observations made at Konkoly Observatory between 1971 and 1979.

We carried out investigations of secondary periodicities in RS Boo using a more extensive material. We had at our disposal 192 moments of RS Boo maximum light (interval J.D. 2417668 - 2444842) published in the literature, as well as 112 moments of maximum light (interval J.D. 2437790 - 2446654) determined from the photometric observations made by G.A. Lange and the author (the depository of Odessa Astronomical Observatory).

The analysis of all the observational material showed that the pulsation period and the light curve shape of RS Boo changed with secondary periods $\Pi_1 = 531.9$ and $\Pi_2 = 47.7$ days. The periodicity with Π_1 and Π_2 retained throughout all the period of the observation of RS Boo.

The following plots are given in Figure 1:

a) the average curves O-C and $\Delta V(m)$ for $\Pi_1 = 530\overset{d}{.}2$ (observations by Kanyó, J.D. 2442443 - 2444008). The phases φ were calculated by the formula:

$$\mathrm{Max}_{0-B} = 2443249 + 530\overset{d}{.}2 \cdot n \tag{1}$$

b) The average curve O'-C' for $\Pi_2 = 47\overset{d}{.}7$ (observations made by the author, J.D. 2441770 - 2441923). The phases ψ were calculated by the formula:

$$\mathrm{Max}_{0-A} = 2434207.9 + 47\overset{d}{.}70 \cdot N \tag{2}$$

The series of observations of RS Boo at our disposal enabled us to carry out investigations of non-stability of the pulsation period P, that of the periods Π_1 and Π_2 as well as the variations in the amplitude of the Blazhko

Table I

Max_{O-B}	n	O-B	$Ampl_{O-B}$
2419823	0^d	0^d	$0\overset{d}{.}015$
26233	12	27	0.019
28363	16	30	0.022
30475	20	14	0.014
33124	25	4	0.015
34169	27	-15	0.015
37925	34	17:	0.025
39531	37	28	0.023
41128	40	29	0.025
42718	43	23	0.020
43249	44	22	0.017
45371	48	17	0.015

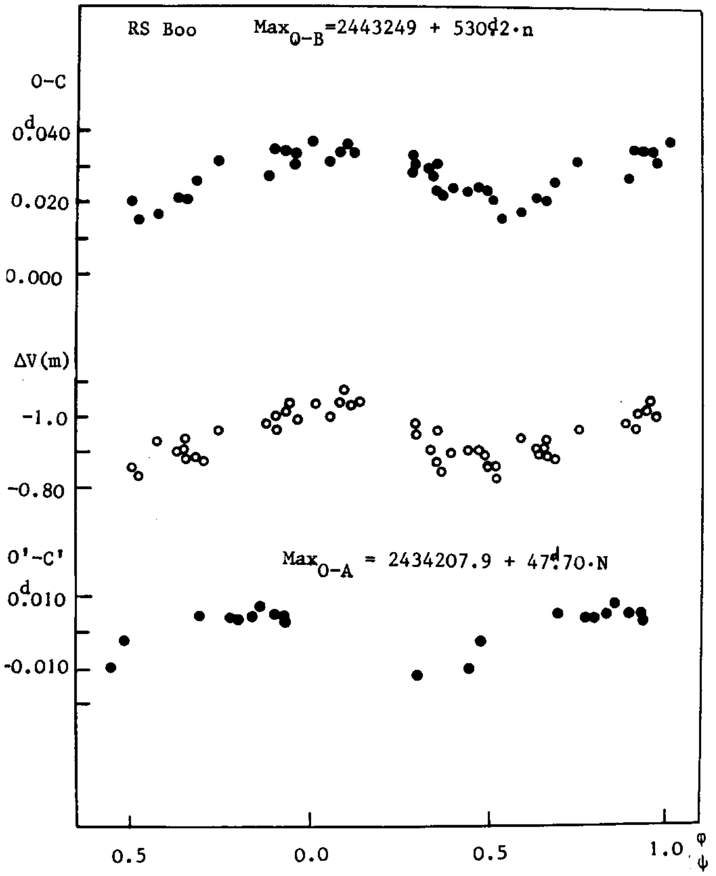

Figure 1

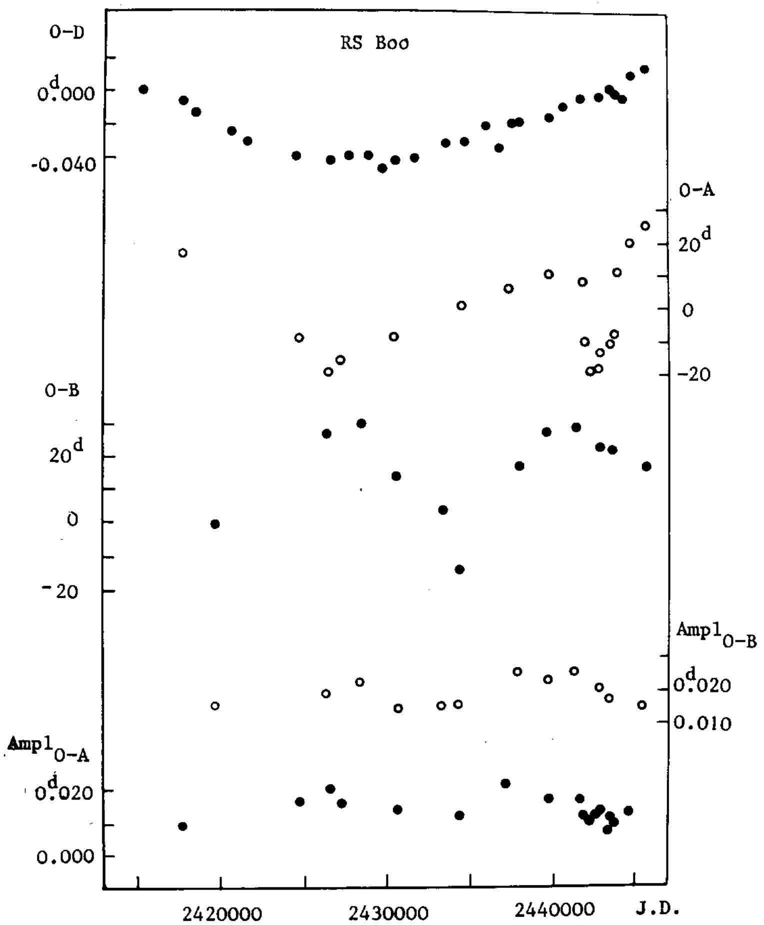

Figure 2

effect with Π_1 and Π_2 from cycle to cycle. To solve this problem, the average curves for cycles Π_1 and Π_2 were constructed. From the seasonal average curves the deviations of the moments of maximum O-B were determined for the cycle Π_1 and those of moments of maximum O-A for the cycle Π_2 as well as the amplitude of Blazhko effect Ampl_{O-B} and Ampl_{O-A} respectively. The values obtained are given in Tables I and II wherein the successive columns contain the following data: the moment of maximum O-B (the moment of maximum O-A); the number of the epoch n (the number of the epoch N); the residual O-B (the residual O-A); Ampl_{O-B} (Ampl_{O-A}).

Table II

Max_{O-A}	N	O-A	Ampl_{O-A}
2417863.2	-343	$16^{d}.4$	$0^{d}.009$
24610.3	-201	- 9.9	0.016
26413.6	-163	-19.2	0.020
27036.2	-150	-16.7	0.016
30429.9	- 79	- 9.7	0.014
34207.9	0	0.0	0.012
37027.4	59	5.2	0.021
39655.5	114	9.8	0.017
41751.9	158	7.4	0.016
41828.9	160	-11.0	0.011
42201.7	168	-19.8	0.010
42393.2	172	-19.1	0.011
42780.3	180	-13.6	0.013
43259.5	190	-11.4	0.007
43549.2	196	- 7.9	0.011
43759.5	200	11.6	0.010
44530.5	216	19.4	0.013
45490.2:	236	25.1:	0.008

The residuals O-B were calculated with respect to the elements:

$$\mathrm{Max}_{O-B} = 2419823 + 531^{d}.9\cdot n \tag{3}$$

while the residuals O-A were calculated with respect to the elements (2).

In Figure 2 there are given:

a) the O-D residuals for the period of pulsation of RS Boo calculated using the formula: Max.hel. J.D. = 2441770.486 + $0^{d}.37733657\cdot E$ (Zessewitsch, 1986);

b) the O-A residuals calculated by the formula (2);

c) the O-B residuals calculated by the formula (3);

d) the plot Ampl_{O-B} ;

e) the plot Ampl_{O-A} .

The analysis of Figure 2 shows that the pulsation period is increasing monotonously. The presence of two periods of Blazhko effect ($\Pi_1 = 531^{d}.9$ and $\Pi_2 = 47^{d}.7$) is a characteristic peculiarity of RS Boo pulsation. The variations of the O-A residuals and those of O-B residuals do not show any ordinary pattern of mirror image of the trend seen in the O-D residuals. However, the residuals O-A and O-B have a similar to each other character of variations, these change cyclically and in antiphase. A characteristic cycle duration is 36 years. The variations of Ampl_{O-A} and Ampl_{O-B} proceed with an analogous cycle but in synphase.

The absence of apparent relation between the nonstability of the pulsation period P and the character of amplitude instability and the periods

Π_1 and Π_2 of Blazhko effect shows that in the case of RS Boo we observe a multiparametrical manifestation of the Blazhko effect.

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THE OPTICAL BEHAVIOUR OF THE X-RAY SOURCE GX 304-1 DURING 1985 - 1988 *

GX 304-1 (4U 1258-61) is known to be a pulsating X-ray source with a period of 272 s (McClintock et al., 1977). The optical counterpart is a B main sequence star (Mason et al., 1978) showing strong double-peaked Hα emission which systematically faded out between 1978 and 1982 leaving Hα in absorption (Corbet et al., 1986). At the same time the system brightened in V from ~14.2 to ~13.7. Periodic X-ray flaring was found by Priedhorsky and Terrell (1983) which is interpreted as reflecting the orbital revolution of 132.5 d. There exist also off-states (Pietsch et al., 1986) where the X-ray flux is appreciably lower than in quiescence. In the following some spectroscopic and photometric observations are reported which might be useful for those interested in the long time behaviour of this system.

The spectroscopy was performed in 1985-1988 using the Boller & Chivens spectrograph attached to the ESO 1.5 resp. 3.6 m telescope with the IDS or a CCD as detector. Table 1 gives the journal of observations. The spectra (Fig. 1) show no emission in Hα thus indicating that the optical companion was still in its inactive state.

UBVRI photometry was obtained in Feb. 1985 using the ESO 50 cm telescope equipped with the single-channel photometer. The results listed in Table 2 are in the same range as reported by Corbet et al. (1986) for the year 1983. Continuous photometry in

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* based on observations collected at the European Southern Observatory, La Silla/Chile

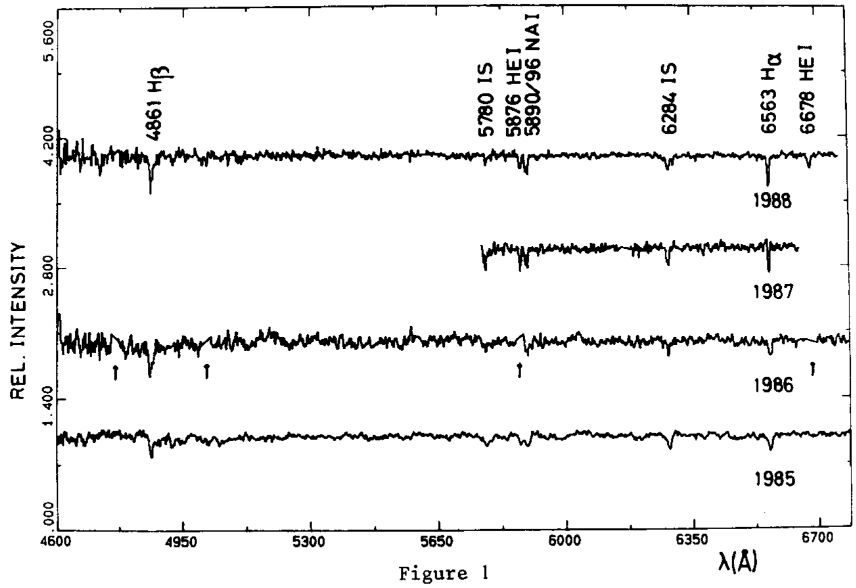

Figure 1

Spectra of GX 304-1. The spectrum of 1986 is of minor quality, arrows indicate pixel errors. The two spectra of 1985 are averaged. Most prominent features are identified.

Table I. Spectroscopy of GX 304-1

Date	Tel.	Detec.	Disp.(A/mm)	Exp. (min)
1985 Feb. 26	1.5m	IDS	114	56
1985 Feb. 27	1.5m	IDS	114	68
1986 March 13	1.5m	IDS	114	40
1987 July 30	3.6m	CCD	59.5	2
1988 June 19	1.5m	CCD	172	20

Table II. Photometry of GX 304-1

Date	V	B-V	U-B	V-R	V-I	n
1985 Feb. 24	13.67±0.03	1.83±0.09	0.66±0.40	1.10±0.03	2.33±0.02	12
1985 Feb. 25	13.71±0.02	1.81±0.06	0.88±0.34	1.11±0.03	2.34±0.02	11

integral light (duration 3 h, time resolution 4 s) was additionally performed in 1985 March 2 and the data was searched for short periodic variations. No significant signal near the X-ray period of 272 s could be found.

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ON THE PRIMARY MASS OF NSV 12615 *

The cataclysmic variable NSV 12615 shows eclipses repeating with a period of 0.06142 d (Jablonski and Steiner, 1987). In a recent paper Mukai et al. (1988) presented spectroscopic observations around Hα and reported on discrepancies in estimating the primary mass. As these authors suggest, one possibility to abolish this problem would be to enhance the semi-amplitude of the orbital velocity from 56 km/s to ≈100 km/s corresponding to a primary mass of ≈0.2 $M_{\odot}$.

About three months after their observations a spectrum of that object was obtained using the ESO 3.6m telescope equipped with the Boller & Chivens spectrograph and CCD. Besides Hα the HeI line λ 5876 is present in the recorded wavelength region (Fig. 1). Spectral resolution and integration time were nearly identical with their spectroscopy (binned data) and similar values for the FWZI of Hα and the separation of the components can be derived. Given their epoch of the inferior conjunction of the secondary and the known period the corresponding phase for that spectrum is 0.8±0.3, i.e. near the maximum of the radial velocity curve. A Gauss fit to the line wings of Hα yields a (heliocentric) velocity of ≈ 60±10 km/s. This either would correspond to a higher semi-amplitude of ≈ 120 km/s or to a shift of the γ-velocity by ≈ 60 km/s. The higher semi-amplitude would still (or even better) be in accordance with their diagnostic diagram and would thus favour a low primary mass.

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* based on observations collected at the European Southern Observatory La Silla / Chile

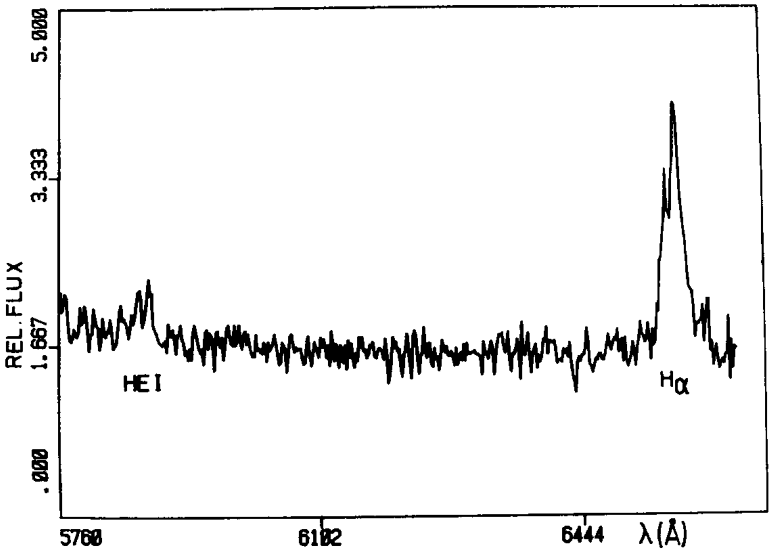

Figure 1 Spectrum of NSV 12615

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BV PHOTOMETRY OF IOTA BOOTIS

The light variability of iota Bootis was firstly reported by Guthnick and Prager (1918). Based on two short data series Albert (1980) suggested a 35-40 minute period with 0.025 magnitude variation in B. Kholopov et al. (1985) reported this star as DSCTC type.

Our observations were made on four nights in June 1988 with the 40 cm Cassegrain reflector of JATE University at the Baja Observatory described by Hegedüs (1987).

Iota Boo (=21 Boo=HR 5350=HD 125161=ADS 9198=NSV 06610, $V=4^m.75$ A7V) was observed as var2 during a photometric study of the δ Scuti type star κ^2Boo. Iota Boo is a visual binary, A and B components were observed together.

The comparison star was ϑ Boo (=23 Boo=HR 5404=HD 126660=NSV 06669, $V=4^m.05$ F7V). Although it is a suspected variable (Kukarkin et al. 1982), probably is not δ Scuti star.

The ι Boo A+B − ϑ Boo differential light curves in the instrumental BV system are presented in Figure 1. By use of the Fourier analysis of unequally spaced data (Deeming, 1975), the power spectra for all our data were calculated. Table I shows the peaks in the spectrum of the ΔV light curve. The frequency spectrum for ΔB is similar, but there are differences in the position of frequencies.

Table I

	frequency (c/d)	amplitude (mag)
f_1	2.822	0.016
f_2	9.279	0.014
f_3	13.675	0.012
f_4	22.660	0.012
f_5	36.782	0.013

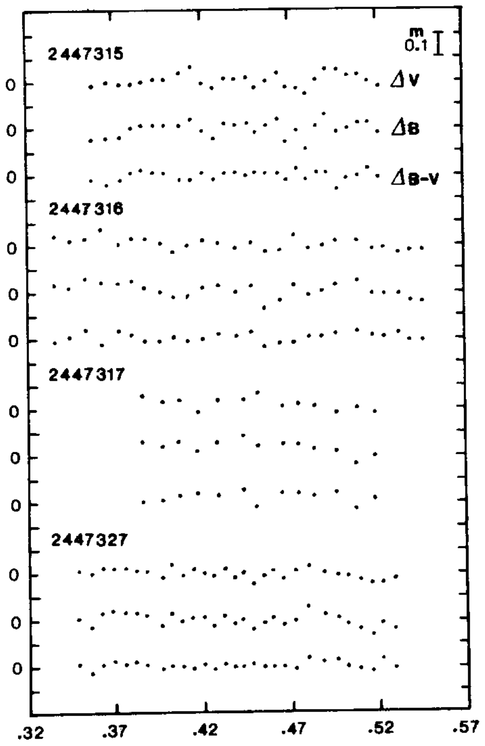

Figure 1. ι Boo A+B − ϑ Boo light curves on four nights. O signs are the averages: $\langle \Delta V\rangle = 0^m.6996$, $\langle \Delta B\rangle = 0^m.4784$, $\langle \Delta B-V\rangle = -0^m.2212$. Data are in IAU Archives as file 167.

In the case of f_2, f_3 and f_4 the determination of the true frequencies is difficult because the 1 c/d aliases have similar peak-heights. We note that $f_2+f_3 \sim f_4$ and $f_3+f_4 \sim f_5$. The short period P_5=38-39 minutes is very close to Albert's result.

Our observations were also analysed by the Maximum Entropy Method (Burg, 1975; Ulrych and Clayton, 1976). The data were made equidistant by linear interpolation. One or two peaks at the average period of $0^d.026$ is present on each night. The position of the other peaks at longer periods varies.

There is an interesting group of the δ Scuti stars with such a short period ($0^d.021<P<0^d.032$): V377 Cas, BG Cet, V624 Tau, V534 Tau, V650 Tau, UU Com, ρ Vir, γ CrB and V 1644 Cyg. These stars have small amplitude and very complex light variation.

We conclude that iota Bootis may be really a δ Scuti star with a characteristic short period $P=0^d.027\pm0^d.002 = 39\pm3$ minutes. More observations are needed to determine its periodic behaviour.

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o AND: ANOTHER MAJOR SHELL PHASE JUST COMING?

The bright B6IIIe shell star o And (1 And, HR 8762, HD 217675, SAO 52609) has been observed spectroscopically and photometrically for nearly a century. The Be shell star is the brightest component A of a multiple system of at least four stars (see, e.g., Hill et al. 1988, Harmanec et al. 1987 and Harmanec 1983, plus references therein). Component B at a distance of about 0.3" apparently revolves in a common orbit with A - the estimated orbital period is well over 100 years. Component B itself is a double-lined spectroscopic binary with a period of 33.08 days composed of two B6-B8 stars. There is a faint fourth component a at a distance of some 0.05" for which no direct spectroscopic evidence has been found so far. If this component is also gravitationally bound to A, the expected orbital period is about 10 years.

Many investigators since the end of the 19th century have helped to accumulate evidence of the gradual variations in the spectrum of o And A from B-absorption to Be, Be shell, and vice versa. Horn et al. (1982) demonstrated that the object becomes fainter during the development of a new shell, similar to BU Tau, 88 Her or V1294 Aql. Harmanec (1984) - compiling and analyzing all historical photoelectric photometry and most of the available spectroscopic records - concluded that both - the light minima and re-appearances of the hydrogen shell lines - are cyclic or even periodic, with a cycle length of about 8.5 years. He also pointed

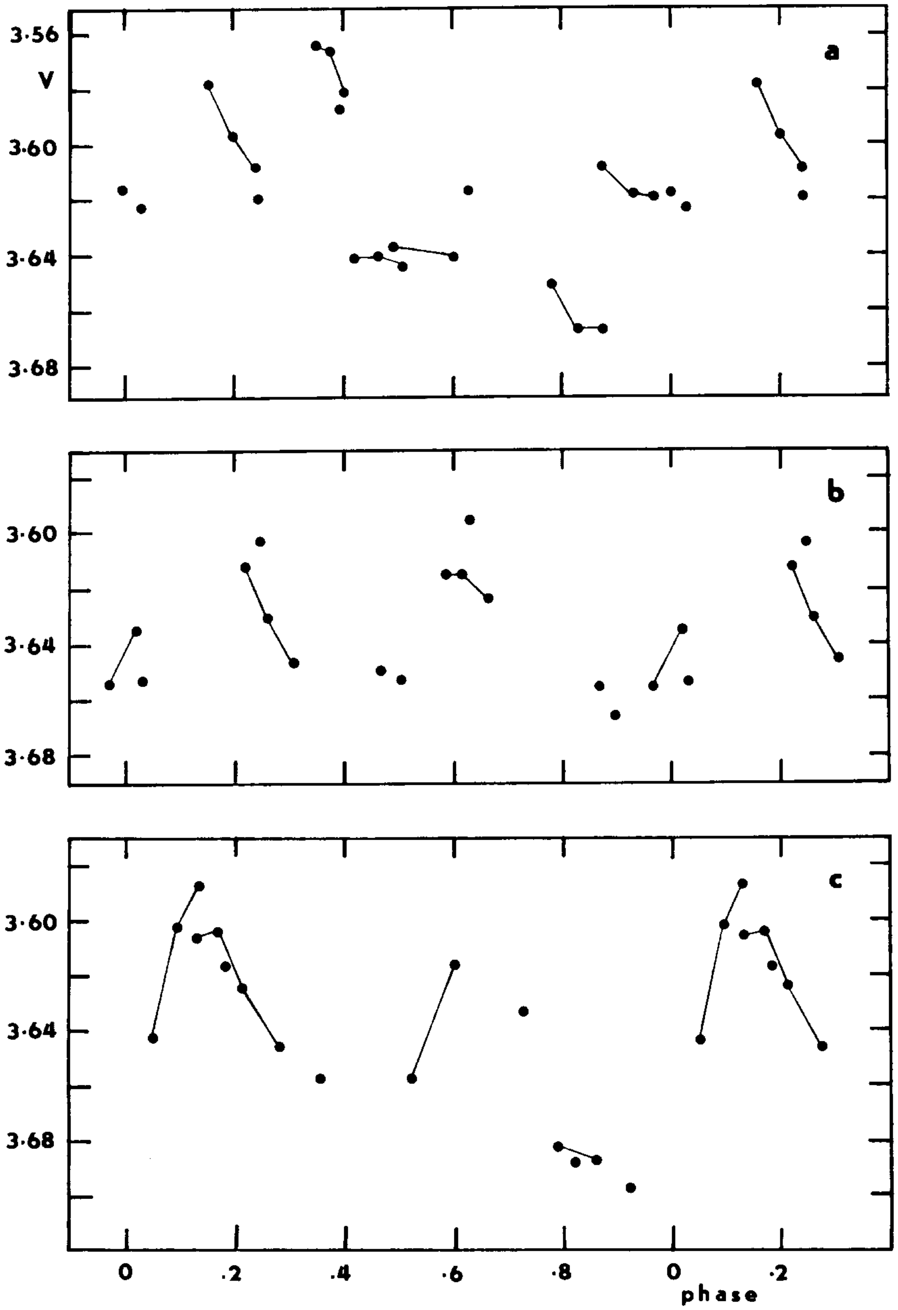

Fig. 1

out the possible connection of this cycle with the expected orbital period of subsystem Aa. Harmanec further concluded that the short-term light variations of o And are periodic, with a period of 1.571 days, but that the light curve varies in amplitude and shape along with the 8.5-year cycle. In particular, he noted that a well-defined double-wave light curve with a full amplitude of 0.1^m in V and B, reminiscent of a close eclipsing binary, is usually observed during the presence of the hydrogen shell lines.

Gulliver et al. (1980) and Koubský (1984) have shown that the overall behaviour of the shell may be more complicated than simply periodic. Koubský stressed that the 8.5-year period is in a better agreement with those shell events when also metallic shell lines were observed. These were recorded in 1891, 1949-53, 1974-76 and 1981-83. Should the suspected 8-9 year cycle be preserved, the first indications of a new major shell phase must soon re-appear.

Since the occurrence of the last major shell in 1981, o And has been monitored systematically by a large group of photometric observers associated with the International Be Observing Campaign (Harmanec, Horn and Koubský 1981). The results will be published elsewhere. Here, we wish to report first preliminary results of the UBV observations of the star secured by us with the 0.65-m reflector of the Hvar Observatory, Yugoslavia in July, August and October 1988. They seem to indicate that a new major shell phase may indeed be just coming.

Fig. 1 is a plot of our preliminary V observations versus phase of the 1.577-day period (the best-fit seasonal value of the period) shown separately for the data secured before HJD 2447372 (Fig. 1a), between HJD 2447373 and ... 387 (Fig. 1b) and in October (HJD 2447443-58) - Fig. 1c. It is seen that the variations displayed in Fig. 1a are somewhat erratic, while Figs. 1b and 1c show a double-wave light curve of a growing amplitude. (The comparison star was HR 8733, the V magnitude of the check, 10 Lac was 4.88^m, with a 0.02^m scatter.) A full amplitude of the rapid light variations in V as large as 0.10^m (as seen in Fig. 1c) has only been observed during the major hydrogen and metallic shell phases, for the last time in 1981-83. Our observations may therefore indicate a rapid development of a new major shell.

We thus alert all northern-hemisphere observers to obtain as many as possible new photometric, polarimetric, spectroscopic and magnetic observations of o And before the star disappears from the winter sky.

We thank M. Malarić, who helped to secure some of the observations.

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ON THE ORBITAL PERIOD OF FO AQUARII

Patterson and Steiner (1983) identified the 13^{th} magnitude cataclysmic variable FO Aquarii as the optical counterpart of the X-ray source H2215–086, and found strictly coherent large-amplitude pulsations in the light curve, with a period of 21 minutes. In addition they found a shallow modulation recurring at the same period with which the emission lines move, which appeared to be 0.16802 days. This period has been adopted as the fundamental orbital period in all later studies, but we shall see below that it is probably incorrect, being a 24-hour alias of the true orbital period.

Tables 1 and 2 contain all available information on the two signatures of the orbital motion: the timings of "orbital dips" in the light curve, and the timings of inferior conjunction of the emission-line source. as revealed by radial velocity studies. The photometric data are sufficient to establish that the dips follow one of the following ephemerides:

(a) Minimum light $= JD_{\odot}\,2,44782.867 + 0\overset{d}{.}202060E$

(b) Minimum light $= JD_{\odot}\,2,44782.888 + 0\overset{d}{.}168017E$

In Table 1 we give cycle counts and $O-C$ residuals for the timings under each of these alternatives. The $O-C$ diagrams are shown in Figure 1, which shows that ephemeris (a) provides an excellent fit with an rms scatter of only 0.03 cycles, while ephemeris (b) is much less satisfactory, with an rms scatter of 0.09 cycles. Still a third cycle count, corresponding to $P = 0.1680466\ d$, was suggested as a possibility by Semeniuk and Kaluzny (1988), but Figure 1 shows that this is not possible.

This evidence ***strongly*** favors the longer period. Normally we would consider this evidence decisive, but the three spectroscopic timings, given in Table 2, supply contrary evidence. They occur at a consistent orbital phase according to ephemeris (b), but not according to ephemeris (a). This strongly favors the shorter period.

We can envision 3 solutions to this confusing problem:

TABLE 1 – Orbital "dips" in the light curve

Time	Observatory	ephemeris (a)		ephemeris (b)		Source
($JD_{\odot}$ 2,440,000+)		E	$O-C$ (cycles)	E	$O-C$ (cycles)	
4782.871	KPNO	0	+.02	0	−.10	Patterson and Steiner 1983
4787.914	KPNO	25	−.02	30	−.09	Patterson and Steiner 1983
4789.938	KPNO	35	−.01	42	−.04	Patterson and Steiner 1983
4790.953	KPNO	40	+.02	48	+.00	Patterson and Steiner 1983
4791.969	KPNO	45	+.05	54	+.05	Patterson and Steiner 1983
4834.801	CTIO	257	+.02	309	−.03	Patterson and Steiner 1983
4873.789	KPNO	450	−.02	541	+.02	Patterson and Steiner 1983
4881.673	KPNO	489	−.01	588	−.05	Patterson and Steiner 1983
4882.685	KPNO	494	+.00	594	−.03	Patterson and Steiner 1983
5117.881	ESO	1658	−.01	1994	−.20	Pakull 1986
5505.029	UKIRT	3574	−.00	4298	+.02	Sherrington, James & Bailey 1984
5613.733	KPNO	4112	−.02	4945	+.01	This paper
5919.867	KPNO	5627	+.04	6767	+.05	Mateo 1985
5929.142	AAO	5673	−.06	6822	+.25	Berriman *et al.* 1986
(6931.67)	KPNO	7962	+.01	9575	+.11	This paper
(6682.64)	CTIO	9402	+.02	11307	−.10	Semeniuk and Kaluzny 1988
6684.655	CTIO	9412	−.00	11319	−.10	Semeniuk and Kaluzny 1988
6685.665	CTIO	9417	−.00	11325	−.09	Semeniuk and Kaluzny 1988
6695.574	CTIO	9466	+.03	11384	−.12	This paper
6704.625	McDonald	9699	−.01	11652	+.02	Shafter and Macry 1987

TABLE 2 – Times of inferior conjunction of emission lines

Time	Observatory	ephemeris (a)		ephemeris (b)		Source
($JD_{\odot}$ 2,440,000+)		E	$O-C$ (cycles)	E	$O-C$ (cycles)	
4791.939	McGraw-Hill	45	−.10	54	−.13	Williams 1981
4872.939	Lick	446	−.23	536	−.04	Shafter and Macry 1987
5915.475	KPNO	5605	+.30	6741	−.09	Mateo 1985

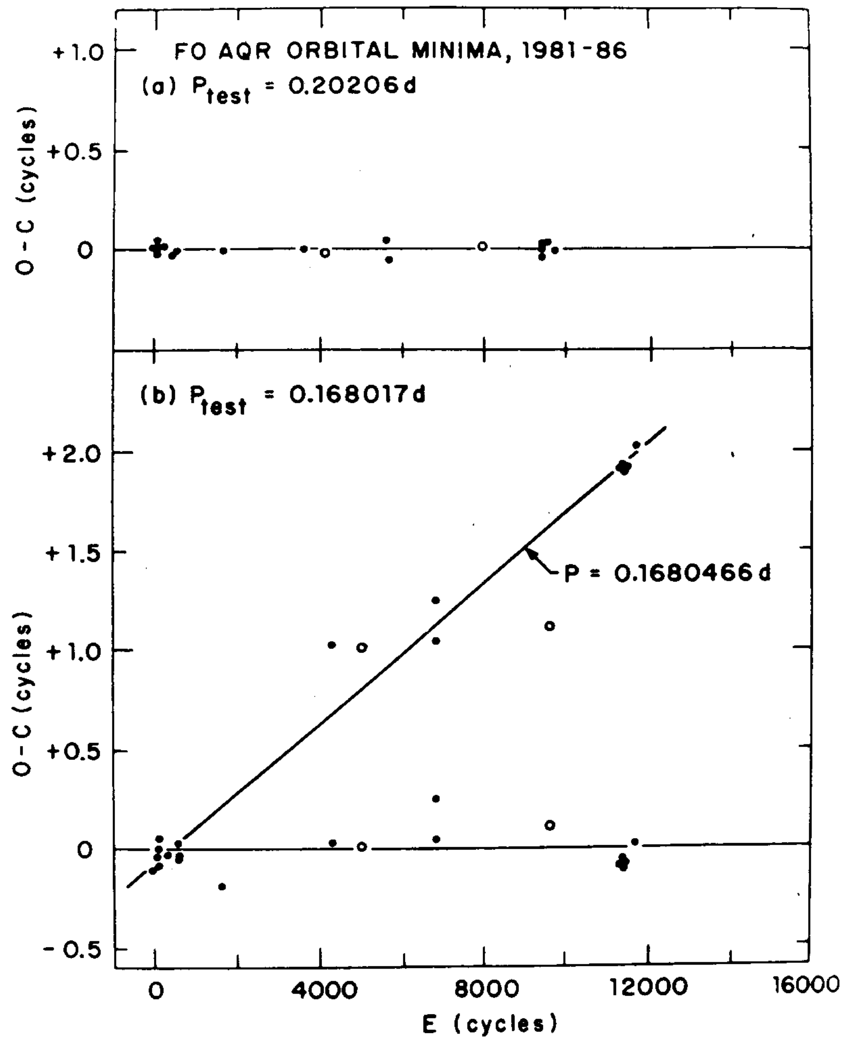

Figure 1. $O - C$ diagrams of the orbital dips, relative to three candidate ephemerides. The scatter about ephemeris (a) is by far the least, suggesting that it is the correct choice.

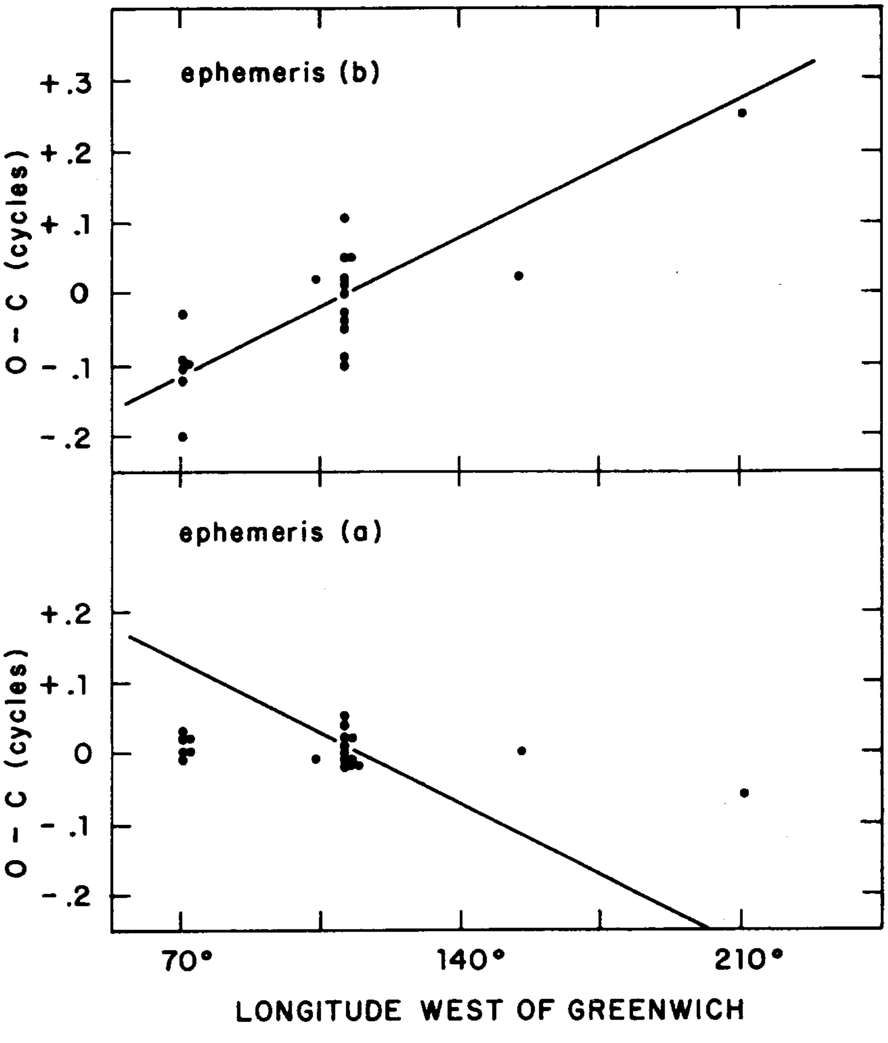

Figure 2. Dependence of dip timings on observatory longitude. No dependence is seen for ephemeris (a), but ephemeris (b) shows a systematic trend with longitude - in agreement with the solid line, which shows the trend expected if a cycle count error is present.

(1) The photometric period is really 0.20206 days, but the spectroscopic period is slightly different, sufficient to cause the inconsistent $O - C$ residuals in Table 2.

(2) Both photometric and spectroscopic periods are really 0.168017 days, but the uncertainties in the timings conspired by accident to give a substantially better fit to the longer, incorrect period.

(3) Both periods are really 0.20206 days, but at the time of Mateo's (1985) spectroscopy, the dominant emission-line source switched from its normal location by ~ 180°.

While none of these can be entirely excluded, we suspect that (3) is the correct answer. The accreting white dwarf in the system is a strong X-ray source which may cause a significant emission-line luminosity from the secondary and/or the hot spot region, due to the reprocessing of X-rays. This would be significantly out of phase with the motion of the accretion disk, normally the site of emission lines in cataclysmic variables. It's possible that a small rise in X-ray luminosity might shift the dominant role in the emission lines away from the accretion disk.

In principle, it might be possible to find the orbital frequency by finding an optical modulation at the sideband frequency ($\nu_x - \nu_{\rm ORB}$) caused by X-ray heating of surfaces fixed in the orbital frame. Such a modulation appears to be intermittently present, seen in the power spectra published by Patterson and Steiner (1983; $P = 1370 \pm 15$ sec) and Semeniuk and Kaluzny (1988; $P = 1374 \pm 4$ or 1351 ± 4 sec). The 0.168 d orbital period predicts $P_{\rm SIDE} = 1373$ sec, while the 0.202 d orbital period predicts $P_{\rm SIDE} = 1352$ sec. Hence this evidence, though far from conclusive, slightly favors the shorter period.

A better test, in our opinion, is to look for a systematic dependence of the $O - C$ residuals on the observer's terrestrial longitude. Figure 2 shows that such an effect does exist with ephemeris (b), but not with ephemeris (a). As Figure 2 demonstrates, the observed sign and magnitude of the effect provides strong support for the hypothesis we favor, that ephemeris (a) is correct.

Finally, it's worth noting that any lingering uncertainty about the photometric period could be dispelled by a single, high-quality timing obtained in Europe, Africa, or Asia. This will break the 24-hour alias which is the root of the problem.

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THE W UMa STARS AB Tel AND BF Pav

The two W UMa stars AB Tel and BF Pav have been observed by Hoffmann (1984) but he has not been able to undertake a detailed analysis of the light curves due to incompleteness in the data (Hoffmann, 1980, 1981). These two stars were included in a programme of photometry of W UMa stars that was commenced at SAAO, but in this case also the light curves are incomplete and cannot be analysed. The results are therefore discussed here in general terms in the light of Hoffmann's conclusions, and times of minima are presented which may be used in studying period changes in these stars.

The BV observations of AB Tel and BF Pav, which will be presented elsewhere, were obtained with the St Andrews Photometer on the 1.0 m telescope at SAAO, Sutherland and have been transformed on to the standard system through observations of E-region stars (Menzies et al. 1980). The comparison and check stars, all of which were constant to less than 0.01 mag over the periods of the observations, and their adopted magnitudes are listed in Table I.

AB Tel

Hoffmann (1980) obtained only a partial light curve for AB Tel, but from two timings of a minimum (2444435.5645 and 2444441.7580) derived a period of 0.32597 d. Using the method of Kwee and van Woerden (1956), the minimum covered by the SAAO observations is at HJD 2445885.45616 ± 0.00006, which corresponds to a phase of 0.930 using Hoffmann's ephemeris. The depth of the minimum is $\Delta V=0.63$ and $\Delta B=0.66$ mag. Assuming that the light curve has not changed in shape, this is not the minimum observed by Hoffmann which has depths $\Delta V=0.72$ and $\Delta B=0.72$ mag.

Hoffmann states that there are indications that the minimum he observed represents an annular eclipse, and concludes that the mass ratio (q) of the components is at least 0.5. Using the atlas of Anderson and Shu (1979), the SAAO observations taken in conjunction with Hoffmann's observations suggest $q \gtrsim 0.6$ and $i \sim 80^{\circ}$. The B-V colours of AB Tel are 0.76 at minimum and 0.73

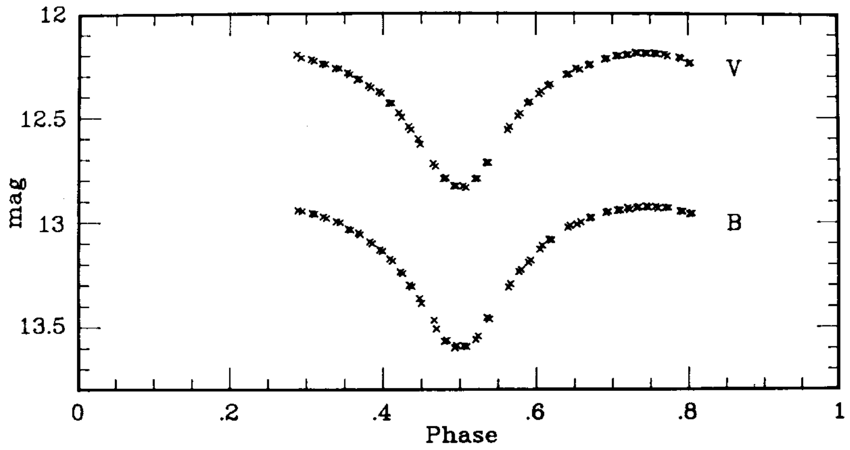

Figure 1. V and B light curves of AB Tel. The phase has been calculated using Hoffmann's period and the minimum has been arbitrarily shifted to phase 0.5.

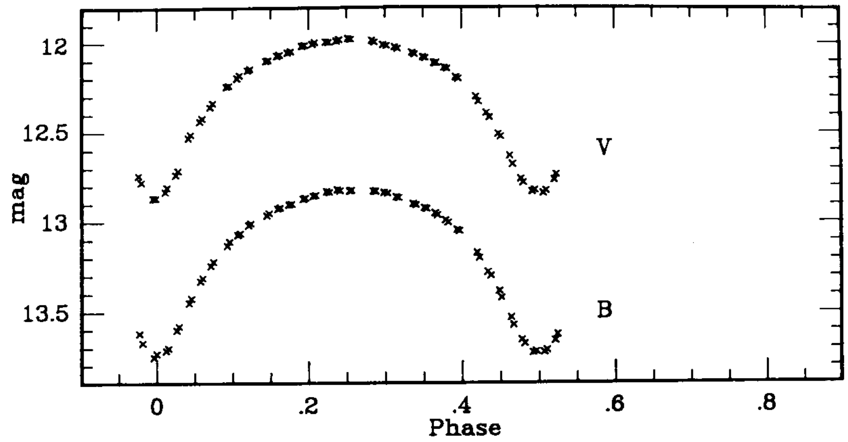

Figure 2. V and B light curves of BF Pav. The phase has been calculated using Hoffmann's period and the first minimum has been arbitrarily shifted to phase 0.0.

Table I

		V	B-V	n
AB Tel	HD 171456	9.822 ± 0.002	1.083 ± 0.003	36
	HD 171846	9.550 ± 0.005	0.533 ± 0.003	4
BF Pav	CPD-59°7353	10.100 ± 0.003	0.129 ± 0.003	35
	HD 172081	9.273 ± 0.003	0.783 ± 0.003	4

at quadrature. The reddening is not expected to be large ($E(B-V) \sim 0.10$) (Burstein and Heiles, 1982) indicating that AB Tel is a W-type W UMa system.

BF Pav

Hoffmann (1981) obtained an almost complete light curve (excepting the portion around one of the minima) for BF Pav, from which he derived a period of 0.3056 d and a time of minimum at HJD 2444438.7611. The SAAO observations cover the two minima and the intervening quadrature. The minima are not well defined, but the method of Kwee and van Woerden (1956) gives times of HJD 2445886.40884 ± 0.00014 and 2445886.56152 ± 0.00036 (the times of minima have been calculated for both B and V, and averaged). The errors on these times do not allow a refinement of the period, but should nevertheless be useful in a future study of possible period changes in BF Pav.

The present data confirms Hoffmann's conclusion that $q \sim 0.8$ and $i > 80^{\circ}$ and would indicate that the shape of light curve is unlikely to have changed in the period between the two sets of observations. The B-V colours are ~0.88 at the minima and 0.85 at quadrature, which, with the low expected reddening (Burstein and Heiles, 1982), suggest that BF Pav is a W-type W UMa system.

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A NEW PERIOD CHANGE OF BX And

The short period eclipsing binary BX And (=BD+40°442=HD13078) is the brighter component of the visual binary ADS 1671. It was announced as a variable star by Soloviev (1945). Its light elements and times of minima have been published by various authors (see references to Table I).

BX And was observed at the Ege University Observatory. The observations were made in B and V bands using the 48 cm Cassegrain reflector with a photoelectric photometer equipped with an unrefrigerated photomultiplier tube EMI 9781A. BD+39°476 and BD+39°484 were used as comparison and check stars, respectively.

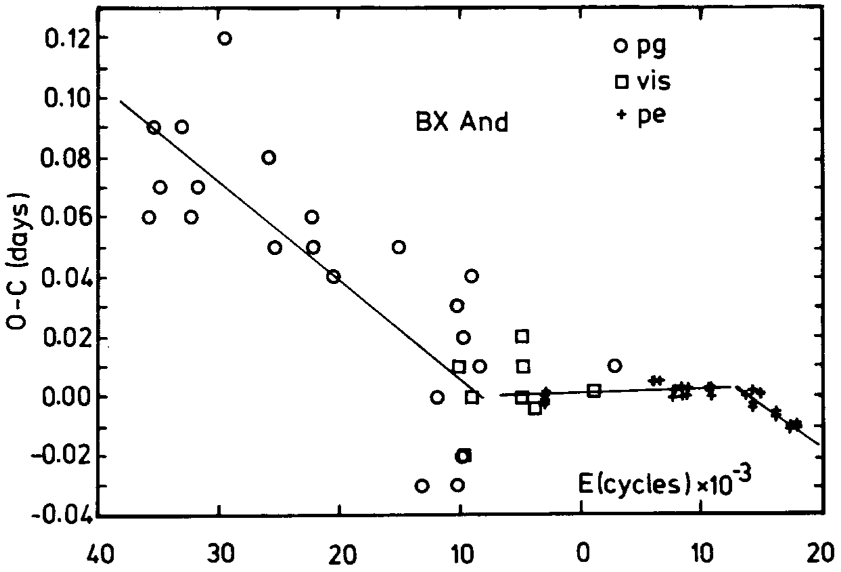

Figure 1 : The O-C diagram for BX And. (Ephemeris: Chou, 1959).

Table I. Times of minima of BX Andromedae

J.D. Hel.	min	method	E	O-C_1	O-C_2	Ref.
2414688.54	I	pg	-35797	0.06	-0.03	1
966.78	I	pg	-35341	0.09	0.00	1
15282.80	I	pg	-34823	0.07	-0.02	1
16371.88	I	pg	-33038	0.09	0.01	1
860.55	I	pg	-32237	0.06	-0.02	1
17168.67	I	pg	-31732	0.07	-0.01	1
18542.70	I	pg	-29480	0.12	0.05	1
20751.89	I	pg	-25859	0.08	0.03	1
803.74	I	pg	-25774	0.08	0.02	1
21089.86	I	pg	-25305	0.05	-0.01	1
22942.79	I	pg	-22268	0.06	0.01	1
23019.65	I	pg	-22142	0.05	0.00	1
24064.77	I	pg	-20429	0.04	0.00	1
27357.88	II	pg	-15031.5	0.05	0.03	1
28502.68	I	pg	-13155	-0.03	-0.05	1
29274.51	I	pg	-11890	0.00	-0.01	1
30306.79	I	pg	-10198	-0.03	-0.04	1
324.54	I	pg	-10169	0.03	0.02	1
339.17	I	vis	-10145	0.01	0.00	1
594.82	I	pg	-9726	0.02	0.02	1
597.83	I	pg	-9721	-0.02	-0.02	1
647.25:	I	vis	-9640	-0.02	-0.02	1
996.25:	I	vis	-9068	0.00	-0.01	1
31076.52	II	pg	-8936.5	0.04	0.03	1
438.60	I	pg	-8343	0.01	0.01	1
33541.65	I	vis	-4896	0.00	0.00	1
571.57	I	vis	-4847	0.02	0.02	1
582.54	I	vis	-4829	0.01	0.01	1
34242.672	I	vis	-3747	-0.004	-0.004	2
699.6515	I	pe	-2998	-0.0004	-0.0014	4
699.6525	I	pe	-2998	0.0006	-0.0004	4
710.6325	I	pe	-2980	-0.0015	-0.0024	4
710.6350	I	pe	-2980	0.0010	0.0001	4
735.6475	I	pe	-2939	-0.0012	-0.0022	4
735.6495	I	pe	-2939	0.0008	-0.0002	4
743.5780	I	pe	-2926	-0.0022	-0.0032	4
743.5815	I	pe	-2926	0.0013	0.0003	4
36528.7777	I	pe	0	0.0000	-0.0013	5
538.540	I	pe	16	0.000	-0.001	5
37180.688	II	vis	1068.5	0.002	0.001	6
38269.447	I	pg	2853	0.010	0.009	7
40100.398	I	pe	5854	0.005	0.003	8
103.448	I	pe	5859	0.005	0.003	8
133.344	I	pe	5908	0.005	0.003	8
496.363	I	pe	6503	0.005	0.003	8
41186.4006	I	pe	7634	0.0024	0.0002	9
210.805	I	pe	7674	0.002	0.000	10
213.853	I	pe	7679	0.000	-0.003	10
276.697	I	pe	7782	0.002	-0.001	10

Table I (cont.)

J.D. Hel.	min	method	E	$O-C_1$	$O-C_2$	Ref.
2441618.3634	I	pe	8382	0.0035	0.0012	11
679.371	I	pe	8442	0.000	-0.003	11
900.538	II	pe	8804.5	0.000	-0.003	11
951.484:	I	pe	8888	0.001	-0.001	11
951.486:	I	pe	8888	0.003	0.001	11
43012.4755	I	pe	10627	0.0021	-0.0005	12
033.8307	I	pe	10662	0.0032	0.0007	13
034.7460	II	pe	10663.5	0.0034	0.0008	13
098.8043	II	pe	10768.5	-0.0004	-0.0030	13
099.7228	I	pe	10770	0.0029	0.0003	13
44868.4446	I	pe	13669	0.0003	0.0000	14
45213.4622	II	pe	14234.5	-0.0023	-0.0011	15
217.4266	I	pe	14241	-0.0037	-0.0024	15
218.3475	II	pe	14242.5	0.0021	0.0033	15
220.4784	I	pe	14246	0.0024	-0.0012	15
576.484:	II	pe	14829.5	0.001	0.004	16
638.411	I	pe	14931	0.001	0.004	16
46348.5782	I	pe	16095	-0.0059	0.0005	17
359.5598	I	pe	16113	-0.0064	0.0001	17
366.577	II	pe	16124.5	-0.005	0.001	17
47040.4438	I	pe	17229	-0.0111	-0.0015	18
043.4947	I	pe	17234	-0.0108	-0.0012	18
062.4079	I	pe	17265	-0.0111	-0.0015	18
063.3246	II	pe	17266.5	-0.0096	0.0001	18
439.460:	I	pe	17883	-0.010	0.001	18
440.3766	II	pe	17884.5	-0.0089	0.0025	18
455.3223	I	pe	17909	-0.0110	0.0005	18

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The times of minima obtained in 1985 (two primary and one secondary) and in 1987 (three primary and one secondary) implied a new sudden period change in the system. Therefore, the observations were continued in 1988 and two additional primary and one more secondary minima were also obtained. These minimum times, clearly confirming a sudden decrease in the period, and all the other ones from the literature are given in Table I. The $O-C_1$ and E (number of cycles) values were calculated with following light elements which are given by Chou (1959):

$$\text{Hel Min I JD} = 2436528.7777 + 0^{d}.61011534\cdot E \qquad (1)$$

The $O-C_1$ residuals versus E values are shown in Figure 1. As it is clearly seen in the figure, the first period change occurred between JD 2431500 and JD 2433500 (between 1945 and 1950). A new change in the period occurred recently around 1981. These two occurrences of the period change divide the time axes into three parts for BX And. Therefore, the new light elements are separately calculated by weighted least squares method for these three parts as follows:

$$\text{Hel Min I JD} = \underset{\pm 24}{2424064.773} + \underset{\pm 49}{0^{d}.61011214}\cdot E \qquad (2)$$

for the first part (up to JD 2431500),

$$\text{Hel Min I JD} = \underset{\pm 28}{2436528.7790} + \underset{\pm 5}{0^{d}.61011546}\cdot E \qquad (3)$$

for the second part (between JD 2431500 and JD 2444700),

$$\text{Hel Min I JD} = \underset{\pm 17}{2446359.5597} + \underset{\pm 15}{0^{d}.61011255}\cdot E \qquad (4)$$

for the last part (after JD 2444700).

The last ephemeris clearly shows a decrease in the period about 0.25 sec with respect to ephemeris (3). The $O-C_2$ values in Table I are calculated with the new light elements according to the time interval in which the observations were made.

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PHOTOELECTRIC UBV LIGHT CURVES OF RT And

The star RT And has been classified by Hall (1976) as an object belonging to a "Short-Period Group" with properties similar to the RS CVn group.

Mancuso et al. (1979a) have published a series of V light observations for the years 1972, 1973, 1974 where a complete historical review of the star's observations are also presented.

The star was observed photoelectrically with the 1.2 m Kryonerion telescope from 26 Sep. 1988 to 19 Oct. 1988 through a single channel photon counting photometer described by Dapergolas and Korakitis (1987). The photometer employs a high gain 9789 QB phototube and UBV conventional filters. Its output is fed directly to a microcomputer enabling rapid data access.

The data reduction method is the standard one, comparison and check stars are BD +52° 3384 and BD +52° 3377 and the accuracy of the observations presented here is ±0.015 mag for V, B and ±0.025 for U.

The observations have been reduced using the ephemeris:

$$\text{Min. I} = 2443732.4498 + 0^{d}.62892965 \cdot E$$

given by Mancuso et al. (1979b). Table I lists the dates of observations and phases covered whereas Figures 1, 2 and 3 summarise the results for U, B, V (Var. - Comp. star).

Table I

Date	Phase
26 Sep.	.42 - .62
28 Sep.	.38 - .81
29 Sep.	.87 - .34
18 Oct.	.19 - .47
19 Oct.	.75 - .98

Our light curves show asymmetry in the secondary minimum getting larger towards shorter wavelengths. A distortion wave with a minimum at about 0.7 - 0.8 phase is also present in our light curves. Zeilik et al. (1982) found this minimum at 0.8 phase.

The variability in the levels of maxima noticed by Mancuso et al. (1979a) have been noticed here as well comparing their observations and those presented here.

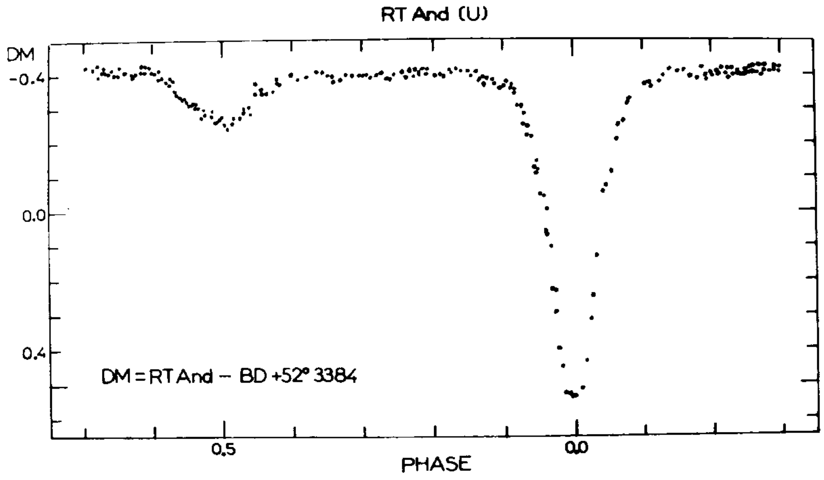

Figure 1

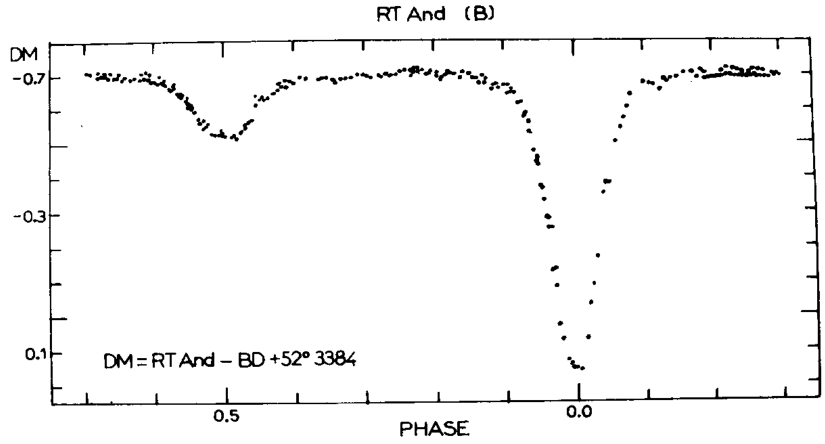

Figure 2

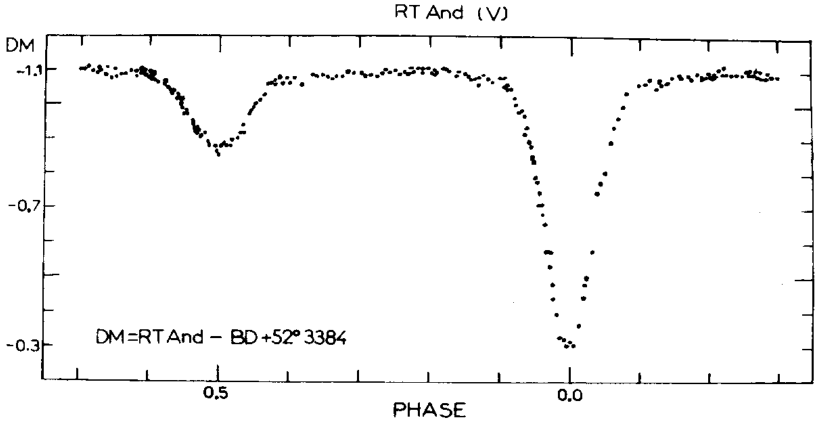

Figure 3

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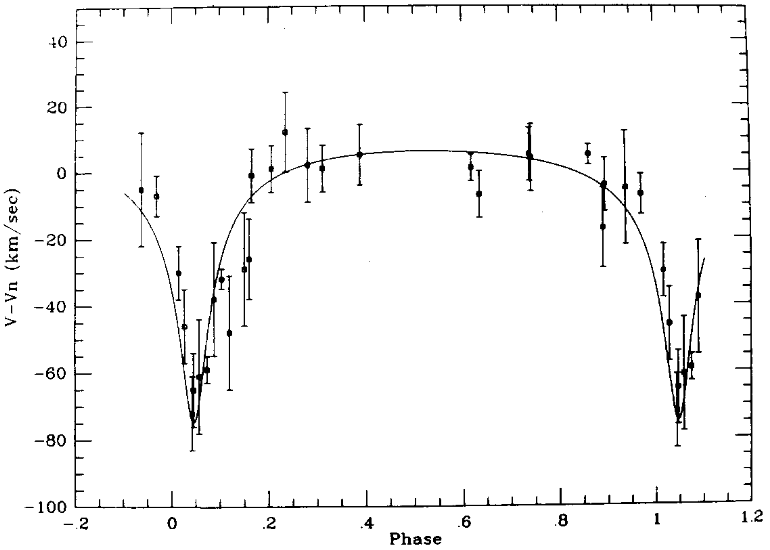
AMENDMENT

In the No. 3246 issue of the IBVS both Figure 1 and Table I contain erroneous data. The correct version of the Figure and Table on HD 37020 is given below

Table I

$a_1 \sin i = 0.171$ AU
$e = 0.709$
$\omega = 182^{\circ}$
$V_o = -5.8$ km/sec + V_n(*)
$T_o =$ J.D. 2444194.651

(*) V_n is the radial velocity of the Orion Nebula



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Variables Near NGC 6760

The work of Sawyer (1953) identified four variables near this globular cluster. Minimum and maximum magnitudes were estimated, though no periods were determined. Sawyer Hogg (1973) lists the variables again, with reference to some eclipsing variables in the field (V406, V407, and V1297 Aql). The eclipsing variables however do not lie as near to the cluster as the other four found by Sawyer and should not be considered as possible members to NGC 6760. Armandroff (1988) was able to determine that variable V1 is not an RR Lyrae member of the cluster, though it might be a Mira belonging to the cluster. He also provides the first color-magnitude diagram from CCD photometry for this cluster.

It should be noted that Armandroff (1988) has misidentified variable V4 because it does not appear clearly on the chart given by Sawyer (1953). In her chart, V4 really lies at the tip of the arrow drawn and is NOT the star seen a small distance away from the arrow. This bulletin is meant to prevent future misidentifications by providing an improved finding chart for the variables, especially V4. Figure 1 is a 20 minute CCD frame of NGC 6760 taken on October 23, 1988 (UT) at Lick Observatory's 1-meter Nickel Telescope using a narrow (100Å) bandpass I filter at 8000Å. North is up, east to the left, and the scale is indicated. Many faint stars have been suppressed in this diagram. The four variables identified by Sawyer are indicated. A CCD exposure in V is given in Armandroff (1988) for NGC 6760.

The identity of V4 was confirmed using Sawyer's positions and the Northern Proper Motion Survey astrograph plates at Lick, on which V4 showed a change of approximately 3 magnitudes. Together, V4's strong red color (through comparison with a CCD V filter frame), large amplitude, and late-type spectrum obtained at the Nickel telescope lead this author to suspect that V4 is a possible Mira variable belonging to the cluster. V1, also a possible Mira, has a late-type spectrum similar to V4's. No periods have ever been determined for these variables however. Continued observations

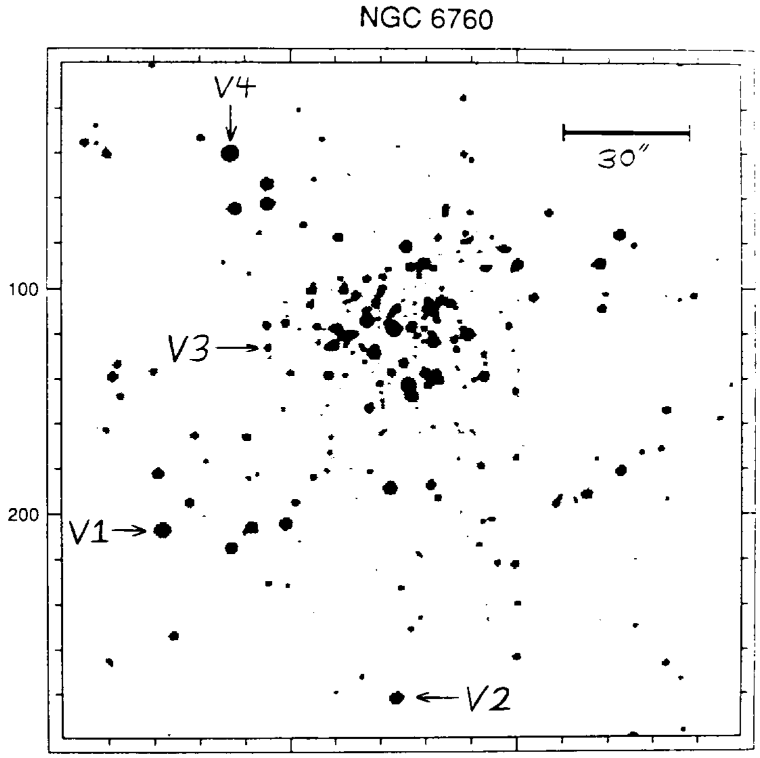

Figure 1

will be made with an effort at determining the variables' periods and I would welcome receiving magnitude estimates from fellow investigators with the aim of establishing the light curves.

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THE SPECTRAL TYPES OF THE SUPERGIANTS HR8752 AND ρ CAS

HR 8752 is one of the most luminous stars in our galaxy. Recently it has been the subject of a large number of studies: Piters et al. (1988) have studied its atmospheric structure, stellar wind and binary characteristics properties; Sheffer and Lambert (1987) have suggested from the analysis of radial velocity data the presence of a bimodal pulsation with possible periods of 421 and 315 days; Halbedel (1988) has discussed the most recent light variations and the $H\alpha$ structure. Regarding the light variations the star shows cyclic variations with a timescale of the order of 1 year (e.g. Mantegazza et al., 1988), and a slow trend of the (B–V) index to the blue which is steadily continuing since 1977 (Halbedel,1988, Sheffer and Lambert, 1987).

Zsoldos (1986) has tried to reconstruct the hystorical light curve of this object. According to him the star was fainter in the middle of the last century and then gradually brightened. This author has also reconstructed the variations of the star's spectral type (see Figure 1,+). The spectral type varies between F8 and G4. According to Luck(1975) in 1973 the spectral type could be as late as K3. However this estimate is not a classical MK determination, but it has been obtained both from the flux distribution and from the curve of growth analysis, so it is not sure that it could be compared with the other spectral estimates. Piters et al. (1988) have found from a model of atmosphere analysis of a spectrum of HR 8752 obtained in 1984, that different models such as T_{eff}=4000K with $\log g = -2$, and T_{eff}=5500 K with $\log g = 1.5$ can explain the atomic line spectrum equally well.

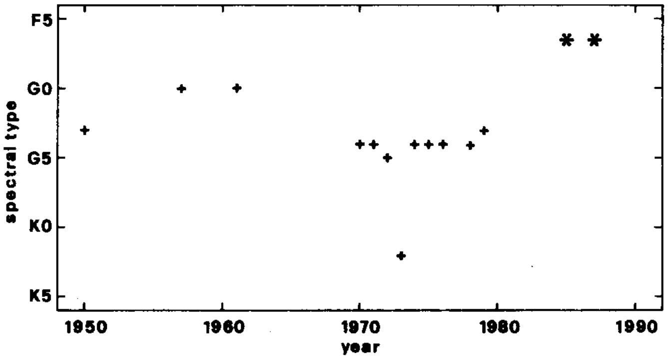

Figure 1

Two spectra of HR 8752 were taken on December 16,1985 and on September 22, 1987 with the Reticon detector of Brera Observatory (Bonanno and Falomo, 1988) at the 182 cm telescope of Asiago Observatory and at the 137 cm reflector of Merate Observatory respectively. In both cases a Boller and Chivens grating spectrograph was used. The spectra cover the region between 7500 and 9000 Å, with a resolution of 2.9 Å/pixel.

Since the spectra were taken in the framework of a programme for the study of the luminosities of intermediate supergiant stars, several standard stars were observed with the same equipment too. This allowed to derive quite accurate spectral types for HR 8752. Some criteria for determining spectral types in this spectral region have been given for example by Parsons (1964) and Bouw (1981). The two spectra of HR 8752 are quite similar and give a F6÷7 type, which is the earliest ever observed for this star. These two points are reported in Fig.1 as asterisks. From the figure we see that the spectral type is changed from the value of G3 which the stars had in the seventees to the present one of F6÷7. This is in agreement with the steadily decrease observed in the same period for the (B–V) index.

Another confirmation of this fact is given by the intensity of the OI 7774 Å triplet. In my spectra this line has the same equivalent width of 2.46 Å. Osmer (1972) who observed it in 1967 or 1968 found a value of 1.57 Å. Sorvari (1974), who measured this feature in his photometric index approximately in 1972, found a value that would correspond roughly to 1.7 Å.

The OI line intensity is linearly correlated with absolute magnitude for F supergiants, however for G type stars this intensity decreases sharply with the decreasing of temperature (see e.g. Sorvari,1974). This fact explains the differences in the equivalent widths. When the star was of spectral type G its OI line was much less strong than now. In fact if we compute by means of Sorvari's equation the luminosity of the star we get from Osmer's or Sorvari's equivalent widths $M_V \simeq -6.2.$, a value too low for a Ia–0 supergiant. This only means that the equation is not applicable because the spectral type is too late. From my equivalent width we get, after the transformation of the equivalent width into Sorvari's index (Mantegazza, in preparation), M_V=–9.5, a value which is in good agreement with the –9.5÷–9.1 interval derived by Humphreys (1978) for this star on the basis of its membership in the association Cep OB1.

ρ Cas is a supergiant quite similar to HR 8752. Recent observations of its light variations are due to Halbedel (1988) and Leiker et al.(1988). Sheffer and Lambert (1986), as a result of their spectroscopic observations, have proposed that this star could pulsate radially with a dominant fundamental radial mode with period of about 520 days.

This star also shows variations of spectral type. According to Morgan et al. (1981) its spectrum has changed from F8 to G4. For this star too there are contradictory classifications according to the system adopted to determine it; here we will follow MK types (Morgan et al., 1981).

A spectrum of this star, with the same characteristics of those of HR8752, has been taken on September 16, 1987 at Merate Observatory. It looks quite similar to those of HR 8752, however it is definitely later and can be classified as F8. Therefore the spectral type of this star was F8 in the thirties, K0 in 1947, it went from G0 to G4 during the seventies and now it has returned to F8.

The only striking difference between the spectra of ρ Cas and HR 8752, apart from the small ones due to the slightly different spectral types, is the intensity of the FeI 8824 Å line, which for ρ Cas is more than three times stronger than for HR 8752. For comparison the adjacent MgI 8806 Å line has roughly the same intensity for both the stars.

Lambert et al.(1981) and Lambert and Luck (1978) have found that FeI 8824 Å line is highly variable in HR 8752, due to the presence of emission components which they assigne to the circumstellar shell. However in my two spectra of HR 8752, its intensity is quite similar.

The OI 7774 triplet has an equivalent width of 2.13 Å. The resulting visual absolute magnitude computed by means of Sorvari's equation would be –8.4. The corresponding luminosity is quite low if compared to that assigned to the star by Humphreys(1978) ($M_V = -9.5$) on the basis of its membership in the association Cas OB5. However this estimate is strongly dependent on the assumption that the interstellar visual absorption is 2.13 mag, which in turn was derived assuming a spectral type of F8 Ia. If we assume, as it is more reasonable, that the spectral type at the time of Humphreys' observations was G0 Ia, then A_V=1.53 and consequently M_V=–8.9. On the basis of different considerations Sargent(1961) derived for ρ Cas M_V=–8.4. A further indication that the luminosity assigned to the star by Humphreys is too high is given by Morgan et al.(1981): according to them in 1977 the luminosity class of HR 8752 was brighter than that of ρ Cas.

In any case this discussion bears into evidence how large are the uncertainties connected to the determination of absolute magnitudes of high luminosity stars and how necessary are further efforts to improve this situation.

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AD LEO: FLARE ACTIVITY IN 1988

AD Leonis continued its ultraviolet activity this season although none of the seven flares that we observed within our 16.4 hours of sampling were particularly dramatic. All of these flares occurred during the 9.5 hours of the first five nights. As in the past, the 0.6-m telescope at Mt. Cuba, an EMI 6256S photomultiplier, and a Johnson U filter were used for the observations. Data analysis and plotting of the light curves was performed following the procedure described in IBVS 3069 (Herr & Opie, 1987).

All figures are plotted to the same vertical scale in units of the flux of the comparison star. Outside of the recognized flares AD Leo averaged 2.7 times brighter than the comparison star. However, on February 17 this level remained higher as may be seen in Table 3 and in the figures for the

Table 1. Flares of AD Leo

No.	1988	UT max	t_b	t_a	Δm	P	Air	JD
	mo da	h m	min	min	mag	min	Mass	244 0000+
1	Jan 24	04:55.3	0.3	3.3	0.26	0.50	1.22	7184.7051
2	Jan 24	05:20?*	?	5	>0.28?	1.3?	1.16	7184.7222
3	Feb 17	02:06.6	0.6	4.4	0.66	0.71	1.52	7208.5872
4**	Feb 17	03:32.6?	1 ?	16 ?	0.52?	3 ?	1.19	7208.6476
5	Apr 10	03:09.2	0.5	4.8	0.45	0.92	1.09	7261.3614
6	Apr 10	04:04.5	0.5	2.5	0.44	0.55	1.18	7261.6698
7	Apr 14	03:00.0	0.4	7.4	0.53	0.90	1.10	7265.6250

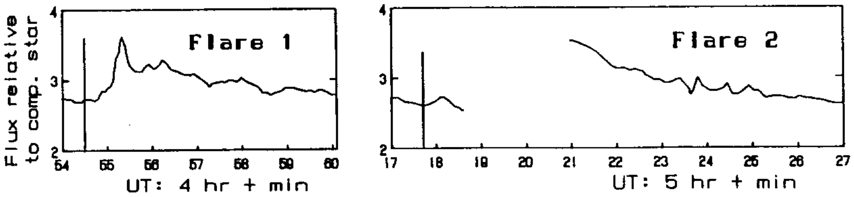
* Maximum probably occurred between 5:18.6 UT, when we moved to measure sky, and 5:21, when we returned to find an elevated, declining signal.

** Peak of Flare 4 may have been missed.

Times, including estimated minutes before and after the maximum, and the magnitude change were measured directly from the original charts. P is the flare's equivalent duration (in minutes of quiescent flux).

Table 2. Monitoring Coverage in 1988

Date	U.T. in hours and minutes		
Jan. 24	4:16.0- 4:21.3,	4:30.1- 4:41.6,	4:43.4- 5:02.5,
	5:06.6- 5:18.6,	5:21.0- 5:36.1,	5:41.6- 5:56.9.
Feb. 17	1:29.7- 1:38.0,	1:39.7- 1:51.7,	1:54.5- 2:10.1,
	2:12.6- 2:25.0,	2:26.4- 2:38.6,	2:41.9- 2:57.4,
	2:59.5- 3:13.0,	3:17.2- 3;30.7,	3;32.0- 3;46.1,
	3:48.5- 4:03.9,	4:05.2- 4:19.1,	4:21.1- 4:37.9,
	4:39.2- 4:58.2,	5:00.2- 5:14.1,	5:15.4- 5:33.7,
	5:34.8- 6:06.0.		
Apr. 6	1:56.3- 2:04.2,	2:05.4- 2:18.8,	2:20.9- 2:39.8,
	2:41.6- 2:51.9,	3:05.3- 3:17.7,	3:19.8- 3:34.5,
	3:36.7- 3:56.6,	3:58.7- 4:15.9,	4:18.1- 4:29.5.
Apr. 10	3:02.0- 3:16.6,	3:18.0- 3:21.4,	3:22.8- 3:33.0,
	3:42.8- 3:55.1,	3:58.3- 4:11.7,	4:15.2- 4:28.5,
	4:31.0- 4:42.2,	4:45.0- 4:55.4.	
Apr. 14	2:30.4- 2:33.0,	2:55.4- 3:07.6,	3:11.6- 3:23.7,
	3:26.8- 3:32.0.		
Apr. 27	1:20.9- 1:35.9,	1:38.4- 1:40.3,	1:52.0- 2:02.8,
	2:05.1- 2:17.4,	2:20.3- 2:39.0.	
May 8	1:40.3- 1:52.1,	1:54.1- 2:08.0,	2:09.1- 2:24.5,
	2:26.4- 2:40.1,	2:42.1- 2:57.8,	2:59.7- 3:13.0,
	3:18.1- 3:20.0,	3:22.3- 3:38.0,	3:40.1- 3:56.0,
	3:58.3- 4:11.0.		
May 9	1:27.8- 1:31.0,	1:33.3- 1:40.1,	1:42.5- 1:58.5,
	2:00.6- 2:16.0,	2:17.8- 2:32.0,	2:34.4- 2:50.0,
	2:52.2- 3:07.0,	3:09.0- 3:22.0,	3:26.8- 3:40.6,
	3:42.4- 3:55.7,	3:58.1- 4:10.2.	
May 15	2:17.8- 2:32.0,	2:35.0- 2:49.0,	2:51.2- 3:07.0,
	3:09.2- 3:24.0,	3:26.3- 3:39.0,	3:41.1- 3:56.0.



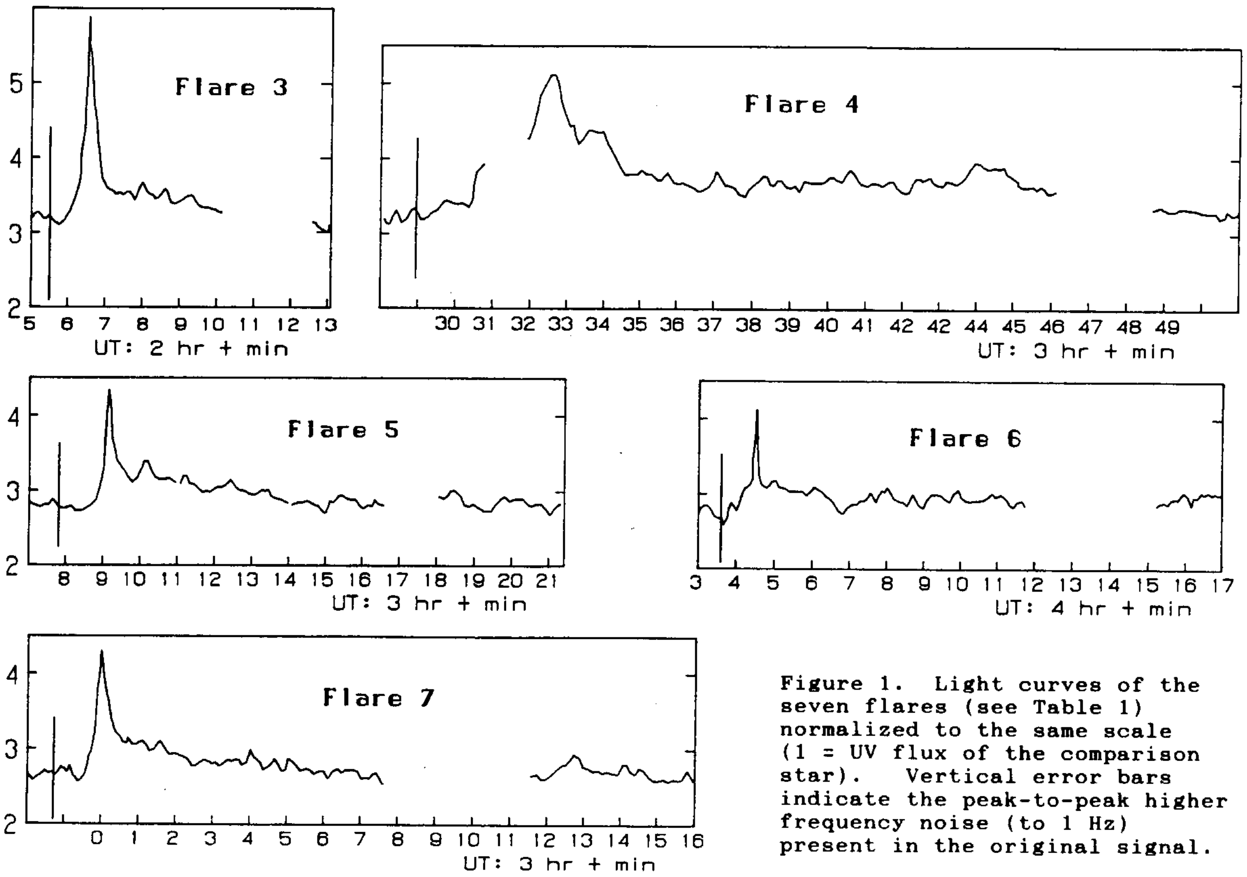


Figure 1. Light curves of the seven flares (see Table 1) normalized to the same scale (1 = UV flux of the comparison star). Vertical error bars indicate the peak-to-peak higher frequency noise (to 1 Hz) present in the original signal.

Table 3. Ultraviolet magnitude differences between the comparison star and AD Leo during quiescence. Signal/noise is estimated from the chart pen excursions (response to 1 Hz) within a four-minute interval.

Date 1988	Time hr min	JD 2440000+	m_c-m_v	$\frac{I_o}{\sigma}$	Air Mass
Jan. 24	4 48	7184.7000	1.14	8.6	1.24
	5 34	7184.7319	1.03	8.1	1.14
Feb. 17	1 57	7208.5183	1.27	7.8	1.58
	3 21	7208.6396	1.24	8.6	1.22
	4 53	7208.7034	1.21	11.1	1.08
Apr. 6	2 34	7257.6069	1.09	9.7	1.06
	3 22	7257.6403	1.18	9.3	1.09
Apr. 10	3 05	7261.6285	1.12	12.3	1.09
	4 01	7261.6674	1.08	11.2	1.17
	4 39	7261.6938	1.16	11.1	1.27
Apr. 14	2 57.4	7265.6232	1.10	11.4	1.10
	3 20	7265.6389	1.06	11.5	1.13
Apr. 27	1 29	7278.5618	0.99	4.8	1.07
	2 35	7278.6076	1.01	4.5	1.14
May 8	2 03	7289.5854	1.20	7.6	1.16
	3 03	7289.6271	1.13	7.3	1.32
	3 49	7289.6590	1.10	5.9	1.53
May 9	1 56	7290.5806	1.05	8.7	1.15
	3 00	7290.6250	0.92	7.7	1.32
	4 02	7290.6681	1.12	6.0	1.64
May 15	2 41	7296.6118	0.85	6.1	1.34
	3 37	7296.6507	0.92	6.6	1.63

flares (Nos. 3 and 4) on that night. After Flare 4, AD Leo remained even brighter for some minutes with evidence of continued activity. This may be contrasted to Flares 5-7 in similar time intervals following their peaks.

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PHOTOGRAPHIC OBSERVATIONS OF V651 Mon, THE CENTRAL STAR OF THE PLANETARY NEBULA NGC2346

The central star of planetary nebula NGC2346(AGK3-0965) is known to be a spectroscopic binary with a period of about 16 days (Mendez 1980). From at least 1899 to 1981 Nov. it did not vary in brightness (Schaefer 1983). But in 1981 Dec. unexpected large amplitude eclipse variations in brightness were observed (Kohoutek 1982). Since then a lot of observations have been reported by many authors as Kohoutek (1983), Feibelman and Aller (1983), Marino and Williams (1983, 1984), Schaefer (1985), Jasniewicz and Acker (1986) and others. They have revealed that the central star of NGC2346 showed fast and complex light variations due to eclipse and the amplitudes of the eclipse varied rapidly.

We have observed the the planetary nebula NGC2346 since 1981 and found that its eclipse amplitude rapidly decreased in 1986 and pointed out that the amplitudes would be decreasing (Hao 1987).

In this paper we present new photographic observations made in March and April 1987 using the 32/385 cm refractive telescope at the QingDao observatory. The plates and filter combination used for the photographic and photovisual magnitudes were Eastman Kodak-103_a0 (or II_a0) and Kodak-103_aD + GG14 respectively. The method of the magnitude determination is described by Hao (1987). From these we obtained the m_{pg} and m_{pv}, the results are given in Table I and Table II respectively. The photographic light curves we obtained in 1985, 1986 and 1987 are plotted in Figure 1. In Figure 2 the photovisual light curve is plotted.

The magnitudes in Table I and II contain contributions from both the central star and the nebular radiations..

From these observations we can state that the brightness variations of the central star of planetary nebula NGC2346 have an obvious difference from 1985 to 1987. The eclipse amplitude is decreasing rapidly from $4^m.0$ (1985), $1^m.1$ (1986) to about $0^m.4$ (1987). The fluctuation in the light curve

Table I

No	Plates No. QA-	J.D.hel. 2446000+	M_{pg}	Phase
1	1003	870.978	11.13	0.982
2	1004	871.983	11.49	0.045
3	1005	872.972	11.41	0.170
4	1008	879.990	11.26	0.540
5	1010	880.985	11.35	0.609
6	1011	887.971	11.34	0.047
7	1014	901.003	11.22	0.864
8	1015	901.985	11.30	0.925
9.	1017	902.986	11.27	0.957
10	1018	906.983	11.20:	0.238
11	1021	907.996	11.33	0.302
12	1022	908.985	11.38	0.364
13	1025	911.984	11.39	0.552
14	1026	913.997	11.40:	0.678

Table II

No	Plates No. QA-	J.D.hel. 2446000+	M_{pg}	Phase	C
1	1006	837.991	11.43	0.171	-0.02
2	1009	880.927	11.38	0.608	-0.03
3	1012	887.984	11.52	0.048	-0.18
4	1013	900.988	11.33	0.863	-0.11
5	1016	901.998	11.37	0.926	-0.07
6	1019	906.996	11.27	0.239	-0.07
7	1020	907.983	11.25:	0.301	0.08
8	1023	909.010	11.17	0.365	0.21
9	1024	912.015	11.30	0.554	0.08

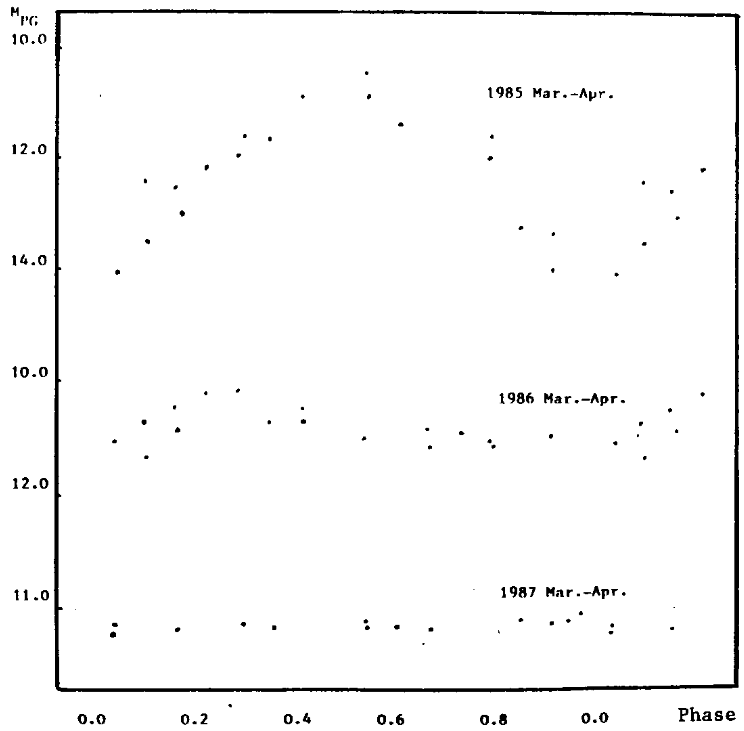

Figure 1. The light curves of AGK3 - 0965 . Phases were computed using the elements given by Hao (1987).

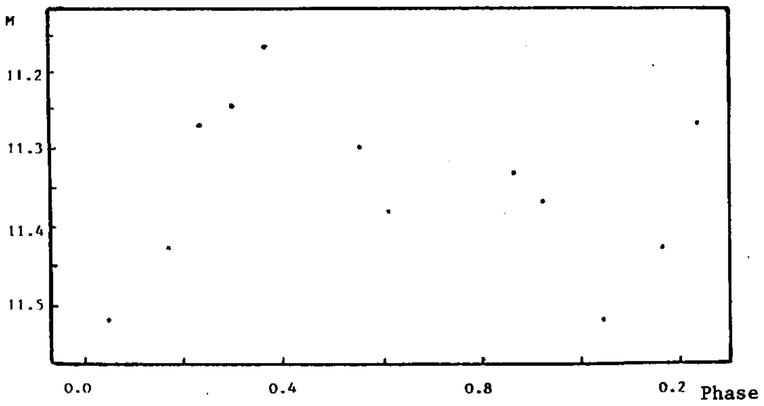

Figure 2. The light curve of AGK3-0965 (photovisual magnitudes).

is increasing in 1987 even we could not see the eclipse variations in photographic region.

The maximum brightness (m_{pg}) of this object showed no obvious change between 1985 and 1986 but in 1987 increased by about one magnitude ($11^{m}.2$). The variation of minimum brightness is larger than that of the maximum brightness (m_{pg} nearly $14^{m}.0$ in 1985 to about $11^{m}.5$ in 1987).

From Figure 2 it seems that the eclipse variation still exists and its amplitude is only about 0.35 mag. which is smaller than in 1986.

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PHOTOMETRY OF THE ECLIPSING BINARY W Cru

The brightness of W Cru (HD 105998;$AR_{50}=12^h09^m20^s$,$D_{50}=-58^o30'.3$) has been estimated on 205 plates which are in the archives of the Bamberg Observatory (taken in the years 1964 -1971 at the Boyden Observatory, South Africa, and at the Mount John Univ.Observatory, New Zealand; 10" Metcalf and 3" Ross, blue sensitive emulsions Gevaert 67A50 and Perutz Astro, exp.time 30-60 min, observers Clark, Fischer, Knigge, Meier, Paterson, Schöffer, Sosna). The times of one Min.I and of two Min.II have been determined using 103 plates measured with the iris-photometer of the Hamburg Observatory in Bergedorf (see Table I). The comparison stars given by O'Connell (1936) and marked on the chart 801 (Bateson,Morel,1985) were measured photoelectrically at La Silla, Chile (ESO 50cm tel.,May 1987,EMI 6256 photomultiplier); they are listed in Table II (our star g =100 is that near W Cru). The mean difference between our brightness of the comparison stars a-f ($m_{pg}= B - 0^m.11$ was used) and those given by O'Connell (1936) is $-0^m.06$. New elements of the light curve have been derived according to our Min.I and according to all primary minima summarized from the literature in Table I. Mean errors of the times of Min.I were either published by the respective authors, or estimated in this study; they serve for the calculation of the weights used for determining the elements. The derived elements of the light curve

$$\text{Min.I} = \text{JD } \underset{\pm .23}{2440731.84} + \underset{\pm .007}{198^d.537} \cdot \underset{\text{m.e.}}{E}$$

differ only very slightly from those given by Plavec (1984).

The whole light curve is represented by 21 mean points given in Table III. We can compare it with that observed by O'Connell (1936):

Table I. Observed minima

JD 2400000+ (Phase)	Min.	Author
10158^{d} ±1.0	I pg	Russell (1912)
27628.5 ±0.5	I pg	O'Connell (1936)
38544.5 ±1.0	I pg	present paper
40731.6 ±0.3	I pe	Knipe (1972)
45695.5 ±0.3	I pe	Kvíz,Rufener (1988)
45893.7 ±0.1	I pe	Menzies,Jones (1984)
45894.08 ±0.13	I pe	Marino et al.(1984)
10254 ±2.5 (0.484)	II pg	Russell (1912)
27726.0 ±1.5 (0.491)	II pg	O'Connell (1936)
38848.5 ±2.0 (0.514)	II pg	present paper
39241.2 ±1.5 (0.492)	II pg	present paper
45795.45 ±0.40 (0.503)	II pe	Marino et al.(1984)

Table II. Comparison stars

Star	C.P.D.	V	B-V	U-B	m_{pg}	n
a	-58°4135	7.80	+0.99	+0.68	8.68	4
b'	-58 4153	8.88	+0.24	+0.12	9.01	5
d	-58 4147	9.55	+0.07	-0.08	9.51	5
e	-57 5312	9.50	+0.70	+0.20	10.08	6
f	-58 4145	10.29	+0.15	+0.05	10.33	6
g		9.92	+1.23	+1.16	11.04	5

Table III. Mean points

Phase	m_{pg}	n	Phase	m_{pg}	n
0.019	$10\overset{m}{.}05$	9	0.565	$9\overset{m}{.}38$	8
0.040	9.79	8	0.630	9.19	10
0.077	9.39	8	0.661	9.13	8
0.151	9.13	11	0.703	9.08	9
0.187	9.01	12	0.754	9.01	10
0.259	9.07	10	0.780	8.99	12
0.289	9.14	8	0.811	9.04	8
0.324	9.17	9	0.853	9.15	12
0.371	9.28	10	0.890	9.23	11
0.436	9.36	12	0.942	9.63	10
0.496	9.47	10			

a) The light curve shows again continuous light changes with broad minima; nevertheless the width of Min.II respective to Min.I was greater than in 1932-1936.

b) There was very probably no difference in the brightness of the two succeeding maxima (before and after Min.I).

c) We found the following photographic brightness of the maximum, Min.I and Min.II, respectively: $9\overset{m}{.}02$, $10\overset{m}{.}1$, $9\overset{m}{.}45$. May be that the depth of Min.I was somewhat greater and that of Min.II somewhat smaller than before. There is no totality visible at Min.II; nothing can be said about the totality of Min.I.

The secondary minimum is very shallow and the determination of its time is about 2.5-3 times worse than that of the primary minimum. Nevertheless it shows a changing displacement from a point midway between two primary minima. This displacement can also be seen if we calculate the period using Min.II only: this result $198\overset{d}{.}560 \pm \overset{d}{.}012$ is somewhat greater than the period of the binary. (The mean value of the Min.II determined from the Bamberg plates was used for this calculation.) The value of $\Delta\omega$ is difficult to derive due to the very small excentricity. Adopting $e = 0.048$ (Woolf,1962) and $i = 78\overset{\circ}{.}1$ (Kopal,1941), we find $\omega = 85\overset{\circ}{.}8 - 0\overset{\circ}{.}41(t-1980)$, so that we estimate the period of the apsidal motion to be about 880 years. This is the first apsidal motion stated for a G-type supergiant.

We are very much indebted to the directorate of the Bamberg Observatory and to R.Knigge for enabling us to use the plate archives of the observatory. Some observations have also been collected at the European Southern Observatory, La Silla, Chile.

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THE FARTHEST KNOWN ECLIPSING BINARIES IN OUR GALAXY

This paper contains a list of 12 farthest eclipsing binaries known in our Galaxy. These stars are selected from catalogues (Brancewicz and Dworak, 1980; Kholopov et al., 1985, 1987) under the following conditions: distance modulus $m - M > 13^{m}.0$ so a parallax ¶$\leq 0''.00025$ (i.e. $d \geq 4000$ pc). Additionally the value $d \cdot \sin|b|$ was calculated where b is a galactic latitude for a given star.

The consecutive columns of the Table I contain : name of star, coordinates α and δ for the epoch 1950.0, period in days, magnitude (photographic p, photoelectric V or B), distance d in parsecs, distance from the galactic plane $d \cdot \sin|b|$ in parsecs.

As we can notice, seven stars are placed in the galactic plane ($d \cdot \sin|b| <$ 1000 pc) and only five stars can belong to the galactic halo. Further observations (astrometric and spectrometric) are necessary to confirm this hypothesis which can be very useful in the investigations of kinematics of our Galaxy.

Table I

The list of the farthest eclipsing binaries in our Galaxy

Name	α (1950)	δ	Period	Mag.	d [pc]	d sin|b| [pc]
BO And	$22^{h}56^{m}23^{s}$	$+45^{\circ}15'.7$	$5^{d}.79733$	$13^{m}.4$ p	6700	2300
UX CVn	12 12 16	+36 56	0.573703	13.07V	6700	6500
FP Car	11 02 33	-62 18.3	176.027	10.1 B	5000	200
UU Cas	23 48 11	+60 38.0	8.51929	10.4 p	5000	100
AQ Cas	01 15 50	+62 07.0	11.72115	10.06V	5000	30
V366 Cas	01 05 15	+58 26	0.729274	12.0 p	4000	300
V814 Cen	13 24 44	-47 10.6	1.168129	14.1 V	6900	1800
W Cru	12 09 20	-58 30.3	198.53	9.04B	5000	300
V698 Cyg	19 58 02	+36 08.4	97.7732	12.2 p	5000	300
HP Lyr	19 19 58	+39 50.4	140.75	10.5 p	10000	2000
V471 Per	01 55 33	+52 39.3	0.16668	13.03V	38000	5700
RY Sct	18 22 43	-12 43.2	11.12471	9.12	5000	10

It is possible that the star V381 Sco is also very distant one (its $d \approx 10000$ pc) but it is in the region of galactic centre. Moreover, the data for V381 Sco are uncertain (Brancewicz and Dworak, 1980).

All the data for computations are taken from following sources: Brancewicz and Dworak (1980), Dworak (1975, 1976, 1983), Kholopov et al. (1985, 1987).

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UBV PHOTOMETRY OF BD+61°1211 DURING 1986 and 1987

BD+61°1211 (=DM UMa =#75 in the catalog of Strassmeier et al. 1988) is an unusually active noneclipsing RS CVn system. Kimble et al. (1981) report variations of about 0.32 mag during 1979. Mohin et al. (1985) find considerable variation in the amplitude of the light curves from 1980 to 1984. Crampton et al. (1979) find an orbital period of 7.492 days based on radial velocity variations. Nations and Ramsey (1986) find $H\alpha$ emission variability on timescales as short as a few hours. These observations indicate a high level of chromospheric activity and possible variations in this activity.

We performed the observations between April and July 1986 and between February and July 1987 on the 24" telescope operated by San Diego State University at Mt. Laguna, CA. The photometer employs an EMI 6256 phototube, cooled to -10 F and operating at -1300V, and is equipped with standard Johnson UBV filters. We used a 19" aperture with a larger aperture on a few nights of poor seeing. Data were transformed to the standard Johnson UBV system. BD+60°1301 (= SAO 15365) was the comparison star, and BD+60°1306 (= SAO 15388) was the check star.

The light curves for BD+61°1211 are in Figures 1-3, with the 1986, early 1987 (February - April), and late 1987 (June - July) data indicated. We plot differential magnitudes in the sense star - comparison. Figure 4 shows the ΔV data on the check star plotted to the same scale. The comparison star shows no evidence for variability. We computed the orbital phase using ϕ =JD 2443881.4 + 7.492E (Crampton et al. 1979).

Our 1986 V light curve (Fig. 1) is roughly similar to the 1979, 1980, 1983, and 1984 V light curves (Kimble et al. 1981, Mohin et al. 1985). However the 1981 and 1982 light curves show double rather than single peaks. In addition, the amplitude of variability and phases of maximum and minimum amplitude vary considerably between 1979 and 1986. The amplitude of variability ranges from 0.32 mag in 1979 to 0.115 mag in 1982. The Δ V at maximum brightness ranges from 0.30 to 0.47 with rapid year to year evolution. In terms of the starspot model a decrease in maximum brightness can be understood if the relatively unspotted hemisphere develops some small spots. A decrease in the amplitude of variation can be understood either as a decrease in the starspot activity if the Δ V at maximum is small (bright) or as a longitudinal spreading of the starspots if the Δ V at maximum is large (faint).

The 1987 light curves show rapid evolution in the behavior of this system. The amplitude decrease between 1986 and early 1987 is obvious. There is also a decrease between early and late 1987. These decreases confirm the very significant evolution on a 1 year timescale and indicate a less dramatic but still significant evolution on a timescale of a few months. The June-July 1987 variations are minimally larger than the variations in the check star (~0.04 mag), indicating minimal variability during late 1987. The Feb.-April 1987 ΔV light curve has an amplitude of about 0.09 mag compared to the lowest previous amplitude of 0.115 mag.

In terms of the starspot model, we interpret the evolution in our light curves as the large spot (or group) visible in the 1986 data breaking up and becoming more evenly distributed. The maximum

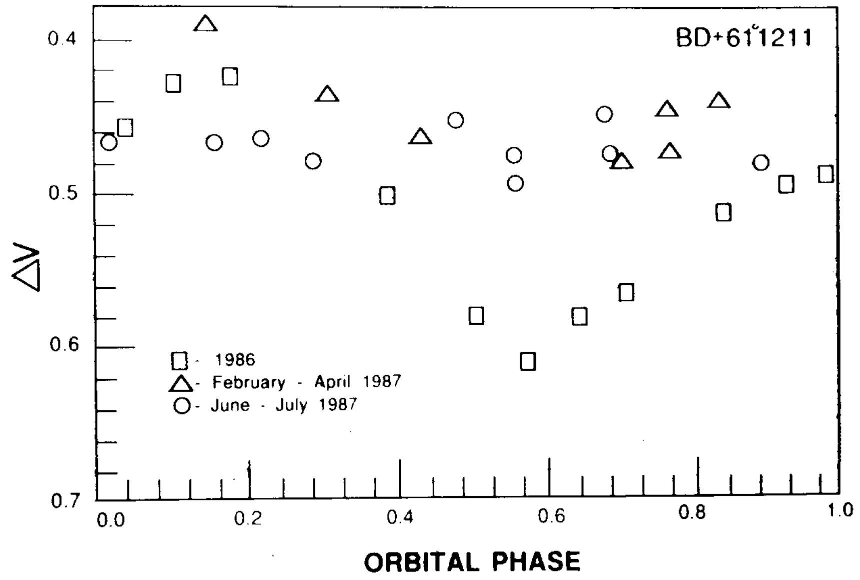

Figure 1

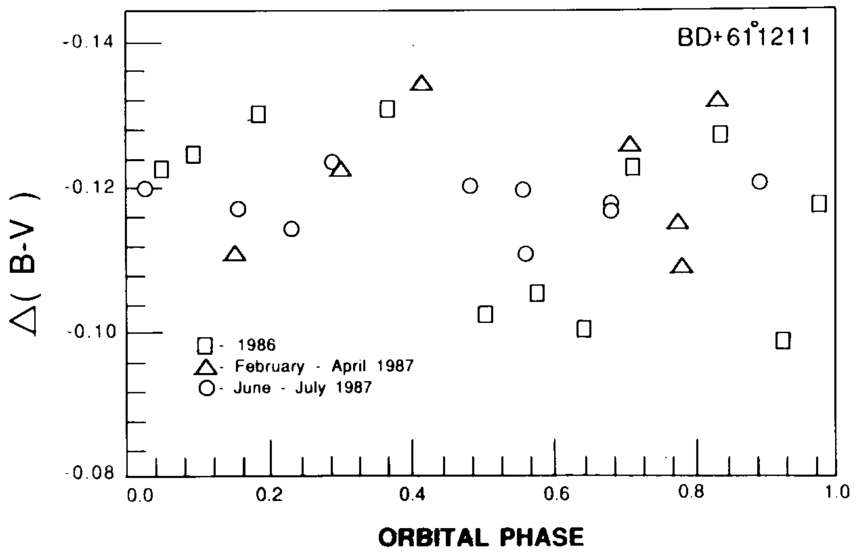

Figure 2

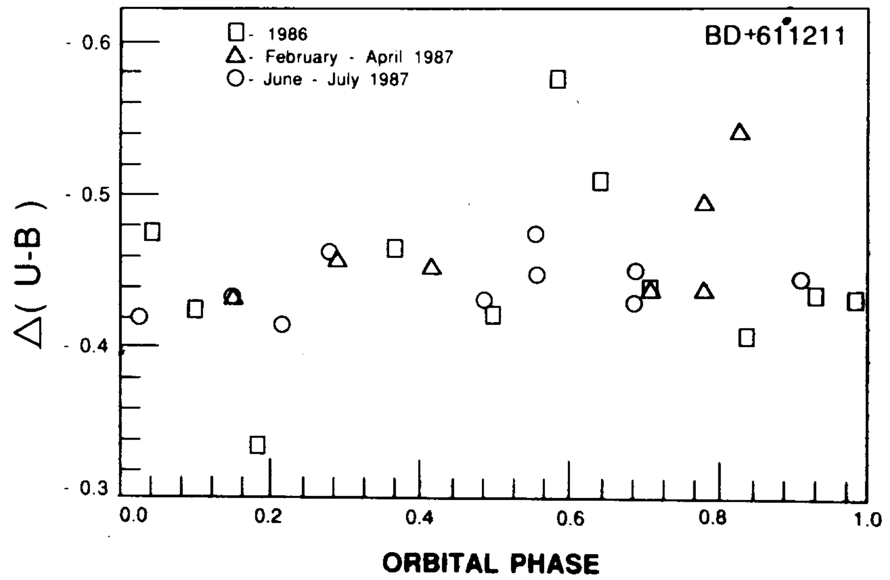

Figure 3

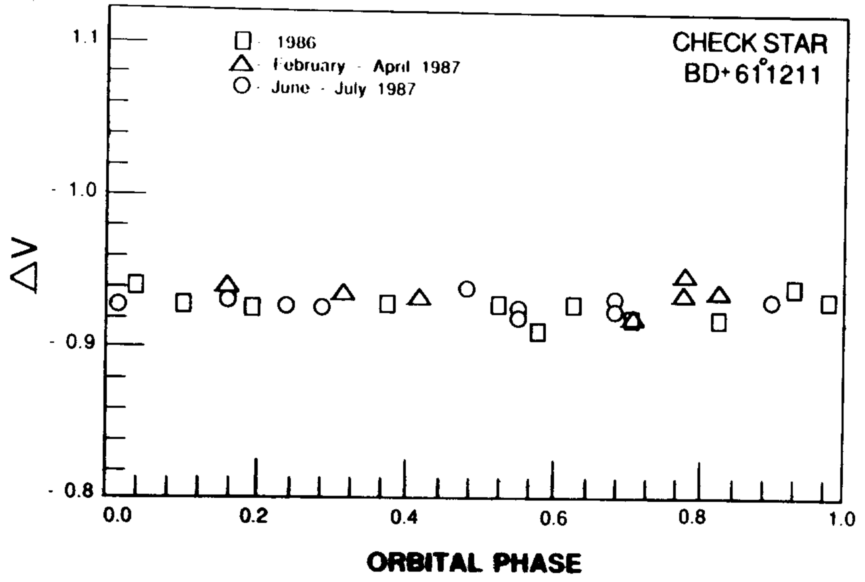

Figure 4

brightness in 1986 and early 1987 is roughly the same; so the spot concentration in the unspotted hemisphere did not increase significantly from 1986 to early 1987. Meanwhile the starspot activity in the spotted hemisphere decreased significantly during the same time, as shown by the decrease in the ΔV amplitude. Between early 1987 (Feb. - April) and late 1987 (June - July) the amplitude of the ΔV curve decreased even more, suggesting a near cessation of the spot activity on the formerly spotted hemisphere. During late 1987 however, the system is about 0.08 mag fainter in V than the maximum brightness during 1986 and early 1987. We therefore infer that the spots did not disappear completely, rather they became more uniformly distributed over the star's surface.

Our $\Delta(B-V)$ and $\Delta(U-B)$ color curves show similar evolution. Kimble et al. (1981) find that their $\Delta(B-V)$ curve has a large amplitude with the maximum and minimum at roughly the same phase as the ΔV curve. We find the same trend in our 1986 $\Delta(B-V)$ curve and the opposite trend (with somewhat more scatter) in the 1986 $\Delta(U-B)$ curve. As the amplitude of the ΔV curves decreases the amplitudes of the $\Delta(B-V)$ and $\Delta(U-B)$ color curves also decrease. The color curves are consistent with the hypothesis that spots cooler than the rest of the star cause the variations.

In conclusion, BD+61°1211 showed considerable variations in starspot activity between 1979 and 1986 and a rapid decrease during mid 1987. The starspots did not entirely disappear during 1987, rather they spread out more evenly over the entire surface.

During May 1988 one of the authors (PAH) obtained additional UBV photometry, which will be reported in a future paper. We plan to continue monitoring this system to determine long term cycles.

Ron Angione scheduled generous amounts of time on the Mt. Laguna 24" telescope for this work. Harold Nations suggested observing these stars and provided helpful comments.

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A NEW VARIABLE STAR BD $+2^{\circ}$ 1867

During the observations of the eclipsing binary YY CMi, the star BD$+2^{\circ}$1867, which served as a comparison star, turned out to be variable. No information about the variability of this star can be found in literature or in the Center of the Star Data in Strasbourg.

During the present and the previous observational seasons photoelectric observations of the new variable were performed in order to determine its variability type. The observations were carried out at the Astronomical Observatory of the Jagiellonian University in Cracow using the 50 cm Cassegrain telescope, as well as the mountain station Roztoki Gorne using a 20cm refractor. Differential measurements of the star were made with a V filter using BD$+1^{\circ}$1994 as the comparison star. The light constancy of the comparison star was checked against BD$+1^{\circ}$1989. The observations were corrected for atmospheric extinction using mean extinction coefficients for each observation site. A detailed description of both photometers and photometric systems was published by Flin et al. (1986). Data concerning the three stars mentioned above are given in Table I.

Table I

Data about the stars involved

star	BD	HD	ptm	ptg	Sp
new variable	$+2^{\circ}1867$	66853	$9\overset{m}{.}1$	$9\overset{m}{.}4$	F2
comparison	$+1^{\circ}1994$	67028	8.2	8.3	A2
check	$+1^{\circ}1989$	66829	9.1	9.4	F

The new variable star usually changes its brightness with an amplitude of about $0\overset{m}{.}1$ within a period of about 3 hours. There were also nights when the star kept a nearly constant brightness. The light changes over six nights with the largest number of observations are presented in Figure 1. Time is expressed in fractions of a day and the brightness is given as the difference between the comparison and the variable star expressed in stellar magnitudes with zero point corresponding to the mean value for all differences (341 observational points).

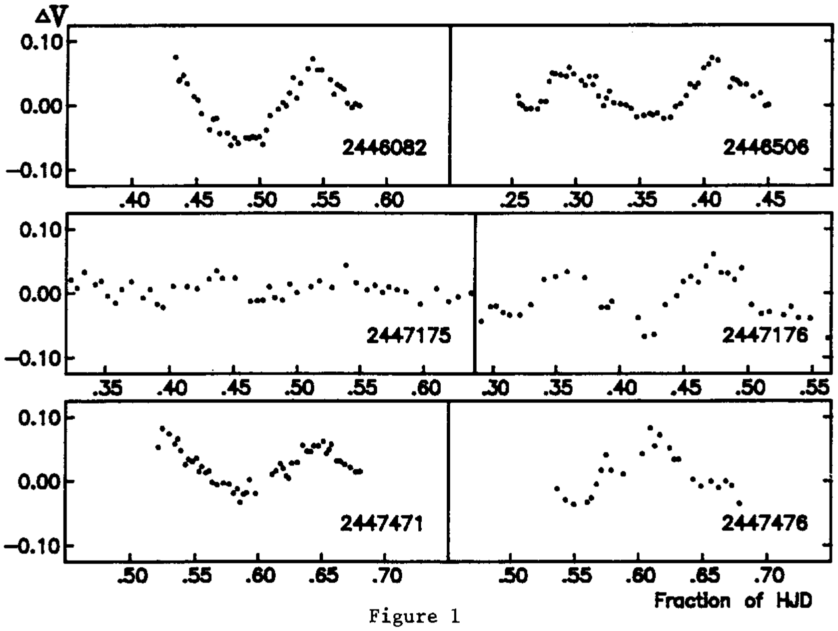

Figure 1

14 times of maxima were determined and the tentative elements for the new variable were estimated:

$$\text{Moment of maximum HJD} = \underset{\pm .0034}{2446768.6343} + \underset{\pm 8}{0\overset{d}{.}1194660} \cdot E$$

The times of maxima and the O-C calculated from the above formula are given in Table II.

Table II

HJD 24..	E	O-C	HJD 24..	E	O-C
45673.4835	-9167	-0.0057	46826.4703	484	0.0145
46082.4334	-5744	0.0120	46827.3923	492	-0.0192
46082.5411	-5743	0.0002	46851.4364	693	0.0122
46137.3662	-5284	-0.0096	46857.3970	743	-0.0005
46506.2970	-2196	0.0100	47176.3614	3413	-0.0104
46506.4058	-2195	-0.0005	47176.4728	3414	-0.0184

Taking into account the spectral type of the new variable and the amplitude changes, the authors suggest BD+2°1867 to be a δ Sct-type variable.

It would be advantageous to obtain as many observations as possible during one night. This is difficult at our Observatory because of its high latitude. For this reason observations made at lower latitudes are highly desirable.

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NEW PHOTOELECTRIC OBSERVATIONS OF CY AQUARII

CY Aquarii (=BD+0°4900) is one of the most thoroughly observed SX Phe type stars. Because of its short period (0.061 day≈1h 28m) and large amplitude (about 0.9 mag and 0.7 mag in B and V, respectively) CY Aqr has attracted considerable attention in the past fifty years. All the observations published up to 1980 have been summarized by Mahdy and Szeidl (1980). New photoelectric observations were obtained by Bohusz and Udalski (1980), Purgathofer and Schnell (1984), Peña et al. (1985) and Rolland et al. (1986).

The changes in the period of CY Aqr have been investigated in several papers and the results are contradictory. Percy (1975) and Mahdy and Szeidl (1980) came to the conclusion that the perios of the star changed abruptly around 1951-1952 by about $-18\cdot10^{-8}$ day = -16 ms. Kämper (1985) stated that during the past fifty years the star was subjected to three abrupt period changes, two sudden decreases and one sudden increase: $-173\cdot10^{-9}$ day = -15 ms in 1953, $-43\cdot10^{-9}$ day = -4 ms in 1967 and $+27\cdot10^{-9}$ day = $+2$ ms in 1977. Zissell (1968) also claimed that the star's period was essentially constant, at least between 1953 and 1966. Bohusz and Udalski (1980) tried to check the constancy of the period of CY Aqr until 1978. They found that the period between 1966 and 1971 was the same as in the years 1973-1978, although a small shift of moments of maxima of about 0.003 day after 1973 suggests that the period was slightly shorter between 1971 and 1973.

Detre and Chang (1960) noticed that the O-C diagram could not be approximated by a linear formula and they derived an ephemeris with a quadratic term of $\beta/2 = -7.42\times10^{-13}$ days. Hardie and Tolbert (1961) also found the period gradually decreasing and a second-degree solution seemed to have appeared to them as being satisfactory with $\beta/2 = -6.0\times10^{-13}$ days. A continuously decreasing period was assumed by Karetnikov and Medvedev (1966), too. They derived the new elements with a quadratic term $\beta/2 = -6.35\times10^{-13}$ days. A detailed study of the period changes in CY Aqr was carried out by Rolland et al. (1986). They found that the ephemeris with a quadratic term of -4.58×10^{-13}days (a parabolic fit to the O-C values) explains the observations better. Soon after this result had been achieved, Peña et al. (1985) obtained three new moments of maximum light, and made a new quadratic fit to the O-C values, using Purgathofer and Schnell's (1984) observations, too. This new fit resulted in the ephemeris:

$T_{max} = 2440892.63705+0\overset{d}{.}0610\ 3832\ 01.E\ -4\overset{d}{.}45\mathrm{x}10^{-13}E^2$

Because the residuals from this fit seemed to be fairly large we decided to observe the star again in order to obtain new times of maximum light and to reinvestigate its period changes.

The photoelectric observations were carried aout at Kottamia Observatory by the 74 inch telescope in two colours (B and V) during the nights of July 23 and 24 and August 19 and 20, 1985. The photoelectric photometers attached to the f/18 Cassegrain focus had an EMI 9558B tube with an S-20 photocatode.

The observations yielded 16 light curves, eight in each colour which are reproduced in Figure 1. It is clear from this figure that the light curves of CY Aqr are characterized by a more or less constant shape but noticeable changes in the shape and height of maximum light do occur from cycle to cycle. This effect was interpreted as double mode pulsation by Elst (1972) and by Fitch (1973) but further studies denied this possibility.

Eight times of maximum light could be determined from our observations. These new light maxima are listed in Table I. (Each is a mean of the blue and yellow maximum).

In this study of period changes of CY Aqr all the published 261 photographic and photoelectric maxima have been used. The list of maxima given in the paper of Mahdy and Szeidl (1980) has been supplemented by the maxima published by Bohusz and Udalski (1980), Purgathofer and Schnell (1984), Rolland et al. (1986) and Peña et al. (1985). The O-C residuals have been computed by the formula

$C = 2434308.4310 + 0\overset{d}{.}0610\ 3839\ 5 \cdot E$

and are plotted against epoch numbers in Figure 2.

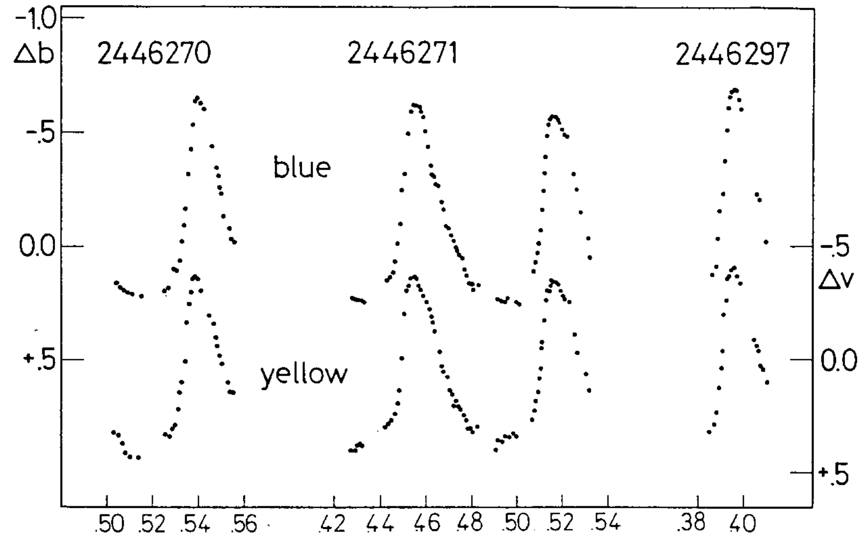
A second order least squares fit was carried out to the 261 observed light maxima and our results are:

$T_o = 2434\ 308.42804$

$P_o = 0.0610\ 3842\ 21$ day (1)

$\beta/2 = -4.637\mathrm{x}10^{-13}$ day

The parabolic fit is drawn in Figure 2. The O-C versus epoch number diagram with the new quadratic ephemeris (1) is shown in Figure 3. This figure convincingly proves that there are some significant deviations from


-1.0
Δb
-.5
0.0
+.5
2446270
2446271
2446297
blue
yellow
-.5
Δv
0.0
+.5
.50 .52 .54 .56
.42 .44 .46 .48 .50 .52 .54
.38 .40

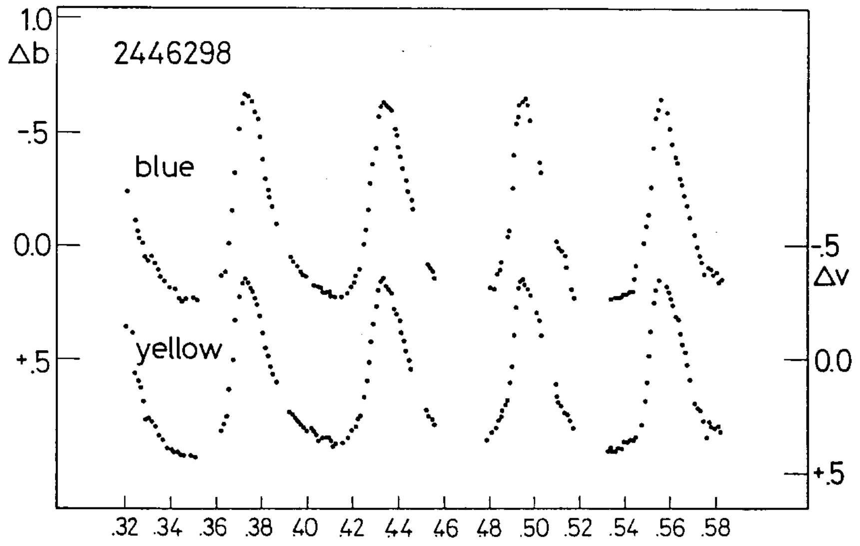

1.0
Δb
-.5
0.0
+.5
2446298
blue
yellow
-.5
Δv
0.0
+.5
.32 .34 .36 .38 .40 .42 .44 .46 .48 .50 .52 .54 .56 .58

Figure 1

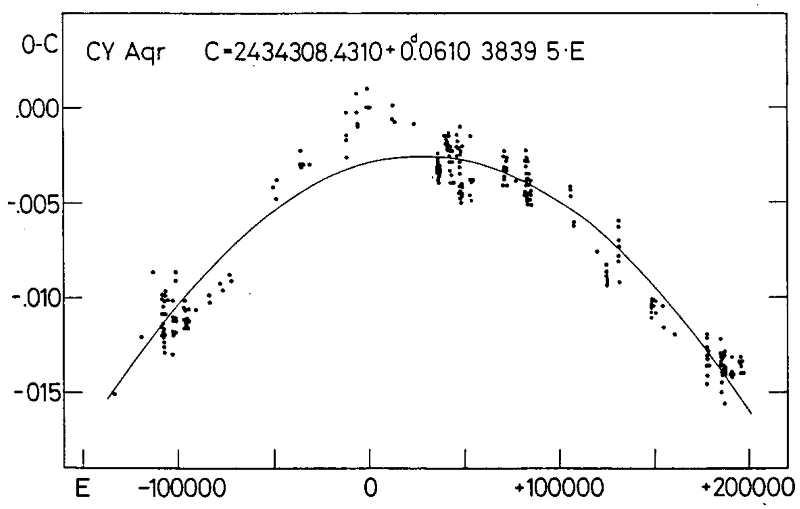


Figure 2

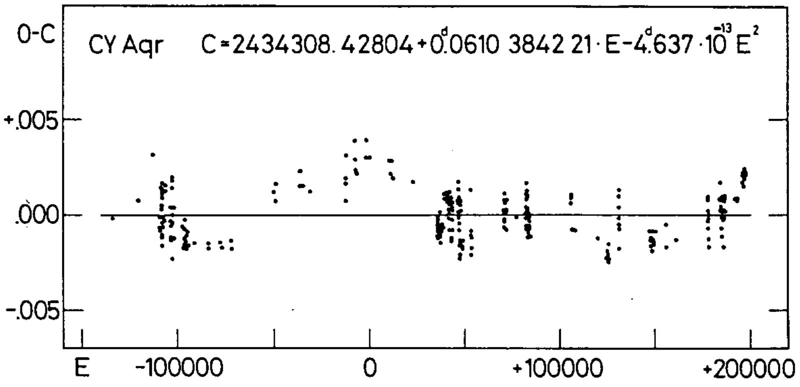


Figure 3

Table I

New times of light maximum of CY Aqr

J.D.	J.D.
2446 270.5393	2446 298.3726
2446 271.4541	.4335
.5154	.4949
2446 297.3960	.5557

the parabolic fit. These systematic deviations suggest that the decrease of the period of CY Aqr.is not smooth and may not be continuous. At present the period changes of CY Aqr can also be interpreted in such a way that the constant period is subjected to abrupt decreases and increases (Kämper, 1985). Further observations can only clear up to the character of the period changes of CY Aqr.

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PHOTOELECTRIC OBSERVATIONS OF ST AQUARII

The eclipsing binary ST Aquarii (BD-7°5753, HD 211965, SAO 146035) was discovered by Miss Leavitt at Harvard (Pickering, 1908). She classified the system to be an Algol type. Zacharov (1928) estimated the period to be $0^{d}.390455$. Later on Mergentaler (1928) discovered that the period should be much longer than that estimated by Zacharov. Zacharov (1930) reclassified the system to be β-Lyrae type, and he found the period about twice the original value, or $0^{d}.7810161$. The system consists of a bright A7 component accompanied with a faint G8IV component (Roman, 1956).

The eclipsing binary ST Aqr was observed photoelectrically at Kottamia observatory (Egypt) on 5 nights during October to December 1978. The cassegrain focus of the 74-inch reflector was equipped with a cooled two-channel photometer. The detector was an EMI 9862B/350 photomultiplier tube, powered by an Isotopes Development Ltd. type 1388 D.C. amplifier and then fed to a Honeywell chart recorder. Two wide - band filters (B, V) have been used in this work. The blue filter was a BG12 1mm + GG385 2mm, and the yellow filter was a BG18 1mm + GG495 2mm Schott Glass B filter. The effective wavelength for B and V filters were 4258 Å and 5385 Å, respectively, and the bandwidth for the filters was 982 Å for B and 981 Å for V.

For comparison and check, the stars BD-7° 5751 and BD-7°5755 were used, respectively. A total of 386 and 370 observation points were obtained in B and V filters. The phases of the observations have been computed from the light elements given by Gleim (1973):

Min I (Hel.) = 2441 236.316 + $0^{d}.78099525$ E

The light curves for V and B are shown in Figure 1 and 2. Table I shows the times of minima and O-C values derived from the light curves.

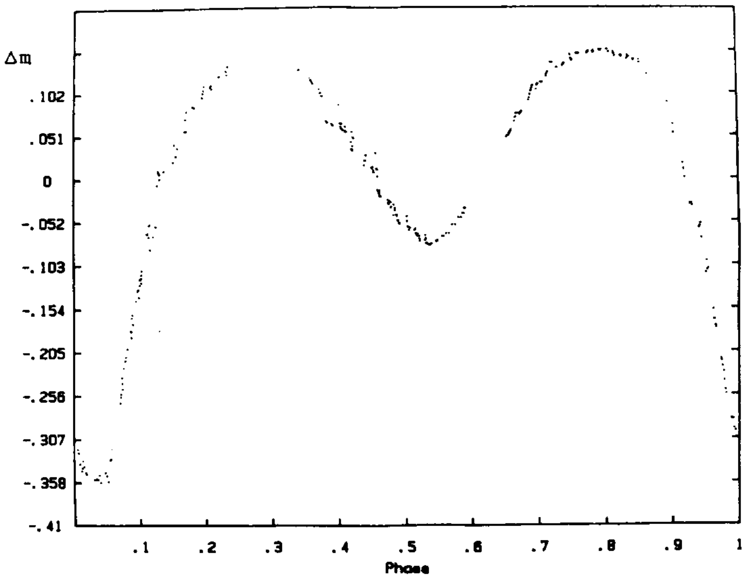

Figure 1

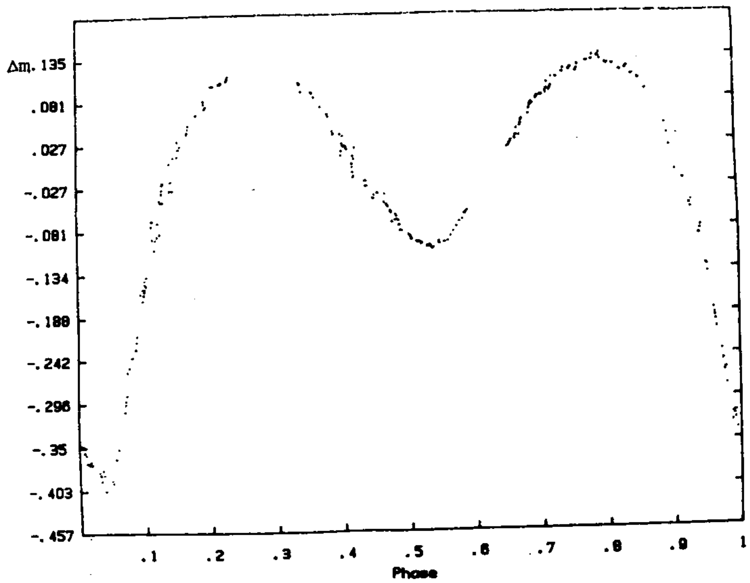

Figure 2

Table I

Times of minima and O-C values

Minimum	Observed (Hel.J.D.)	Calculated (Hel.J.D.)	O-C
I	2443801.9104	2443801.8854	0.0250
II	2443835.8877	2443835.8587	0.0290

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PHOTOMETRIC FLUCTUATIONS IN THE LIGHT CURVES OF R ARAE

The southern peculiar bright binary system R Arae (HD 149730A = HJ 4866A, $M_V \sim 6{\cdot}5$, RA = $16^h\ 35^m\ 6^s$; Dec = -56° 54' (1950)) has received more attention in recent years (Nield *et al.* (1986), Kondo *et al.* (1985), McClusky *et al.* (1983), Wolf and Kern (1983)). Nield reported some discrepancies in earlier quoted values of the period, while pointing out some definite increase of the orbital cycle since the epoch of Hertzsprung (1942). We obtained a new time of primary mid-minimum of HJD 2447386·1200. Again this minimum occurs somewhat later than Hertzsprung's period would predict and a period value of 4·42522 days best describes the interval between Nield's and our current data.

Here we wish to call attention to some clear indications of two types of small-scale optical broad-band (Johnson UBV) photometric variations which seem to persist through all phases and times of observations. These were previously discussed by Nield (1987) and are confirmed here.

In figure 1, an extensive series of measurements of a check star (HD 150745), against the comparison star (HD 147977) used in our differential photometry, is plotted with R Arae using Hertzsprung's ephemeris. This data was collected at the Black Birch outstation of Carter Observatory (New Zealand) over the period April 1986 to September 1988. Some recent improvements to the photometric equipment and its control and data acquisition system have been described by Forbes (1989).

Clearly the variations of R Arae are larger than the 'noise' in the check star and so can be confidently considered intrinsic variations of R Arae and not due to atmospheric or instrumental fluctuations. Similar results are also found in the U and B filter measurements.

Figure 2 shows R Arae in more detail, with the data from various nights plotted separately. The two types of fluctuations are ;

a) a variation throughout most nights of ~ 0·08 mag and on a timescale of order 10 hours (most clearly visible in the out of eclipse regions)

b) a fluctuation in the average magnitude level on different nights (corresponding to the same phase) of ~ 0·15mag

These variations correspond to ~ $3{\cdot}5 \times 10^{27}$ Watts and ~ $6{\cdot}6 \times 10^{27}$ Watts respectively at the source.

R Arae is thought to be an *interactive* eclipsing binary with a (~$3{\cdot}6 M_\odot$) B9 primary and an (~$1{\cdot}4 M_\odot$) F type secondary (cf. Budding (1984)). In this picture, the primary is surrounded by some accretion structure formed from material 'falling' from the secondary which is undergoing Roche Lobe OverFlow. The average period increase since Hertzsprung's Epoch would require a mass transfer rate of ~ $2 \times 10^{-7}\ M_\odot\ \mathrm{yr}^{-1}$ (cf. Nield (1987)). An order of magnitude estimate of the power available from this infall gives ~ 3×10^{27} Watts. It is feasible, therefore, that the short timescale variations of light level might be associated with irregularities in the rate of infall, perhaps some instability of the flow or accretion structure.

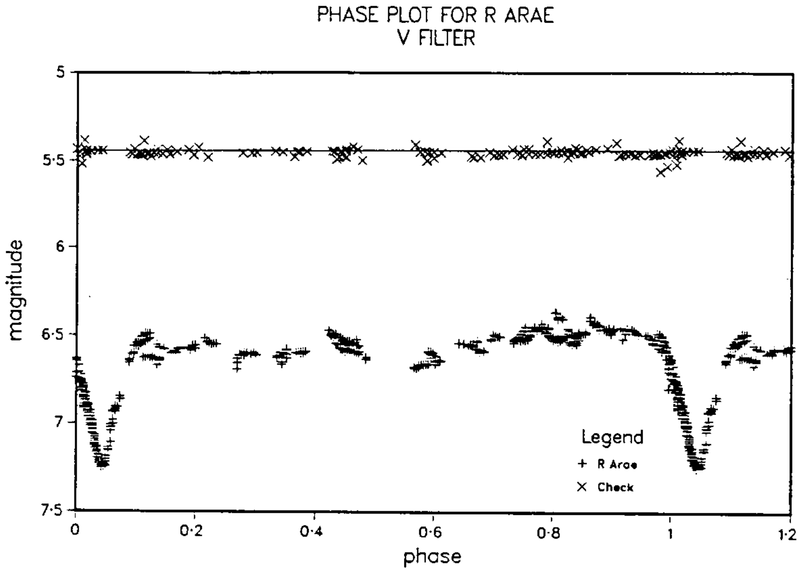

Figure 1

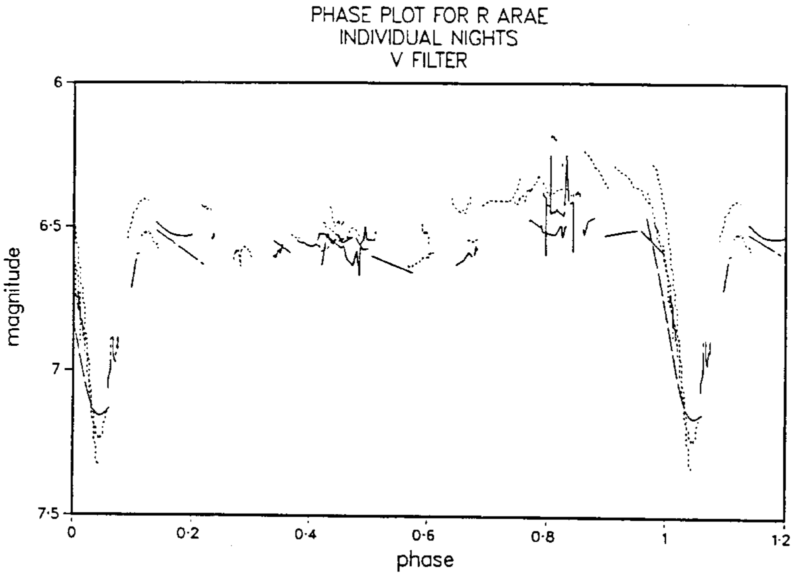

Figure 2

The larger scale variation (night to night) cannot however be explained by a RLOF effect. A point to be kept in mind concerning this is the presence of the visual companion (HD 149730B), only 3·6 arc secs away. All photometry hitherto has included this companion but efforts to measure it's relative contribution have been rather error prone. Nield gave an estimate of 30% ± 10%, though a rather lower figure (16%) is quoted in the General Catalogue of Variable Stars (Kholopov (1985)), see also Jeffers *et al.* (1963). The question arises as to whether this companion might be the source of this ~ 0.15 mag variation. Clearly the proportional effects would have to be large and seem to rule out the possibility of any α^2 CVn type variability. No binarity of the companion has been reported, nor does the variability clearly indicate such.

Hence the undoubted peculiarities of R Arae remain rather mysterious and we can only urge further observational attention to help resolve some of these problems.

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OPTICAL BEHAVIOUR OF THE POLAR AM Her IN 1988

Using the sequence for comparison stars given by Hudec and Meinunger (1977) we measured the star on 55 blue-sensitive (ORWO-ZU21+GG13+BG12), 33 photovisual (ORWO-RP1+GG14) and 41 uv-sensitive (ORWO-ZU21+UG2) plates from 40 nights taken with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 14 February and 7 November 1988. The individual observations will be published in MVS, Sonneberg.

The annual light curves in B, V and U are given in Figure 1, where all observations show the star to be in the high state caused by X-ray heating. The annual mean brightness amounts to $B = 13\overset{m}{.}38$, $V = 13\overset{m}{.}34$ and $U = 12\overset{m}{.}34$. The mean value in B is brighter than in the previous year (Götz, 1987).

From 29 nights we obtained 36 B-V colour indices, and 37 U-B colour indices. The B-V colour indices complete the colour-magnitude diagram m_B-(B-V) given by Götz (1984) and are in agreement with the behaviour shown there. The colour-magnitude diagram m_B-(U-B) is given in Figure 2. It is similar to that given by Götz (1986) but with higher mean B-brightness without any colour index change. In both cases, the U-B colour indices become larger with increasing brightness.

The two-colour diagram (U-B)-(B-V) of the series 1988 is shown in Figure 3. There the B-V colour indices become larger with decreasing U-B. This behaviour also confirms the result obtained from observations of the series 1986 given by Götz.

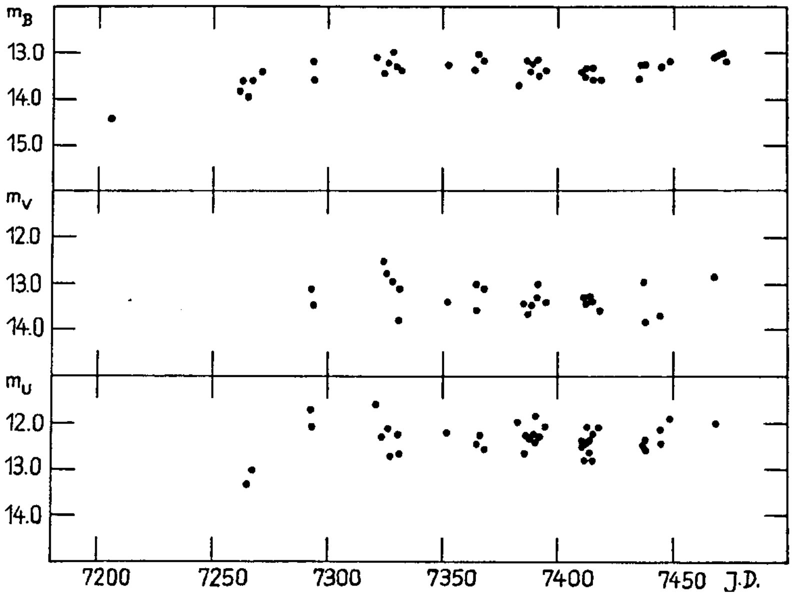

Figure 1

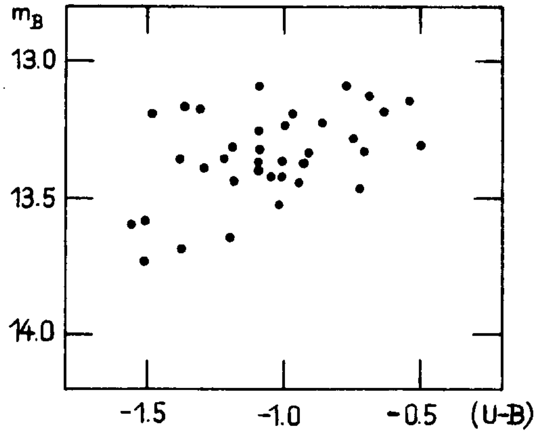

Figure 2

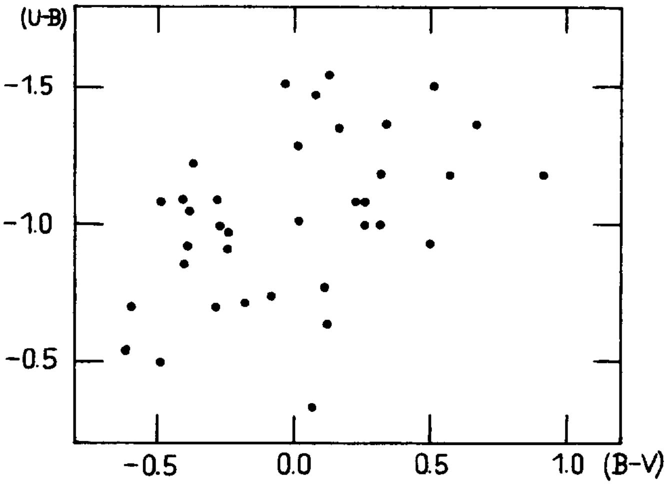

Figure 3

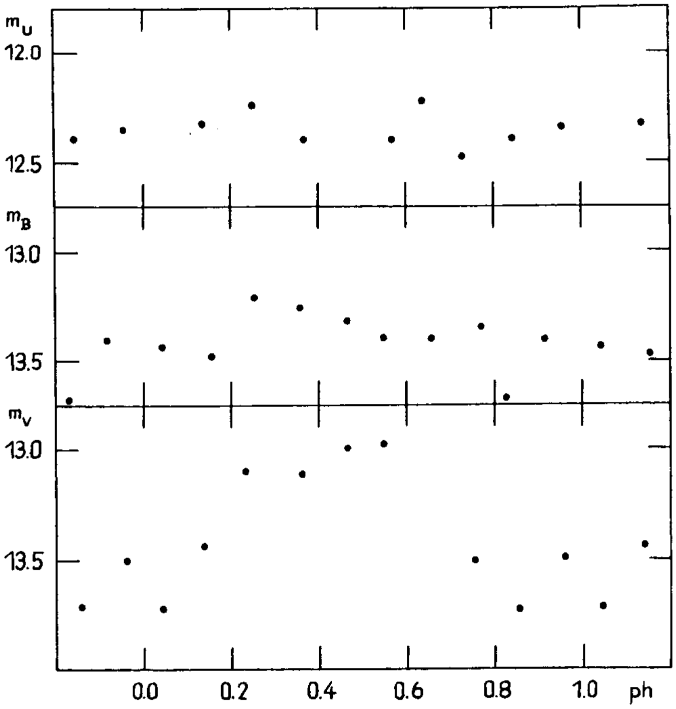

Figure 4

In order to study the influence of occultation light changes on the overall light curves, all observations were reduced to one common epoch by means of the improved orbital elements published by Götz (1984). As it is shown in Figure 4, where the mean magnitudes in B, V and U are plotted against the phases, periodic variations can only be seen in the V range.

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ON THE SUPPOSED PERIODICITY OF RZ PISCIUM

Unpublished results of 113 photoelectric UBV observations, secured at Sonneberg Observatory during the years 1964 to 1974, and of approximately 850 brightness determinations (partly by E. Splittgerber) on Sonneberg sky patrol plates of the years 1929 to 1975 are not consistent with the elements given by Kardopolov and Filip'ev (1988) for photoelectric data of 20 nights of 1978. These authors' doubts on the reality of their period are thus supported. I suppose that their "mean light-curve" is the result of their data being too meagre.

Of course it can never be completely excluded that during a more or less short time interval some periodicity of brightness minima is effective in otherwise irregular variables. See for instance our very dense photoelectric series of SV Cephei (Wenzel 1969) or the behaviour of the central star of the bipolar planetary nebula NGC 2346. In both cases "eclipses" by temporary dust clouds, albeit different in origin, have been taken into consideration. At the later-type Is variables we should rather think of the well known spotted outer layers as an explanation of occasional quasiperiodic brightness changes. RZ Piscium (KO IV) with its large range (>2 mag), however, needs much more dense observations for clearing up its nature, which is strange enough because of the star's rather large angular distance from the galactic equator alone.

Because of possible misunderstandings it might be dangerous to show the "mean light-curves" of RZ Piscium and IP Persei (see in this context Wenzel 1984) in connection with that of the genuine eclipsing star SY Cephei.

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ON THE VARIABILITY OF THE Am STAR 68 Tau (HD 27962)

The star HD 27962 (HR 1389= 68 Tau= V776 Tau) is one of the few Am stars in which magnetic field has been measured (Babcock 1958), so it was included into our programme of photoelectric observations of magnetic stars with the aim of ascertaining the existence of light variations and determining the period, if any. The observations, in the UBV natural system, were carried out in 1973 and 1974 at the Stellar Station of the Catania Astrophysical Observatory using the 90 cm telescope and the equipment described elsewhere (Blanco et al. 1978).

The comparison stars used were: HD 27295 (HR 1339 = 53 Tau, B9 Mn) and HD 27934 (HR 1387 = 65 Tau, A7IV). After the reduction of the observations, HD 27295 was found to be variable, so it was eliminated from the programme: its periodicity has been investigated separately (Catalano et al. 1988). The second comparison (HD 27934) in turn was found in the literature to be a suspected δ Sct star. However, during our observing session, it did not show evidence of variability.

UBV observations of HD 27962 by Winzer (1974) and Kuvshinov et al. (1976) are available in the literature with different results: Winzer (1974), using HD 27819 (HR 1380 = 64 Tau, A7V) as a comparison, found HD 27962 to be constant to better than 0.01 mag on a time-base of 20 days, while Kuvshinov et al. (1976), using the same comparison and on a time-base of about 700 days, found it to be variable with a period of 57.25 days, which they find to be also the period of the orbital motion and of the magnetic field variation. It has to be noted that practically in the same time Conti et al. (1974) did not find any significant radial velocity variation from coude spectra (resolution 10 A/mm) thus questioning that HD 27962 is a spectroscopic binary. This negative result was later confirmed by Häupl (1980).

In this very unclear situation we decided to search for periodicity, using all sets of UBV data and transforming Kuvshinov et al.'s observations and ours into the Winzer's system. By means of the procedure described by

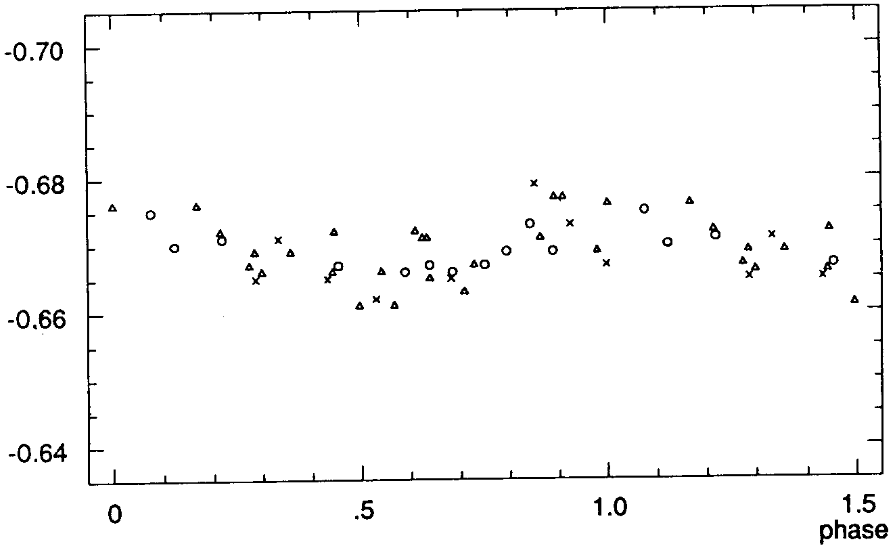

Figure 1
U light curve of HD 27962. The phase is computed according to formula (1) in the text. Code is the following:
Open circles: observations by Winzer (1974)
triangles: Kuvshinov et al. (1976)
crosses: Catalano and Leone (this paper)

Deeming (1975) we found that the data could be best represented by the elements:

$$\text{JD (Max. U light)} = 2440\ 604.34 + 21^{d}.2637\ E \qquad (1)$$

The resulting U light curve is reported in Figure 1, where a small amplitude variation is evident. Using all three sets of data no acceptable phase diagram was obtained with the 57.25 days period given by Kuvshinov et al. (1976).

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ERRATUM

In the ephemerides of the U light curve of HD 27295 (IBVS No. 3220) the initial epoch refers to the minimum light instead of the maximum light given by a clerical mistake.

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The rotation period of the Ap star HD 220825 (κ Psc)

The Ap star HD 220825 was first monitored by Rakosch (1962), who determined a rotation period of 0.5805 day and found the amplitude to vary less than 20 millimagnitudes (mmag) peak-to-peak in blue and yellow filters. A refinement of the rotation period was undertaken by van Genderen (1971), who obtained five-color Walraven photometry. He utilized a second comparison star, HD 221318, in addition to the one used by Rakosch (HD 220858), and found HD 220858 to be slightly variable. A new period of 0.5853 days was determined, based on using HD 220858 as the sole comparison star.

Spectroscopy by Schneider in 1988 revealed spectral line variation that did not agree in phase with this period. For this reason, we decided to reobserve HD 220825. Here, we present our first data obtained by Kreidl at Lowell Observatory in September and October 1988.

Photometry was obtained on seven nights with the Lowell 1.1-m telescope and a narrowband (FWHM ≈70 Å) filter centered at 4060 Å. As comparison stars, HD 221318 (which was utilized by van Genderen), and HD 221950 were used. Neither comparison star showed any indications of variability; HD 221318 (C1) was taken as the primary comparison star and all differential magnitudes reported here are in reference to HD 220825 minus C1.

A periodicity analysis of the differential data was undertaken utilizing Kurtz' (1985) more efficient method of the Deeming (1975) DFT technique. Figure 1 shows peaks in the amplitude spectrum of nearly equal height at the frequencies .704 day^{-1} and 1.708 day^{-1}, the amplitude of the former being slightly greater. The second frequency corresponds to

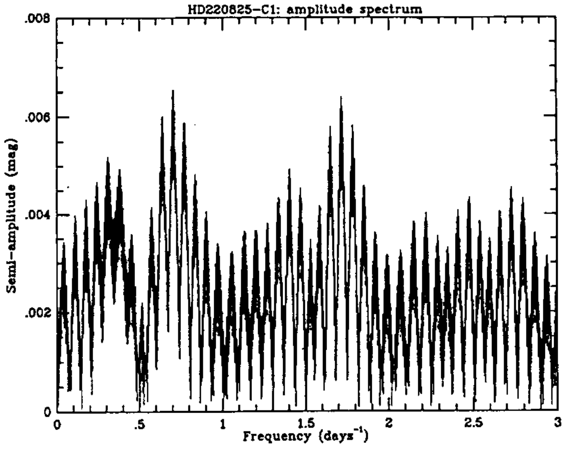

Figure 1.

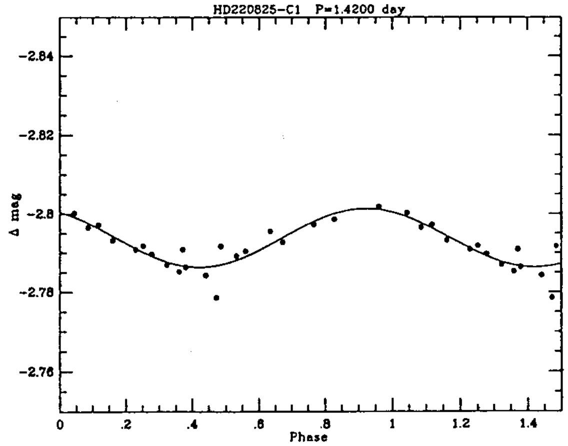

Figure 2.

a period of 0.585 day, essential identical with the period found by both Rakosch and van Genderen. However, the photometric accuracy of the data obtained in this investigation is high enough to show that in a phase plot, the frequency .704 day^{-1} (period=1.420 days) is actually the correct one and that the peak corresponding to .704 day^{-1} is actually a one-day alias in the frequency domain.

A cosine fit to the data yield a best fit to the period 1.4200 ± 0.0005 days; the phased data and corresponding cosine fit are shown in Fig. 2. The rms error of this fit is just 1.8 mmag, compared with the rms error of 2.7 mmag if one assumes a period of 0.5853 day.

A more thorough discussion of this star, including additional photometric data and spectroscopic results obtained by Schneider, will be presented elsewhere.

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MORE ABOUT KX TrA = Cn 1-2 = PK 326-10°1 = He 2-177*

Recently Feibelman (1988) and Allen (1988) commented on the identification and possible outburst properties of the symbiotic star KX TrA. I like to add that it is also listed and (properly) identified in the *Reference Catalogue and Atlas of Galactic Novae* (Duerbeck 1987); it was included because Carlson and Henize (1974) classified it as a slow nova from its spectral appearance, which showed some resemblance to RR Tel. A light curve of the object for the years 1890-1975 was given by Liller (1974). Any major outbursts during this time interval can be excluded.

KX TrA was observed, in 1986, with the B&C Cassegrain spectrograph and IDS detector at the ESO 1.52 m-telescope (Fig. 1). I tend to compare its spectrum with RT Ser, as it appeared in 1986 (Fig. 2), except that in the latter object the [O III] lines are essentially absent. Comparing

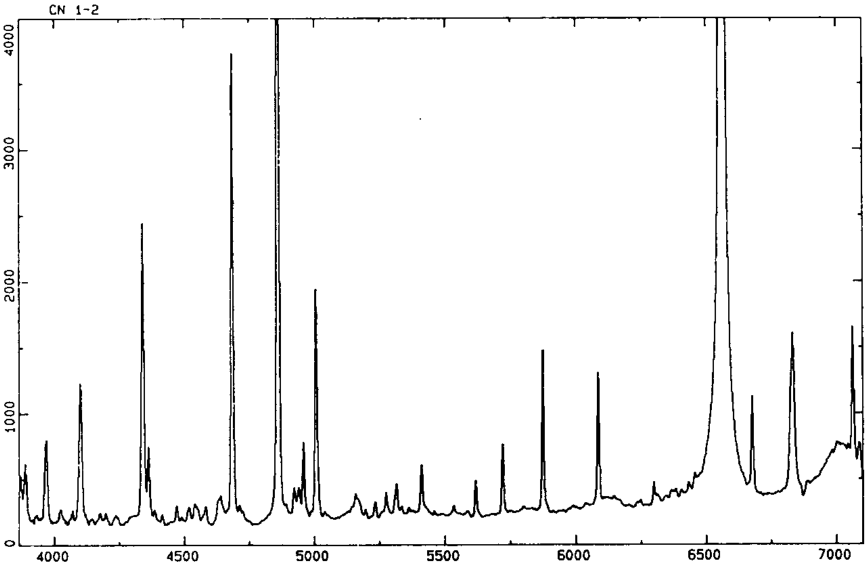

Fig. 1 The spectrum of KX TrA

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*Based on observations collected at the European Southern Observatory, La Silla, Chile

Allen's (1984) spectrum of KX TrA in 1978 with that in 1986, a noticeable relative increase in the strength of He I 4686 is found. It should be noted that the [Ca VII] 561.6, 493.9 lines are relatively strong in both stars. RT Ser also qualifies as a star with a normal M-type companion (Kenyon 1986), a property considered by Allen to be possibly significant for a comparison.

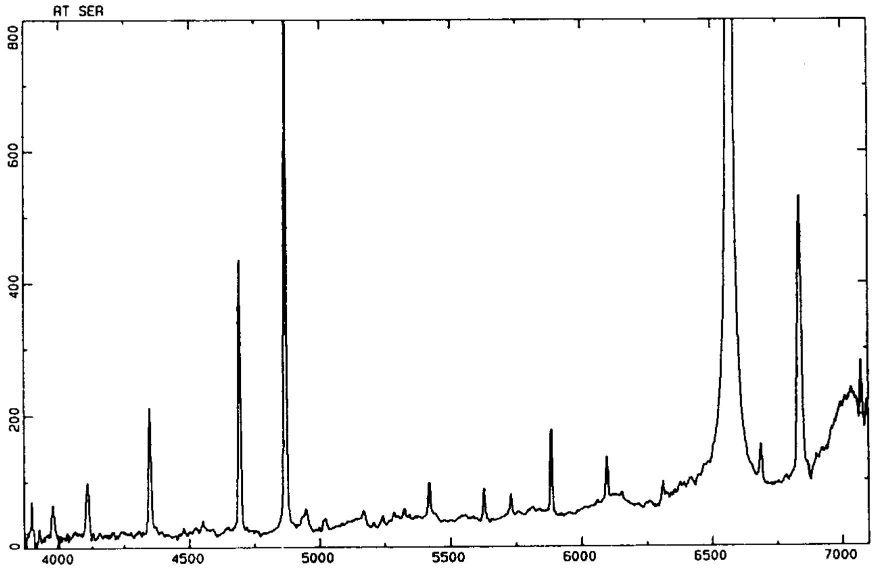

Fig. 2 The spectrum of RT Ser

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THE SPECTRUM VARIABLE HR 7817=HD 194783

This star has been classified as a B9 Mercury Manganese star by Anderson and Nordström (1977) who also remarked that this object is a probable spectrum variable. We have begun an observational programme to monitor peculiar stars that are most likely to be spectrum variables. The choice of the stars is basically dependent on the remarks for these stars given in the Bright Star Catalogue (Hoffleit and Jaschek 1982).

During the period 28 October to 2 November 1988, five spectra of HR7817 at a dispersion of 31 Å per millimeter were obtained with the Zeiss spectrograph at the Cassegrain focus of the one meter telescope of the Vainu Bappu Observatory at Kavalur. Visual inspection of the spectra indicated that Mg II 4481, Si II 4128-31, Mn II 4137, Hg II 3984 and Ca II 3933 are all variable.

Figure 1, shows the density tracings near K, Hg II, Si II and Mn II. The intensities of all these lines were estimated and they indicate a period of about six days for the variability. There is a possible phase shift between Mg II variation and the variation due to other lines. The Mg II 4481 line on 28 October is observed to have a sharp red edge; a suggestion of faint emission in the red wing. The relative strengths of 4128 and 4131 are also found to vary. This Mercury-Manganese star has extremely weak Hg, Mn lines at some phases! Variable faint features at 4077 Å and 4206 Å are also noticed.

The lines are all sharp and the projected rotational velocity v·sini is not likely to exceed 30km/sec. This is consistent with a rotational period of about six days observed for this star. Periods less than a day can be ruled out since we should then expect the lines to be much broader than what is observed. If the elements are concentrated in spots and the period of variation is that due to rotation, then one should expect in analogy with other spectrum variables, that HR 7817 is likely to show a measurable megnetic field even though it is generally believed that Hg Mn stars are non-magnetic.

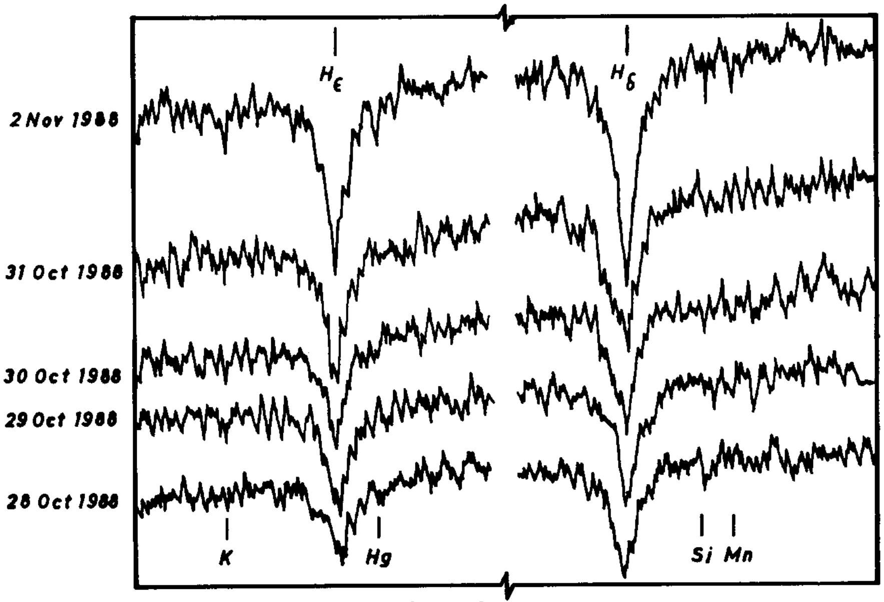

Figure 1

We are thankful to Shri V. Moorthy for his help at the telescope and Shri. A. Ramaswamy for his help at the PDS machine.

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PROFILE VARIATION OF THE He 6678 LINE IN ZETA TAURI

The problem of the spectroscopic and photometric short-term variability of Be stars (a few hours to about two days) received, in these last years, the interest of an increasing number of astronomers. The physical reasons of this variability are not yet clear, but in our opinion non-radial pulsation could be preferred among the other causes invoked by various authors (see two extensive overviews on this matter: Percy, 1986 and Baade, 1987).

In the framework of these problems, some years ago we began a campaign of spectroscopic observations of a few Be stars which in the past showed variability. At first we used photographic plates as the detector, but beginning from 1985 we are able to employ a reticon spectrophotometer. Till now we observed more or less systematically the following objects: Kappa Dra, Theta CrB, omicron And, 28 Cyg, omega Ori.

Zeta Tauri is the Be primary of a binary system with a period of 131.91 days (Hynek and Struve, 1942). Delplace and Chambon (1976) pointed out strong instabilities on a time scale of years in its shell and Bahng (1976) emphasized possible variations in H-alpha emission within a few minutes.

With the aim to throw light on the short-term variability of Zeta Tauri, during the period January 17-24, 1983 we obtained eighty-five grating photographic spectrograms with an inverse dispersion of about 35 Å/mm. Fourty-four of them were collected in the range between 4000 Å and 5000 Å and the other forty-one between 6000 Å and 7000 Å. We used a Boller and Chivens spectrograph applied to the 137 cm. reflector of Merate Observatory.

The results concerning the blue part of this material have been presented (Bossi et al., 1987). Here we show the preliminary results about the profile variations of the He 6678 line, which seems to be very useful in the research of non-radial pulsations in Be stars.

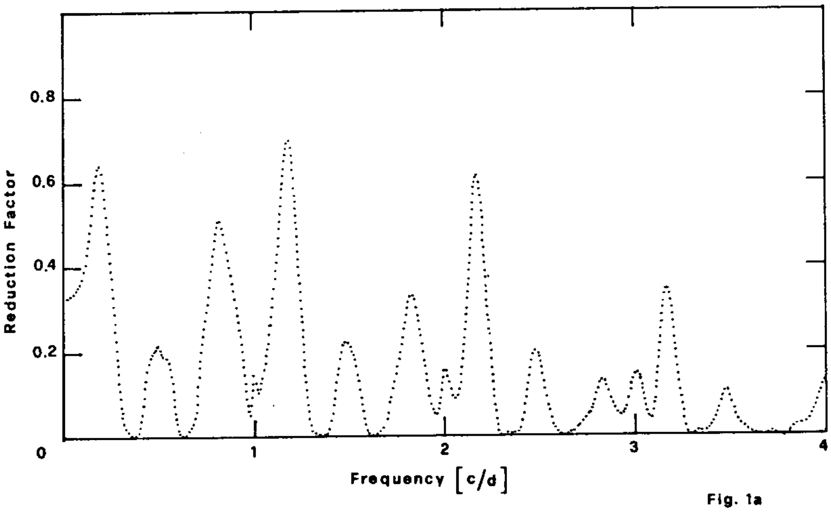

Fig. 1a

Figure 1a

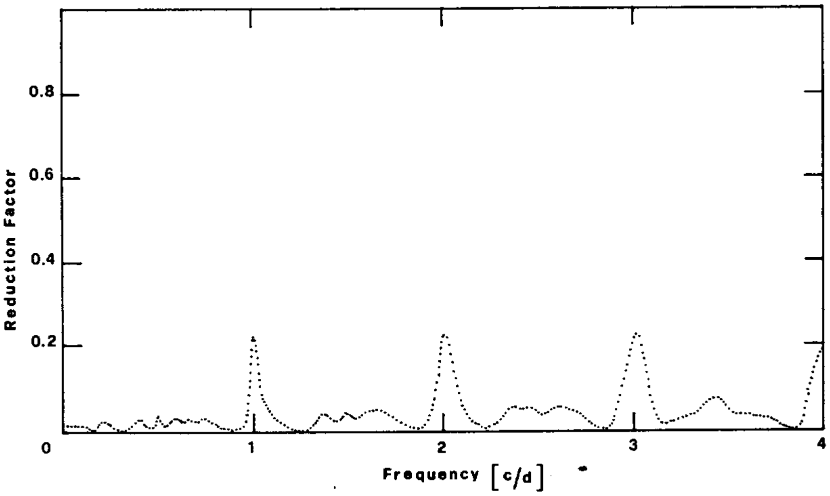

Fig. 1b

Figure 1b

Data reduction has been done as follows. First of all we calculated the asymmetry parameter $A=\frac{HWL-HWR}{HWL+HWR}$ for every spectrum: here HWL and HWR are the left and the right width at half height obtained by fitting the lines by means of two gaussian curves. Table I shows the obtained values of this parameter and the related observational epochs.

Table I

J.D.	A	J.D.	A
24453..		24453...	
52.281	.123	52.304	.301
52.321	.216	52.338	.117
52.358	.241	52.379	.284
52.400	.235	52.422	.308
52.443	.229	52.465	.170
53.292	.343	53.339	.211
54.293	.044	54.362	.086
54.408	-.116	54.481	-.230
55.281	-.147	55.303	.081
55.324	.100	55.342	-.203
55.361	-.119	55.381	-.210
55.402	-.232	55.428	.010
55.453	-.267	55.484	-.313
57.314	.085	57.349	.214
57.383	.227	57.420	-.015
58.318	.253	58.337	.192
58.358	.317	58.383	.225
58.475	.245	58.496	-.010
59.326	.110	59.376	.233
59.396	.105	59.415	-.094
59.470	-.098		

Then we performed the spectral analysis of these data. Figure 1a represents the frequency spectrum calculated between 0 c/d and 4 c/d, which turned out to be the only interesting frequency range as regards the research of possible periodicities. On the vertical axis the reduction factor of the data variance is shown. The greatest peak corresponds to the frequency f = 1.18 c/d (P = 0.85 days). Figure 1b is the frequency spectrum obtained after subtracting the found period P: as one can see, all the peaks present in Figure 1a disappear, except for the small ones corresponding to the integer values of the frequency which could be due to observational effects. The probability that the period P is due to noise comes out to be very small, as we can see by means of the method proposed by Stobie et al. (1977).

So we confide that profile variations were present in He 6678 line between January 17-24, 1983, in spite of the fact that we employed a detector (the photographic plate) with low signal to noise ratio. The found period P = 0.85 days is in very good accordance with the short-term variability of Be stars (Percy, 1986).

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TIME OF MINIMUM DETERMINATION OF THE ECLIPSING BINARY V541 CYGNI

The study of apsidal motion in eclipsing binaries has become more interesting with the recent discovery that at least two well-defined systems, DI Her and AS Cam, have observed apsidal motions significantly less than those predicted from general relativity and standard classical theory (Guinan and Maloney, 1985, 1987; Maloney et al., 1986). V541 Cygni (=BD+30°3704; $m_V = +10^{m}6$) is an eclipsing binary consisting of two massive ($M_1 = M_2 \simeq 2.5 M_{\odot}$) B9 V stars moving in a highly eccentric orbit ($e = 0.474$) with an orbital period of 15.34 days. This system has been identified by Khaliullin (1983, 1985) and Guinan and Maloney (1987) as an important test case for studying general-relativistic apsidal motion. The recent study by Khaliullin (1985) has determined that the contribution to apsidal motion due to general relativity ($\dot{\omega}_{GR} = 0.82 \pm 0.08$ deg/100yr) is over five times larger than the classical contribution ($\dot{\omega}_{CL} = 0.15 \pm 0.03$ deg/100yr) which arises from tidal and rotational distortion of the stars. The dominance of the relativistic contribution to the apsidal motion is unusual, since the apsidal motion from classical effects overwhelms the relativistic contribution in all but a handful of systems. The classical contribution is small in the case of V541 Cyg because of the small fractional radii of the components ($r_1 = 0.044$; $r_2 = 0.043$) so that the tidal deformations of the stars are very small (Khaliullin 1985). Thus, V541 Cyg serves as an excellent test case for post-Newtonian theories of gravity because the classical apsidal motion is small and the general-relativistic contribution is nearly 70 times larger than the relativistic contribution of $\dot{\omega}_{GR}$=43"/100yr for the orbit of Mercury.

The apsidal motion of an eclipsing binary is measured from the times of primary and secondary eclipse. Khaliullin (1985) has measured the apsidal motion of V541 Cyg from two light curves of the system obtained about 23 years apart, and finds $\dot{\omega}_{obs}=0.90 \pm 0.13$ deg/100yr. This value agrees very well with the combined theoretical classical and relativistic contributions to apsidal motion given above of $\dot{\omega}_{GR+CL}=0.97\pm0.09$ deg/100yr. Because Khaliullin's determination is based only on two light curves, we are attempting to secure additional photoelectric timings to determine more accurately the apsidal motion of this important system. We report here a new time of primary minimum determined at Lines Observatory.

Photoelectric photometry of V541 Cyg was carried out on 21 July 1987 using a photoelectric photometer attached to the 20-inch Lines Reflector. The observations were made differentially with respect to a nearby comparison star using blue (B) and yellow (V) filters of the UBV system. BD+30^{o}3702 (listed as star 3 by Karpowicz (1961)) served as the comparison star for which we estimate $\underline{V}$ = +9.9 and $\underline{B-V}$ = +0.36. Extinction corrections were applied to the data and the times were converted to heliocentric Julian day (HJD) in the ususal way. Details of the instrumentation and data reduction are given by Lines et al. (1986).

The differential $\underline{V}$-magnitudes of primary eclipse are plotted against HJD in the figure. A determination of the time of mid-eclipse was made for both the yellow and blue observations using a computer code described by Guinan et al. (1987). The composite result for time of primary eclipse is:

$$T(\min I) = \text{HJD } 2446998.8424 \pm 0.0010.$$

Using the light elements of Khaliullin for primary minimum of

$$T(\min I) = \text{HJD } 2444882.2127 + 15\overset{d}{.}337873E,$$

the (O-C) of this determination is +0.0032 day. This timing as well as earlier eclipse timings have been used to determine the apsidal motion of V541 Cyg of $\dot{\omega}_{obs} = 0.95 \pm 0.06$ deg/100 yr. This value is close to that found previously by Khaliullin and agrees very well with the theoretically expected apsidal motion. However, in these calculations the masses of the stars were assumed to be $M_1 = M_2 = 2.5M_{\odot}$ from their B9 V spectral types. A radial velocity study of this system is badly needed before we can claim complete agreement between theory and observational data. Due to the crucial role that gravity plays in our understanding of the physical universe, it is critical that we make every effort to comprehend the apsidal motion of V541 Cyg and other massive binary systems.

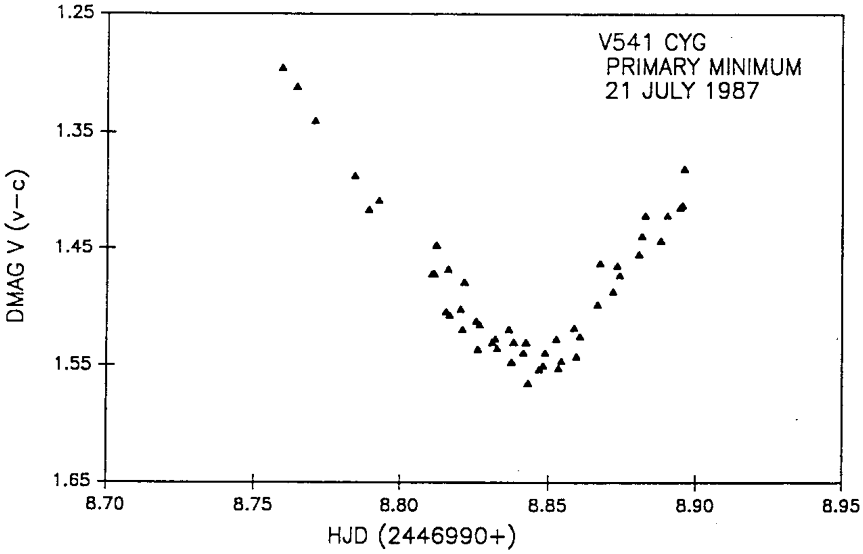

Figure 1. The differential V-magnitudes of V541 Cyg plotted against heliocentric Julian Day number.

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PG 0818+513 - AN ECLIPSING BINARY

Observations on 15 plates taken with the astrograph 400/1600 of Sonneberg Observatory show that PG 0818+513 is eclipsing with an amplitude of about 1.5 mag. The magnitude estimates are given in Table I.

Table I
Magnitude estimates of PG 0818+513

J.D. 2446700+	B	J.D. 2446700+	B
62.393	$14^{\rm m}.63$	64.365	$14^{\rm m}.50$
.430	14.55	.456	15.68
.496	14.55	.561	15.02
.564	14.08	73.403	14.25
63.392	14.98	.450	14.38
.462	14.80	.469	14.42
.606	14.94	.603	14.57
		99.627	14.38

The magnitudes have been derived using the sequence of Andronov (1986). The light curve (Figure 1) is based on the preliminary elements

$$\text{min} = 244\ 6764.460 + 0^{\rm d}.577 \cdot E \quad (?)$$

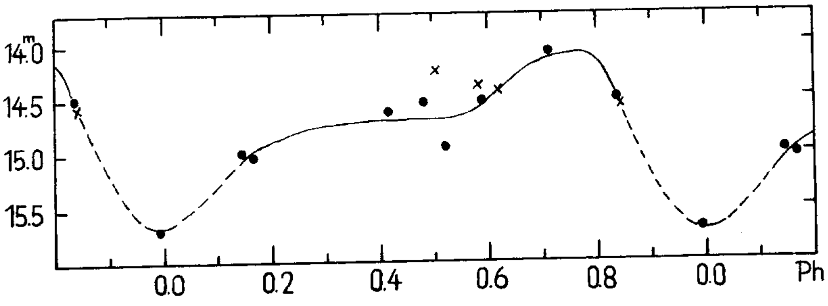

Figure 1
Provisional light curve of PG 0818+513.
Dots: J.D. 244 6762...64, crosses: J.D. 244 6773

Because of the sparseness of the data, the length of the orbital period is still uncertain. If the shoulder near phase 0.75 proves to be real, it would suggest that the bright spot is more luminous than the accretion disk, as is the case in objects with small mass accretion rates, that is, in most of the dwarf novae. But eruptions on PG 0818+513 have neither been observed on Moscow (Andronov 1986) nor on Sonneberg plates so far.

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THE VARIABLE STAR BD $+41^{\circ}2447$

The variability of BD $+41^{\circ}2447$ (R.A.$_{1950}$= $13^{h}57^{m}03^{s}$, Decl.$_{1950}$= $+41^{\circ}03'.7$) was discovered by chance in connection with photoelectric UBV observations of stars in the North Galactic Pole region (Oja, 1985) in March 1980.

The star was put on the observing programme of the 40 cm Cassegrain reflector of the Kvistaberg Observatory. The nearby F5 star BD $+41^{\circ}2450$ was selected as comparison star ($V = 8^{m}.495$, $B-V = 0^{m}.461$, $U-B = -0^{m}.011$) and quite a number of observations were obtained in the autumn of 1980 and the winter and spring of 1981. The observations showed that the V magnitude varied between 9.5 and 10.0, while the colours remained almost constant at $B-V = 0^{m}.30$, $U-B = 0^{m}.00$. The magnitude changed considerably during a few hours, so the period was not likely to exceed a fraction of the day, but a conclusive result as to the length of the period could not be arrived at. More measurements were made in the springs of 1983 and 1987. Altogether 267 observations were obtained.

From the observations in three seasons altogether eleven more or less well-determined epochs of minimum could be derived. To these dates a linear relation

$$\text{Min.} = A + n\times P \quad (n = \text{integer}) \qquad (1)$$

was adjusted by trial and error; this process was greatly facilitated by the existence of two well-determined minima on two consecutive nights in April 1987. A period of 0.258 73 days satisfied the data quite well, and a light-curve was constructed from all available observations. It was, however, obvious that different minima were different in shape; the double period was tried, the result being a much better fit. A period around $0^{d}.517\,46$ thus seemed more probable. All data were now used with a period-searching programme (Oja, 1987); the search was made with $0.5\times(B+V)$, and the resulting best period is

$$\text{Prim. min.} = 2\,446\,895.455 + n\times 0.517\,459\,7. \qquad (2)$$

Defining phase as the decimal part of (J.D. - 2 440 000)/P, the phase of

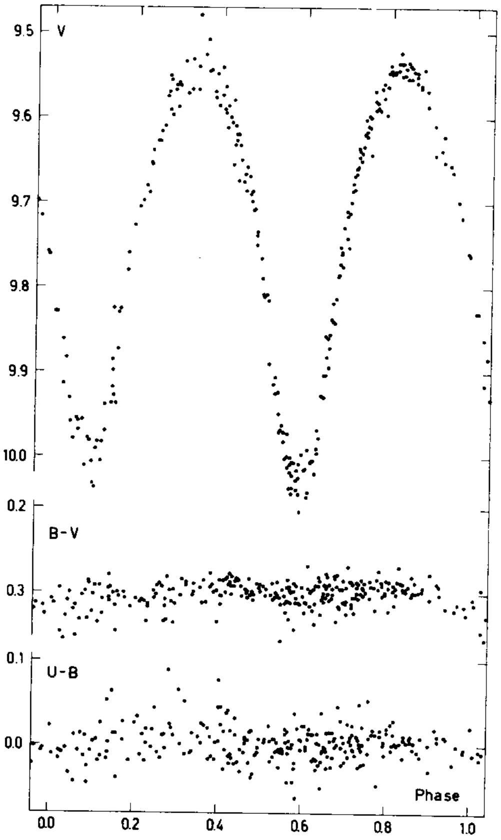

Figure 1. The light-curve of BD +41°2447

primary minimum is 0.588 and that of secondary minimum 0.092. The primary minimum is only $0\overset{m}{.}02$ deeper than the secondary minimum and the phase difference between primary and secondary minima is very close to 0.5. A period half as long as the adopted value perhaps cannot be ruled out completely, although in that case the light-curve certainly is not constant. With the longer period the minimum dispersion resulting from the period-search corresponds to a mean error of $0\overset{m}{.}017$ in one determination of magnitude. This is slightly lower than the mean error of a magnitude determination of a field star in the North Galactic Pole region (Oja, 1985,Table I), a consequence of the differential character of the measurements. It does not leave very much room for a variation of the light-curve.

The light-curve is shown in Figure 1. It is obvious that the colours change very little. The star is slightly redder at minimum, though. During a quarter of a period around primary minimum <B-V> = $0\overset{m}{.}302$, around secondary minimum <B-V> = $0\overset{m}{.}313$, around maxima <B-V> = $0\overset{m}{.}299$; <U-B> = $-0\overset{m}{.}002$ for all phases. The dispersion in U-B is quite large; This is probably due to the fact that many observations were made rather low in the sky, especially so in the autumn and early winter 1979-1980. The amplitude of the light variation is $0\overset{m}{.}5$. The individual observational data (more than 250 observations in each colour) have been deposited as file No. 163 in the archives of unpublished data of IAU Commission 27. The star is present on one of the objective prism plates taken for the survey of the North Galactic Pole region with the 100/135/300 cm Kvistaberg Schmidt telescope. The hydrogen and K line intensities in the Uppsala system (Ljunggren and Oja, 1961) are Hγ = 43, Hδ = 56, K = 57, corresponding to the spectral type F0 and the intrinsic colour $(B-V)_o$ = $0\overset{m}{.}27$. The K line is only insignificantly fainter than for "mean" stars; the values yield ΔS = 1 in the sense Sp(H) - Sp(K) (Preston, 1959). The high amplitude combined with the very small colour variation excludes pulsation as a cause of the light variation. Remain eclipses; indeed, the properties of BD $+41^{\circ}2447$ fit very well into the definition of the EW eclipsing variables (Kholopov, 1985). The conclusion thus is that BD $+41^{\circ}2447$ is a quite typical EW eclipsing variable.

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ON THE SECONDARY MINIMUM OF THE ECLIPSING BINARY ZZ UMa

ZZ UMa was discovered as an eclipsing binary by Kippenhahn (Geyer et al., 1955). The photographic light curve (Döppner, 1962) is of Algol type with the shallow secondary minimum of uncertain depth. The results of the first photoelectric observations of ZZ UMa in two colours were published by Lavrova and Lavrov (1988). According to the light curves obtained by them, the reflection and ellipticity effects are small. Due to the lack of measurements of the secondary eclipse the photometric orbital elements were derived from the primary minima only.

The present paper reports 144 photoelectric U, B, V observations of ZZ UMa in each colour at the orbital phases 0.45- 0.56. The measurements were made on the night of March 16/17, 1988, using the 48 cm Cassegrain reflector of Abastumani Observatory. Typical standard deviation of one observation, as deduced from the maxima, is $0^{m}.018$, $0^{m}.014$, $0^{m}.009$ in U, B, V respectively. The normal points are presented in Figure 1. The magnitude differences are given with respect to BD+62°1138. They are averages of four observations, close in time. For calculations of the phases the light elements given by Döppner (1962) were used.

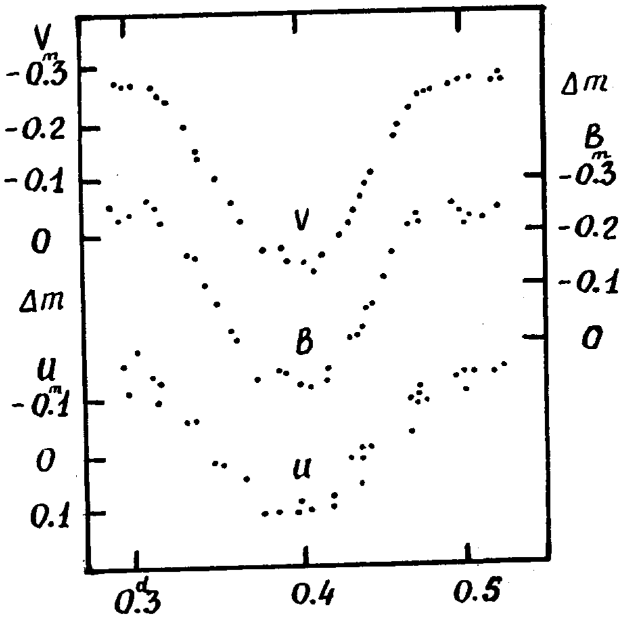
The orbital elements of the system have been derived using the method and programs of Lavrov (1971, 1976). The solutions could be obtained only for a total occultation in the secondary minimum.

The final results and their probable errors are listed in Table I. The subscript 1 denotes the hot primary component and the subscript 2 - the cooler component. Only for V curves $\cos^2 i=0$ and $i=90^{\circ}$. The elements for this curve at $i=90^{\circ}$ are listed in column headed V'. When our results are compared with those published by Lavrova and Lavrov (1988), a good agreement is found for all parameters with the exception of L_1. Our p.e. for L_1 is considerably smaller than the previous one.

Thus the new values of L_1 are more reliable. The values of the amplitudes of the secondary minima A_2 are listed in the last line of Table I. The

Table I :The orbital elements of ZZ UMa

X_2 (adopted)	U 0.75	B 0.75	V 0.60	V' 0.60
k	0.693±0.031	0.710±0.011	0.700±0.042	0.754±0.015
r_1	0.162±0.010	0.149±0.004	0.160±0.011	0.155±0.005
r_2	0.112±0.005	0.106±0.002	0.112±0.004	0.117±0.002
L_1	0.796±0.004	0.756±0.002	0.741±0.007	0.743±0.002
$\cos^2 i$	0	0	0.0020±0.0021	0(adopted)
i	90°	90°	$87^{\circ}.5$	90°
A_2	$0^{m}.25$	$0^{m}.30$	$0^{m}.33$	



J.D. hel. 2447237.0+

Figure 1

spectral class of the secondary star is about G6–G8. Determination of the epochs of mid-eclipse were made for all colours using Lavrov's (1976) program: J.D. hel. 2447 237 + $0^{d}.3990 \pm 0^{d}.0009$ (in U), $0^{d}.3992 \pm 0^{d}.0004$ (in B), $0^{d}.3999 \pm 0^{d}.0004$ (in V).

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VARIABILITY OF LR Hya = HD 91816 NOT CONFIRMED

Bopp *et al.* (1984) found this star to be a new BY Draconis variable with a photometric period of 3.1448 days and an amplitude of 0.02 mag in *V*. The star is a double-lined spectroscopic binary with two nearly identical K0 dwarfs and an orbital period of 6.866 days (Fekel *et al.* 1988). CaII 3950 Å region spectra show composite H and K emission features at a surface-flux level of several $10^6 erg\ cm^{-2} s^{-1}$. The photometric variability is thought to be caused by the presence of starspots rotating in and out of view. As a result of this, Kholopov *et al.* (1987) assigned the new variable star designation LR Hya.

Follow-up photometry has been obtained with the Fairborn APT (Automatic Photoelectric Telescope) in 1984-85 (Strassmeier *et al.* 1989). Their photometry revealed three different possible periodicities of 2.57, 3.57, and 4.86 days. The largest of these, at 4.86 days, results in the greatest reduction of the sum of the squares of the residuals. The formal value of the full amplitude from a sine-curve fit was ~0.04±0.02 mag in *V*, thus, not really significant.

New photometry was obtained during the observing seasons 1986-87 and 1987-88 with the 0.25 m Fairborn APT and the 0.4 m Vanderbilt APT. All observations used HD 91566 = SAO 137648 as the comparison star. A listing of the individual data transformed to the *UBV* system can be requested from the author.

The data were examined for periodicity using a period-finding program that uses least-squares to fit sine curves to the data. No single significant period for any of the data sets showed up. This is demonstrated in the periodograms in Figure 1, where the three panels are for the 1986-87 and 1987-88 observing season, and for the combined data set from 1984 through 1988. The arrows indicate the orbital period and half of the orbital period.

The light curves are plotted with the orbital period of 6.866 days in Figure 2, where zero phase is taken arbitrarily as JD 2,446,800. A Fourier analysis, allowing only for $cos\Theta$ and $cos2\Theta$ terms and using the orbital period resulted in the (formal) amplitudes listed in Table 1. This table also lists the seasonal mean differential brightnesses, their standard deviations, i.e. its "width" or "variability" around that value in Figure 2 and, in the last column, the average deviations or mean absolute deviations of the seasonal mean brightness (all values in magnitudes). From this, the photometric variability seen by

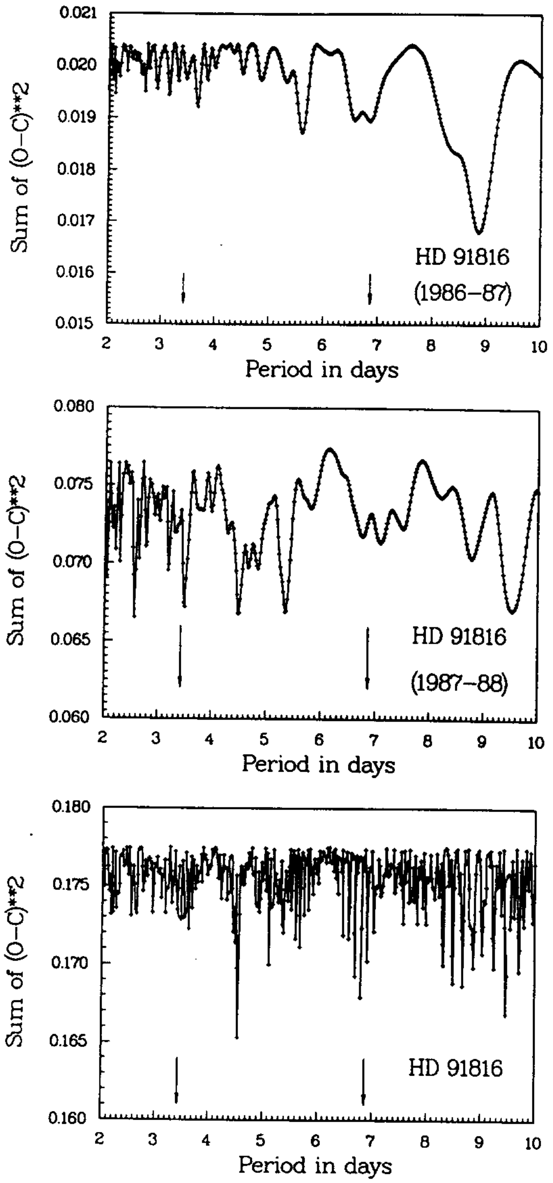

Fig. 1 Periodograms for the observing seasons 1986-87 and 1987-88 (top and middle panel), and the combined data set of Table 1 from 1984 through 1988 (lower panel). The arrows indicate the orbital period and half of the orbital period. No firm conclusion can be made about a photometric period.

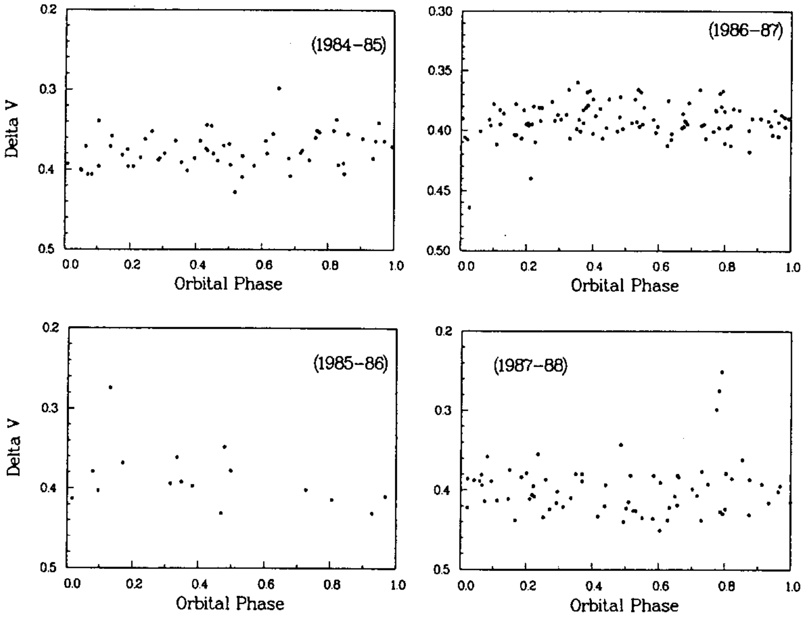

Fig. 2 Differential V light curves for the observing seasons 1984-85 (upper panel) through 1987-88 (lower panel). The data are phased together with the orbital period and an arbitrarily chosen epoch.

TABLE 1

PARAMETERS FROM LEAST-SQUARES FITS

Observing season	JD 2440000+	Data points	Full amplitude	Mean brightness	Standard deviation	Average deviation
1984-85	6045 6197	62	0.011±0.008	0.377	0.020	0.017
1985-86	6417 6555	16	0.071±0.027	0.395	0.024	0.019
1986-87	6806 6943	109	0.011±0.004	0.391	0.012	0.010
1987-88	7141 7318	73	0.026±0.012	0.403	0.023	0.020

Bopp *et al.* (1984) from 1982 through 1984 cannot be confirmed for the follow-up seasons 1984 through 1988. It is, however, interesting to note that the seasonal mean differential brightness is slowly decreasing, from 0.377 mag in 1984-85 to 0.403 mag in 1987-88. This might be an indication that there is a long-term starspot activity. *If* the data contain low-amplitude rotational modulation it is certainly smaller than our standard deviation of around 0.02 mag in V.

High precision, milli-mag photometry is needed to answer whether LR Hya is a micro variable or not.

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TIMES OF MINIMA AND THE LIGHT CURVE OF VW CEPHEI

We made differential B and V photoelectric observations of the W UMa type eclipsing binary system VW Cephei during six nights (from 24 July to 7 August 1988) at the Baja Observatory with the 40 cm Cassegrain telescope. The comparison star was $BD+75^{\circ}765$. Times of minima and the full light curve was determined.

The times of minima were calculated by a least squares parabolic fitting program. The following ephemeris was used (Kreiner and Winiarski, 1981):

$$\mathrm{Min\ I\ (Hel.J.D.)} = 2444157.4131 + 0\overset{d}{.}27831460 \cdot E \quad .$$

The moments of minima are listed in Table I.

The full light curves in B and V bands are shown in Figure 1. It can be seen that the scatter of the measured points near the maximum after the primary minimum is larger than near the other maximum or any minima. This fact indicates that the light curve is strongly asymmetric in contradiction with Glownia's (1988) note.

Table I. Times of minima of VW Cephei

hel.JD -2400000	type	filter
7367.4545	I	V
7367.4543	I	B
7368.4292	II	V
7368.4287	II	B
7368.5664	I	V
7368.5649	I	B
7374.4117	I	V
7374.4122	I	B
7374.5510	II	V
7374.5516	II	B
7375.3878	II	V
7375.3877	II	B
7379.5610	II	V
7379.5610	II	B
7380.3960	II	V
7380.3960	II	B
7380.5340	I	V
7380.5338	I	B

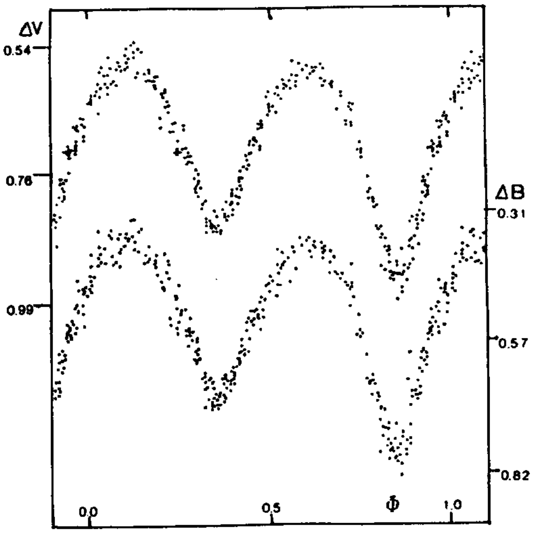

Figure 1. The light curves of VW Cephei

The light curves obtained in different nights show that the heights of the maxima are different (Δh≈0.05 mag) and this difference was varying during our observational period (see also Kreiner and Winiarski, 1981; Kotarska and Glownia, 1983). This behaviour may be explained by the starspot model described by Yamasaki (1982) or Bradstreet and Guinan (1988). The large scatter near the mentioned maximum may be caused by the large surface activity of the components.

The list of the individual observations can be requested from the author. The author wishes to express his thanks to T. Hegedüs for his help and advice in the measurements and the data reduction.

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UBV PHOTOMETRY OF II Peg DURING OCTOBER 1988

II Peg (BD + 27°4642, HD 224 085) is a single-lined active binary non-eclipsing system consisting of a K2-3 IV-Ve primary and a spectroscopically unseen secondary. The activity of II Peg is exhibited in all accessible regions of the electromagnetic spectrum (X-ray, ultraviolet, radio, optical). Its quasi-periodic light curve with a period nearly equal to the orbital period ($6\overset{d}{.}72422$) is variable both in amplitude and mean light level. It is generally attributed to the rotational modulation of starspots (Rucinski, 1977; Vogt, 1981; Poe and Eaton, 1985) and therefore II Peg is classified as RS CVn's. The various shape of the light curve of II Peg during different seasons could be explained by the changes in the temperature, location and the area of the spots, i.e. with the existence of a spot activity cycle. It is necessary to obtain enough light curves throughout a period of several years to define the migration curve.

The UBV photometry of II Peg obtained during October 1988 is presented in this paper. The observations were carried out with the 60-cm Cassegrain telescope equipped with a two-channel photometer (Szymanski and Udalski, 1988) at Mt. Suhora Observatory of Krakow Pedagogical University. In order to satisfy the requirements of the two-channel photometer (the distance between a variable and a comparison star to be between 10 and 20 arcsec) we have chosen BD + 27°4646 as the comparison star.

The observations were corrected for the atmospheric extinction using the mean extinction coefficients for the observatory. Due to the difference of about $0\overset{m}{.}65$ between the colours of the variable and the comparison star, second order extinction corrections were made.

The observational data reduced to Johnson-Morgan system (in the sense comparison minus variable) are listed in Table I. The mean errors are about $0\overset{m}{.}01$, $0\overset{m}{.}01$ and $0\overset{m}{.}02$ in V, B and U filters, respectively. The points marked with symbols ':' and '*' are those of lower quality.

The data are plotted in Figure 1. They cover well three consecutive cycles. One can see the same behaviour of the light curves in the three

Table I

No.	JD 2440000.+	ΔV	ΔB	ΔU	Notes
1	7437.613	1.915	1.253	0.585	
2	7438.400	2.076	1.420	0.709	
3	7439.367	2.129	1.480	0.799	
4	7440.328	2.049	1.407	0.708	
5	7441.426	1.925	1.273	0.602	
6	7443.641	1.778	1.097	0.328	:*
7	7444.346	1.918	1.246	0.580	
8	7446.393	2.136	1.477	0.852	
9	7447.355	2.061	1.388	0.749	:
10	7448.452	1.909	1.240	0.594	:
11	7449.350	1.759	1.067	0.388	
12	7450.336	1.746	1.026	0.345	
13	7451.279	1.964	1.314	0.662	
14	7452.275	2.114	1.464	0.785	
15	7453.327	2.089	1.454	0.775	
16	7453.635	2.094	1.460	0.713	*
17	7454.293	1.998	1.356	0.664	
18	7454.625	1.959	1.363	0.654	*
19	7455.270	1.847	1.182	0.504	
20	7456.255	1.765	1.080	0.362	
21	7456.632	1.721	1.062	0.351	*
22	7457.478	1.831	1.156	0.465	
23	7458.380	2.024	1.412	0.726	:

symbols: ':' bad atmospheric conditions
'*' large zenith distance

filters: one maximum and one minimum per cycle. There are also similar asymmetric shapes in the three cycles. The amplitudes of the light variations in the U, B and V filters are $0^{m}.52$, $0^{m}.45$ and $0^{m}.41$ respectively. These amplitudes are quite large in comparison with those observed in 1985/86 (Wacker and Guinan, 1986) but they are in good agreement with Byrne's (1986) observations made in September 1986 and with those of Boyd et al. (1987) obtained in October 1986 - February 1987.

Our observations allow us to determine a new photometric period value for II Peg : $6^{d}.75$. It is longer than the periods known from the literature: $6^{d}.7026$ (GCVS) or $6^{d}.72422$ (Vogt, 1981). We suggest the increase of the brightness period to be due to the slower rotation of the star at the higher latitudes where the spot (or spots) is (are) situated during this season.

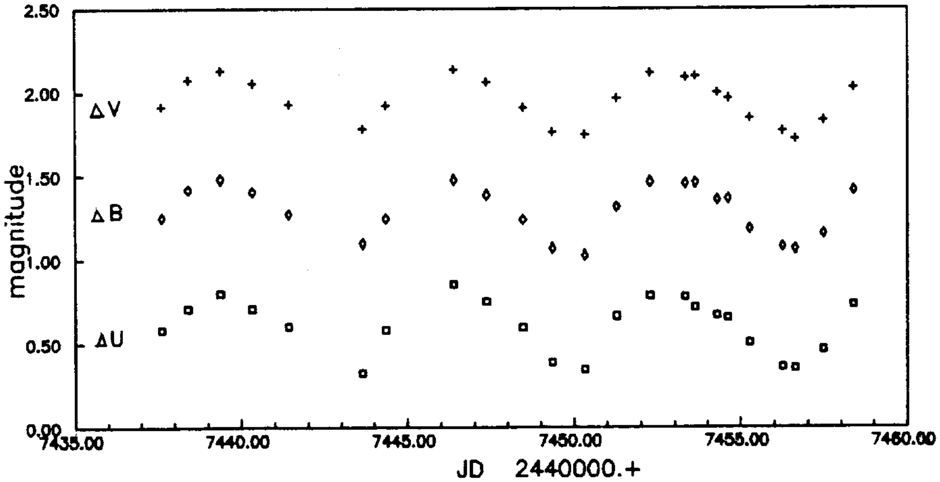

Figure 1

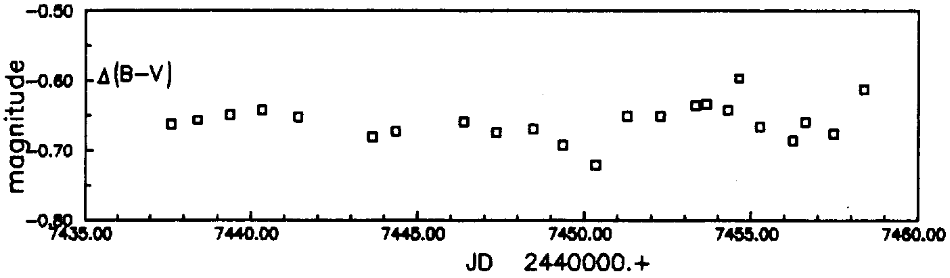

Figure 2

The respective B-V colour variations are presented in Figure 2. Some points (noted with symbols in Table I) do not lie well on the smooth curve determined by the other points. Nevertheless, it is seen that some regular variability exists and it is in phase with the variations in the V, B, and U filters. The amplitude of the B-V variations is about $0\overset{m}{.}05 - 0\overset{m}{.}06$ (if the deviating points are excluded).

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WBVR PHOTOMETRY OF DI HERCULIS

The first photoelectric observations of DI Her (HD 175 227, B4V + B5V, $P = 10\overset{d}{.}55$) were made in 1963 (Semeniuk, 1968). Martynov and Khaliullin (1978, 1980) have determined the photometric elements and apsidal motion period using their own UBV measurements. A significant discrepancy between the observed and the theoretically expected apsidal motion rate was found. To get more precise parameters of DI Her, new multicolour observations were carried out at the Tian-Shan (altitude 3000 m) and Moscow Observatories in 1986-1987. The 48 cm reflector with the WBVR photometer (EMI 9863) was used in Tian-Shan and the 70 cm reflector with UBV photometer (PMT-79, Soviet) was used in Moscow. "V" bands of both photometers are close to each other. BD $+24^{\circ}$ 3555 served as the standard star, and BD $+24^{\circ}$ 3556 as control. Observations were corrected for the atmospheric extinction and reduced to the standard WBVR system. WBVR standards HD 174 262 and HD 168 913 (Khaliullin et al. 1985) were used to derive the stellar magnitudes and colours of the comparison stars and the variable. Table I presents these data.

Table I. Stellar magnitudes

Star	W	B	V	R	W-B	B-V	B-R
BD $+24^{\circ}$3555	8.309 ±5	8.718 ±4	8.600 ±3	8.506 ±5	-0.409	0.118	0.212
BD $+24^{\circ}$3556	9.701 ±9	9.704 ±8	9.496 ±6	9.363 ±9	-0.003	0.208	0.341
DI Her plateau	7.708 ±5	8.486 ±4	8.397 ±3	8.310 ±5	-0.778	0.089	0.176
Min I	8.474 ±7	9.217 ±5	9.103 ±4	9.011 ±6	-0.743	0.107	0.206
Min II	8.229 ±6	9.056 ±4	8.976 ±3	8.892 ±5	-0.827	0.080	0.164

Table II. Moments of photoelectric minima of DI Her

JD hel	E	O-C	Reference	
Min I				
2438245.3838	-865	-0.00004	Semeniuk 1968	
38308.6847	-859	-0.00014	"	
42233.3476	-487	0.00026	Martynov,Khaliullin 1980	
42602.605	-452	0.002	Koch 1977	
42623.7035	-450	-0.00005	"	
43309.467	-385	0.0025	Guinan,Maloney 1985	
45883.7069	-141	0.001	"	
45894.2519	-140	-0.0037	"	
46643.31758	- 69	0.00003	Khodykin,Volkov	
47371.27909	0	-0.00005	"	
47424.0300	5	0.00002	"	
47445.13045	7	0.00014	"	
Min II				
2438306.2454	-860	0.0003	Semeniuk 1968	
40363.5280	-665	-0.0011	Battistini et al. 1974	
40511.2314	-651	-0.0002	Martynov,Khaliullin	*
41882.7545	-521	0.0001	Koch 1977	
42642.366	-449	-0.0009	Martynov,Khaliullin	*
42937.7685	-421	-0.003	Koch 1977	
43264.8256	-390	-0.0017	"	
43296.4789	-387	0.001	Ebersberger et al. 1978	
43676.2843	-351	0.0002	Guinan,Maloney 1985	
43718.4845	-347	-0.0002	Martynov,Khaliullin	*
44024.4399	-318	0.00004	Pohl,Gulmen 1981	
45807.4195	-149	0.0001	Guinan,Maloney 1985	
45944.5734	-136	0.0017	"	
46535.3815	- 80	0.0001	Khodykin,Volkov	
46630.3333	- 71	0.00013	"	**
46651.4332	- 69	-0.0002	Diethelm 1986	
47263.3434	- 11	-0.00016	Khodykin,Volkov	
47432.1462	5	-0.00015	"	

* – found by Guinan and Maloney (1985)

** – found here on the Metlov's observations (Crimea)

We have obtained a new linear ephemeris for DI Her using our eight minima in V band in addition to all known photoelectric times of minima (see Table II):

$$\text{Min I}\quad \text{J.D.hel.} = 2\,447\,371.2791\underset{\pm8}{4} + 10\overset{d}{.}550168\underset{\pm2}{0}\cdot E$$

$$\text{Min II}\quad \text{J.D.hel.} = 2\,447\,379.3954\underset{\pm9}{8} + 10\overset{d}{.}550174\underset{\pm2}{9}\cdot E$$

$$EII-EI = 8\overset{d}{.}116\underset{\pm1}{3} = 0\overset{P}{.}7693\underset{\pm1}{1}\ ,\ \Delta P = PII - PI = 0\overset{d}{.}000\,006\underset{\pm2}{9} = 0\overset{s}{.}6\underset{\pm2}{0}$$

Assuming that the period difference ΔP is caused only by the periastron advance, we found from Roudkjobing's relationship (1959) the apsidal motion period U = 29300 ± 900 years, in agreement with the value yielded by Martynov and Khaliullin (1978).

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1987 PHOTOMETRY OF CG Cyg

CG Cyg (= BD + 34°4217 = No.142 in the catalog of Strassmeier et al. 1988) is a member of the short period RS CVn group. The system has been observed at optical wavelengths since 1965. Sowell et al. (1987) solve the V band light curves for 1979 and 1980 and also reference prior observations. Bedford et al. (1987) and Davies et al. (1987) observed CG Cyg in the infrared during 1984 (BVJK) and 1986 (JHK). They found an infrared excess that they attribute to circumsystem material. Budding and Zeilik (1987) modeled the 1981 light curve of Zeilik et al. (1982) to infer two major spot groups centered at 121° and 219° longitude and 45° latitude.

We observed CG Cyg on the nights of 18, 19, 21, 23, and 26 August and 7-10 September 1987 using the 61 cm telescope operated by San Diego State University on Mt. Laguna California. The photoelectric photometer, which uses an EMI 6256 phototube operated at -1300 V and cooled to -23 C, was equipped with an OG-515 V band filter. Each observation consisted of 3 separate 60 second integrations through a 19" aperture. SAO 70 728 (= BD + 34°4216) was the comparison star for all observations. To obtain the maximum time resolution needed for an analysis of starspot activity, we observed only in the V band. Our reported data (Figure 1) are therefore in the instrumental V band system. These instrumental differential magnitudes (comparison - variable) are sufficient to model the geometrical starspot parameters; so, we made no attempt to use an average (B-V) to convert to the Johnson UBV system (as done by Sowell et al. 1987). Note that in Figure 1 the delta magnitudes have been normalized to unit intensity on the shoulders of the light curve. The open circles are the observed points. Statistical errors in a single set of data were rarely greater than 0.01 mag, with most between 0.005 and 0.008 mag. The solid line is a binary model fit for unspotted stars, following the techniques of Budding and Zeilik (1987).

Using the technique of Budding and Zeilik (1987), we fit the starspot parameters to the distortion wave. We find a single spot at longitude = 120° ±3°, latitude = 38° ± 17°, radius = 13° ± 2° but no evidence for the spot

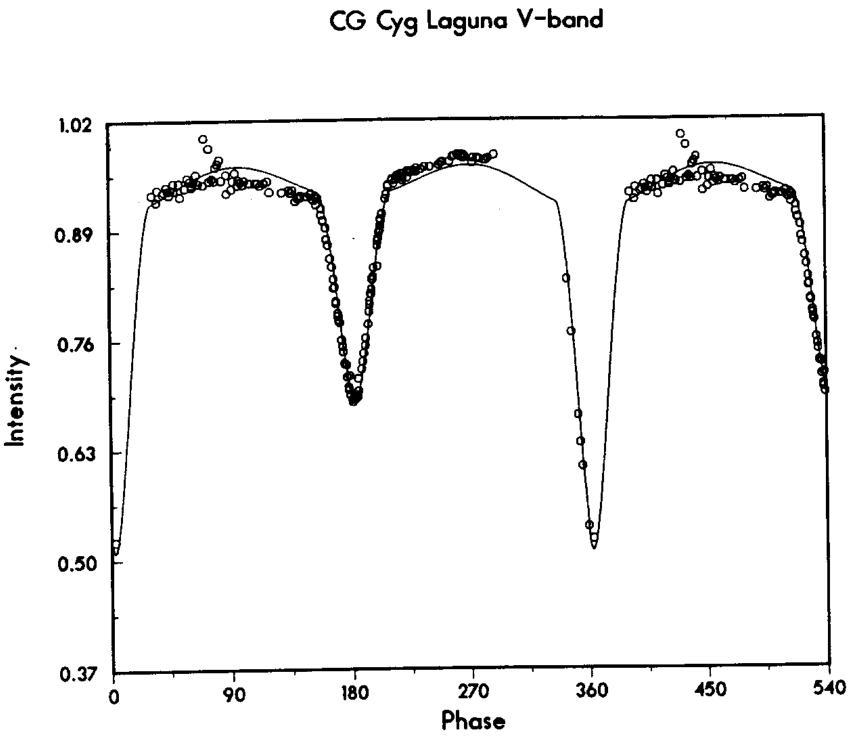

Figure 1

at longitude 219° observed in the 1981 data of Zeilik et al. (1982). In Figure 2, the open circles are the observed maculation wave and the solid line the single spot fit for a black ($T = 0$ K) spot area. We also observed a possible flare on 26 July at 5:50 UT at longitude 72°, going into the major distortion wave, as expected if the distortion wave is caused by a large active region (starspots). No flare was visible in the 19 July observations, which covered the phase range from 0.09 to 0.50. Unfortunately, weather conditions were less than perfect on the night of 26 July. Because we experienced some variable extinction, we cannot completely rule out the possibility that our apparent flare was caused by atmospheric variability. However, we observed our comparison and check stars often enough that we think the flare is real.

We would like to thank Ronald Angione for scheduling generous amounts of observing time at Mt. Laguna for this project.

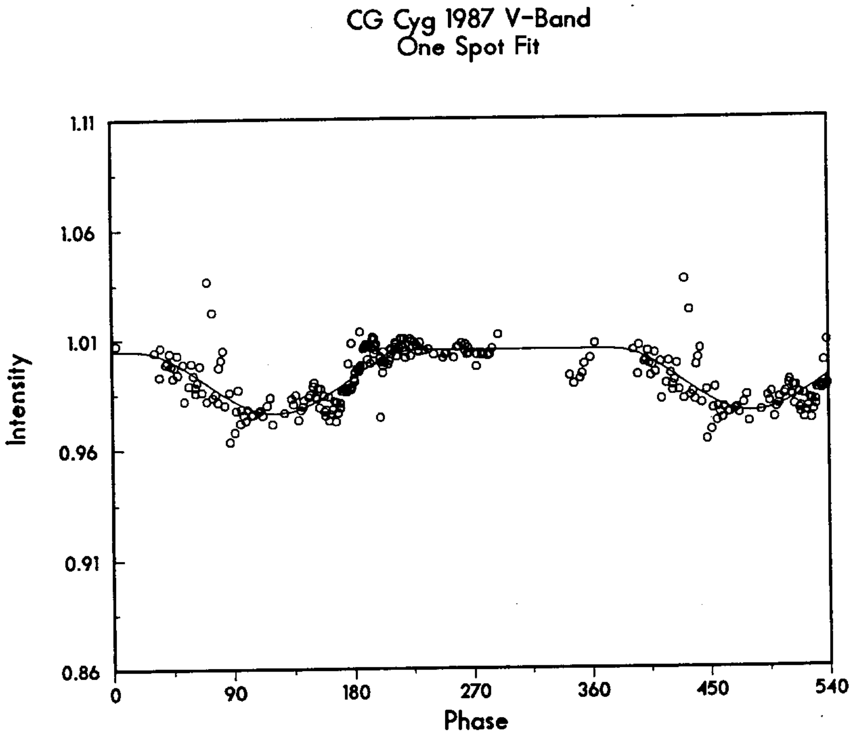

Figure 2

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PHOTOMETRY OF UU HERCULIS: 1986-88

UU Her is an F supergiant, located at high galactic latitude. It is the prototype of the so-called UU Her variables (Sasselov 1984). The star was well known because of its supposed period switches, i.e. it changed its period in a very short time from ≈ 45 d to ≈ 72 d or vice versa. An analysis of visual observations made between 1922 and 1939 showed, however, that the variation of UU Her could be described by (at least) two periods: 72.9 d and 45.3 d

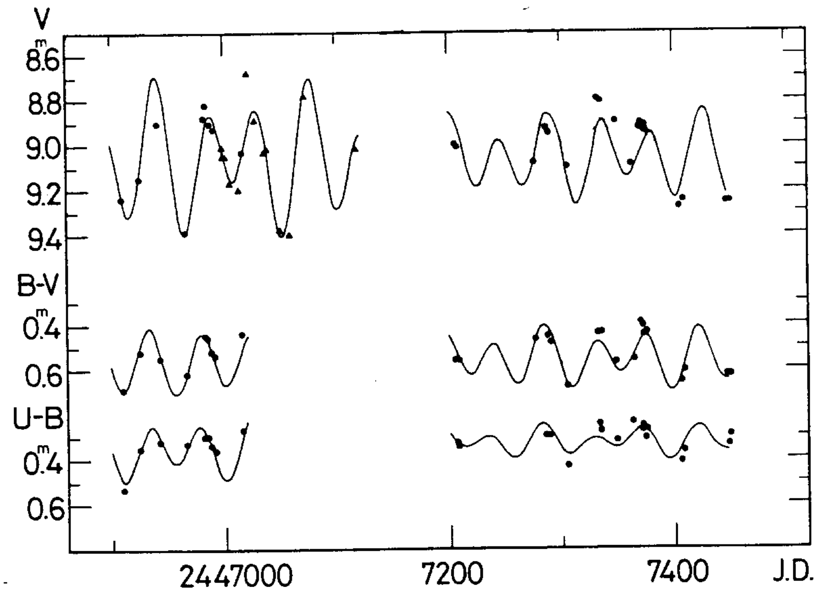

Figure 1

Table I

J.D.	V	B-V	U-B
2446466.639	8.908	0.393	0.241
6560.540	8.720	.367	.242
6678.342	9.074	.648	.356
6679.347	9.096	.652	.360
6853.653	8.621	.261	.551
6910.539	9.237	.692	.526
6925.483	9.154	.518	.354
6942.422	8.902	.546	.315
6966.413	9.391	.622	.329
6983.378	8.884	.449	.302
6984.383	8.824	.459	.304
6988.405	8.906	.521	.336
6991.429	8.926	.540	.359
7016.392	9.036	.443	.274
7207.637	8.998	.555	.334
7208.609	9.014	.556	.337
7277.538	9.079	.471	
7288.507	8.926	.463	.300
7290.496	8.954	.482	.303
7306.442	9.099	.675	.425
7334.491	8.801	.436	.253
7335.468	8.808	.435	.282
7349.355	8.913	.582	.289
.365	8.885	.564	.358
7363.522	9.088	.555	.241
7371.376	8.925	.398	.257
7372.344	8.914	.409	.273
7374.329	8.922	.447	.307
7375.353	8.936	.444	.269
7406.308	9.279	.655	.409
7409.327	9.251	.612	.365
7449.268	9.263	.627	.335
2447450.270	9.263	0.630	0.303

(for details see Zsoldos and Sasselov 1989). These periods are probably always present in the light curve, though with varying amplitude.

Photoelectric photometry of UU Her is very important to decide if there are more periods, and to arrive at more precise values of the periods. Recent photometry of the star was made by Fernie (1986), Sasselov et al. (1987) and Umana et al. (1988). Here we present more observations of the variable, made during 1986-88.

UU Her was observed with the 0.5-m and 1-m telescopes of Konkoly Observatory, at Piszkéstetö. The comparison stars

Table II

Year	Colour	A0	A1	A2
1987	V	9.06	0.26	0.48
	B–V	0.56	0.04	0.26
	U–B	0.35	0.08	0.22
1988	V	9.06	0.14	0.30
	B–V	0.56	0.09	0.21
	U–B	0.33	0.06	0.10

were those used by Sasselov et al. (1987). Table I lists the observations, these were transformed into the UBV system in the usual way. The light and colour curves of UU Her are plotted in Figure 1 (the triangles are the y measurements of Umana et al. 1988). These curves were fitted with the two periods mentioned above, the fits are also shown in Figure 1 as continuous lines (the two years, 1987 and 1988, were treated separately because of the amplitude change). The amplitudes of the periods are given in Table II for each colour (A1 and A2 are the amplitudes of the longer and shorter periods, respectively, A0 is the mean magnitude). Figure 1 and Table II confirm the conclusion of Umana et al. (1988) – the dominant period now is the shorter one (45.3 d), its amplitude, however, is already decreasing.

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A NOTE ON THE PERIOD OF THE W UMa STAR YZ PHOENICIS

The only published data on the star YZ Phe are a light curve and several timings of minima from Sonneberg by Gessner and Meinunger (1976). They state that it is a W UMa star and derive an ephemeris for time of minimum of JD 2436765.622 + $0^{d}.3052$E; they note that, due to the small amplitude of variability, the derived period is uncertain. This star was put on a programme of observation of W UMa stars that was commenced at SAAO. The data that were obtained, however, cover about half a cycle and cannot therefore be analysed in detail, but some conclusions may be drawn on the period of the star.

The observations of YZ Phe were made in $UBVRI_C$ with the St Andrews Photometer on the 1.0-m Elizabeth telescope at SAAO, Sutherland. These have been transformed on to the standard system through observations of E-region stars (Menzies et al, 1980). Regular observations were also made of comparison and check stars, as listed in Table 1, which were constant to within 0.01 mag over the period of the observations. The data, which will be published elsewhere, are shown in Figure 1. For illustrative purposes, the data have been phased with a period of 0.2248 d (see below) and the minimum arbitrarily shifted to phase 0.5. (There appears to be some scatter around maximum in U; the cause of this is not due to variation in sky background or transparency and remains unknown).

The minimum covered by the present observations is at HJD 2445621.39683 ± 0.00018, using the method of Kwee and van Woerden (1956).

The "period" derived from these observations is 0.1124 d; since this actually corresponds to only half a cycle, then the true period of YZ Phe is ~ 0.225 d. This is close to the observed lower limit of periods for W UMa stars, making YZ Phe one of the shortest period objects known in its class. Whilst the period of YZ Phe is likely to have changed, a change as large as thirty per cent is unlikely and indicates that the value of 0.3052 d was in fact incorrect; more probable is that 0.3052 d is a 1 day alias of the true period at that epoch, 0.2338 d.

Table 1

Colour indices of comparison stars for YZ Phe

	V	B-V	U-B	$V-R_C$	$V-I_C$	n	Sp*
HD 10521	8.383	0.360	0.032	0.220	0.442	15	F3V
	.008	.006	.011	.004	.003		
HD 10839	9.070	1.156	1.364	0.658	1.232	3	K2III
	.010	.010	.020	.003	.003		

* From Houk (1978)

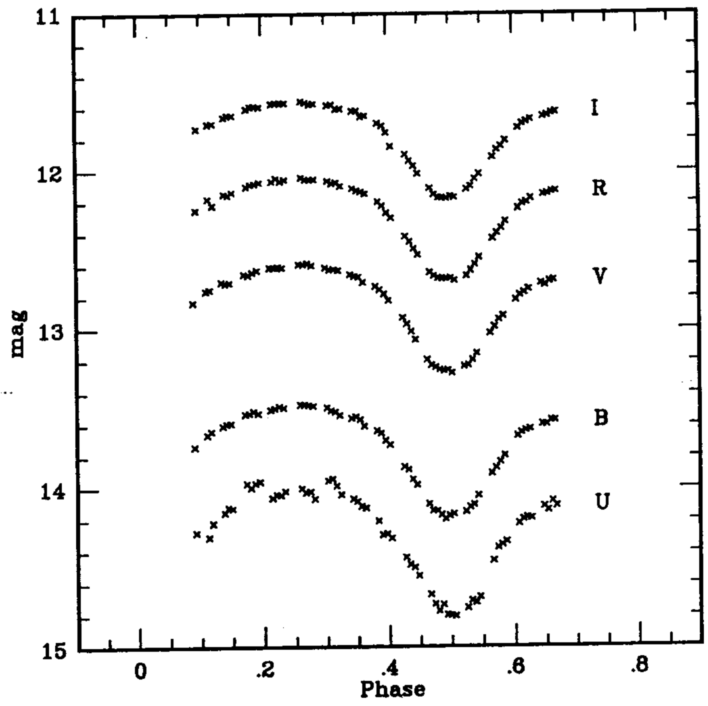

Figure 1. Light curves of YZ Phe

Table 2

Colour indices of YZ Phe

	V	B-V	U-B	$V-R_c$	$V-I_c$
Max	12.597	0.882	-	0.542	1.028
	.010	.005		.010	.013
Min	13.257	0.910	0.613	0.577	1.093
	.015	.015	.027	.008	.017

The colours of the comparison and check stars, when transformed to the Johnson system (Cousins, 1980), are consistent with those of their spectral types (Johnson, 1966; Houk, 1978), implying that the reddening is small or negligible. The colours of YZ Phe are listed in Table 2 (these are the means and s.d. of six measures). These are not consistent with any one spectral type, the (V-R) and (V-I) colours implying a slightly later type (K2-K5) than (B-V) and (U-B) (K0-K2). The (B-V) colour of YZ Phe also appears to be slightly blue for its period (by ~ 0.1-0.2 mag), according to the period-colour relation (Mochnacki, 1985); the short period end of this relation, however, is poorly defined. The colours nevertheless imply that YZ Phe is a W-type W UMa star.

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On the lightcurve of HD27563

The B5III (Cowley, 1972) star HD27563 (= HR1363) has been studied photoelectrically by Mathys *et al.* (1986) in the *uvby* system. They concluded that it was probably a multi-periodic object with periods around 4 days. This was essentially based on observations we made during 20 nights in November 1977 (43 measurements) at the ESO observatory on La Silla, with the 50cm telescope. A few additional data came from two other observing runs we carried out in the same system, at the same telescope, in December 1978 (7 measurements) and September 1981 (7 measurements).

More data have been provided by the "Long Term Photometry of Variable" group (Sterken, 1983) during two months of observing at La Silla in October and December 1982 (27 measurements). They are also in the Strömgren system, although the filter set used at that occasion was less than perfectly conform.

In all four observing runs, HD27563 was used as a comparison star for the variable CP star HD29009. Coincidentally the period of that CP star is also close to four days so that it was not immediately obvious that each object did vary. The other comparison star which was measured proved to be variable too, so that we had to rely exclusively on "absolute" reductions to study the lightcurve of HD27563.

Among period searching methods, Deeming's (1975) method is well suited to multiperiodic phenomena. The power spectra obtained for the largest data sets (1977 and 1982) show a clear peak close to $\nu = .25$ d^{-1} (Figures 1 and 2) as well as strong aliases at $1 \pm \nu$. However the central frequencies do not coincide exactly (0.257 d^{-1} in 1977, and 0.275 d^{-1} in 1982). Because of the longer time base, the 1982 data set is able to show separate components in the peaks, and particularly at 0.254 d^{-1}, close to the 1977 value. The frequency splitting ($\Delta\nu \sim 0.021$ d^{-1}) is only 20% wider than the natural splitting shown in the spectral window, indicating some degree of interference. Power peaks appearing around 1.0 d^{-1} are aliases of very low frequency features—not seen entirely on the figures—and are artefacts due to an improper normalization between the data of October and December 82.

After merging all data sets, Deeming's frequency analysis gives a very noisy spectrum with a complex substructure (Figure 3). The strongest peak occurs at $\nu_1 = 0.25503$ d^{-1} (or 3.9211 d) with fine structure components (barely resolved on

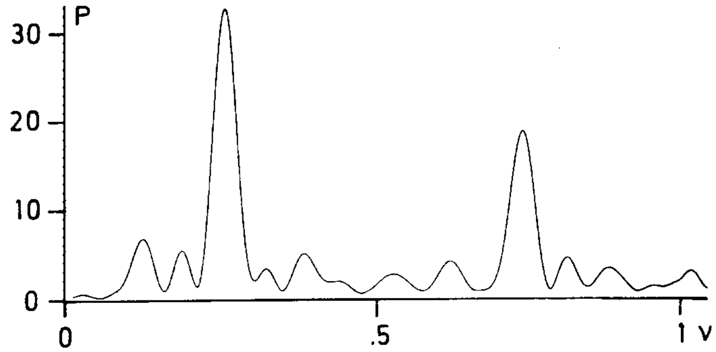

Figure 1: Power spectrum of the observations of HD27563 obtained in November 1977. All colours show very similar behaviours. The geometric mean of u, v, b and y is presented here. Units are mmag^2.

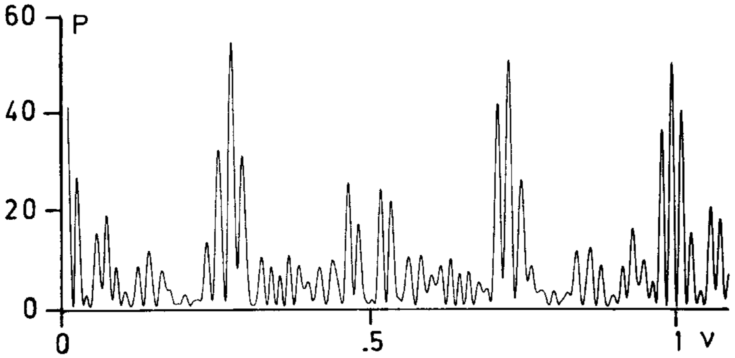

Figure 2: Power spectrum of the observations of HD27563 obtained in October–December 1982.

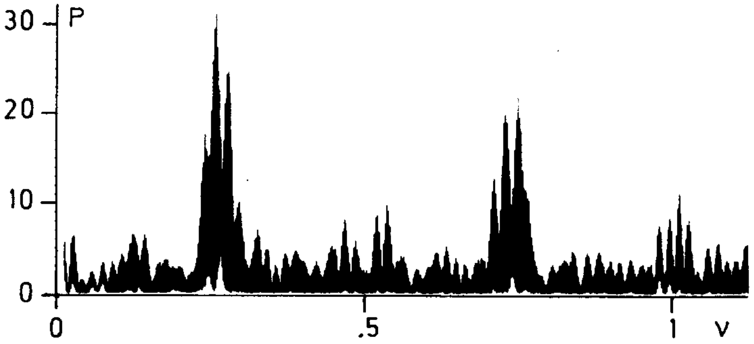

Figure 3: Power spectrum of all observations of HD27563.

Figure 3) around $\nu_1 \pm 0.0022$ d^{-1}. The broader splitting seen in the 1982 data shows itself with main components around $\nu_2 = 0.27502$ d^{-1} (3.6361 d) and around $\nu_2 \pm 0.0022$ d^{-1}. Strong aliases are present close to $1 \pm \nu_1$ and $1 \pm \nu_2$ and so are the combs around multiples of .5 d^{-1}.

After prewhitening by ν_1 or any of its main secondary components, the peaks around ν_2 subsist although with slightly different frequencies and amplitudes. At the same time the $1 \pm \nu$ aliases becomes more important. Prewhitening of the data with several of those frequencies is always less than satisfactory, suggesting the presence of additional frequencies. The main frequency at $\nu_1 = 0.25503$ d^{-1} or 0.25284 d^{-1} is apparently stable over several years. Our analysis favours the presence of at least another frequency ν_2, with the most likely pairings (ν_1, ν_2) being either of the following combinations: (0.25503,0.27785), (0.25503,0.29403), (0.25284,0.27723), (0.25284,0.27504). Because of the complexity of the power spectrum, it is difficult to decide conclusively on the presence or stability of the periodicities. However we notice that a quadruplet of frequencies (for instance 0.228734, 0.255027, 0.277850, 0.289394) yields a very clean prewhitening, and we suggest that such a multiperiodicity is effectively present.

The relatively bad accuracy of the data due to the lack of comparison stars, as well as the closeness of the periods to 4 days, make further analysis of HD27563 desirable.

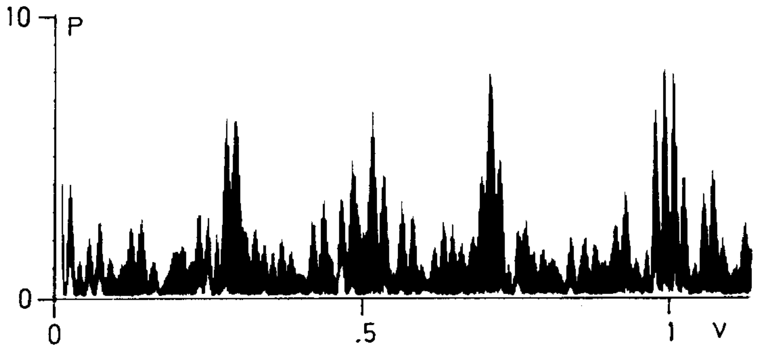

Figure 4: Power spectrum of the observations of HD27563 prewhitened for $\nu_1 = 0.25503$ d^{-1}.

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UBV PHOTOMETRY OF HD 80 715 DURING 1986 AND 1987

Barden and Nations (1985) classify HD 80 715 (= BD + $40^{\circ}2197$ = No.70 in the catalog of Strassmeier et al. 1988) as a BY Dra star with a 3.8025 day period. They find strong Hα and CaII emission. Rufener and Bartholdi (1982) find evidence for microvariability based on 4 photometric observations, but additional photometry is obviously needed to characterize the photometric behavior of this system.

We observed HD 80 715 between April and July 1986 and between February and July 1987 on the 24" telescope operated by San Diego State University at Mt. Laguna, CA. The photometer has an EMI 6256 phototube cooled to -10°F, operates at -1300 V, and is equipped with standard Johnson UBV filters. We used a 19" aperture except on a few nights of poor seeing when we used a larger aperture. Data were transformed to the standard Johnson UBV system. We used SAO 61 417 and SAO 61 403 as the comparison and check stars.

We present our data in Figures 1-3 and Table 1. We plot the V data on the check star in Figure 4 and find no evidence for variability in the comparison star. We computed the orbital phase using φ = JD 2446 502.472 + $3\overset{d}{.}8025$ (Nations).

TABLE 1

Julian Day	Phase	V	(B-V)	(U-B)
2446548.744	0.169	1.034	0.068	0.213
2446549.743	0.432	1.105	0.084	0.242
2446589.707	0.941	1.011	0.060	0.198
2446590.704	0.204	1.059	0.062	0.212
2446883.667	0.249	1.109	0.085	0.213
2446886.656	0.035	1.072	0.072	0.211
2446887.646	0.295	1.056	0.070	0.207
2446888.755	0.587	1.041	0.069	0.208
2446890.751	0.112	1.099	0.069	0.220
2446891.808	0.389	1.024	0.061	0.204
2446959.732	0.252	1.048	0.065	0.199
2446960.693	0.505	1.063	0.076	0.218
2446961.693	0.768	1.127	0.075	0.210
2446962.695	0.032	1.082	0.054	0.233
2446964.692	0.557	1.065	0.065	0.193

The ΔV light curve (Fig. 1) shows the 1986 and 1987 data. We have only 4 points for 1986, but they suffice to show that the light curve changed between 1986 and 1987. We find a ΔV amplitude of about 0.12 mag. Our 1987 data were taken after Nations' APT data from the first quarter of 1987. Nations

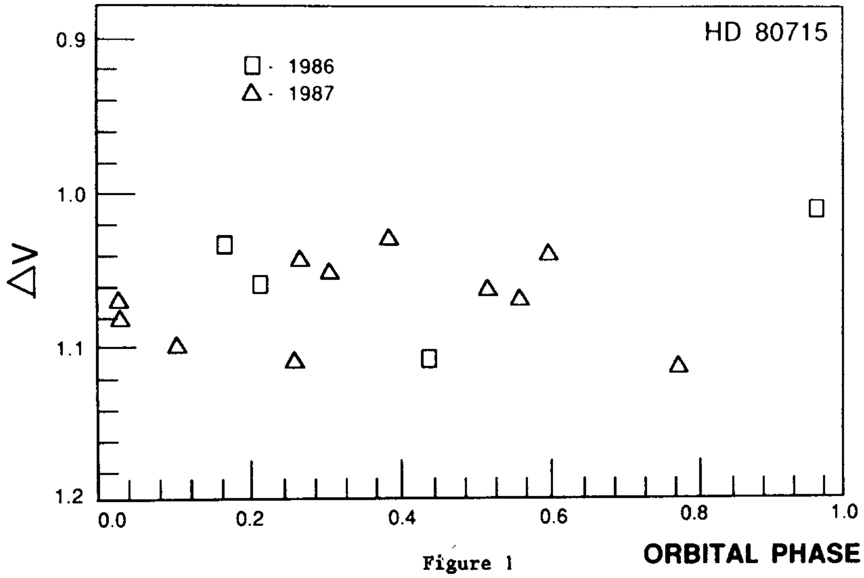

Figure 1

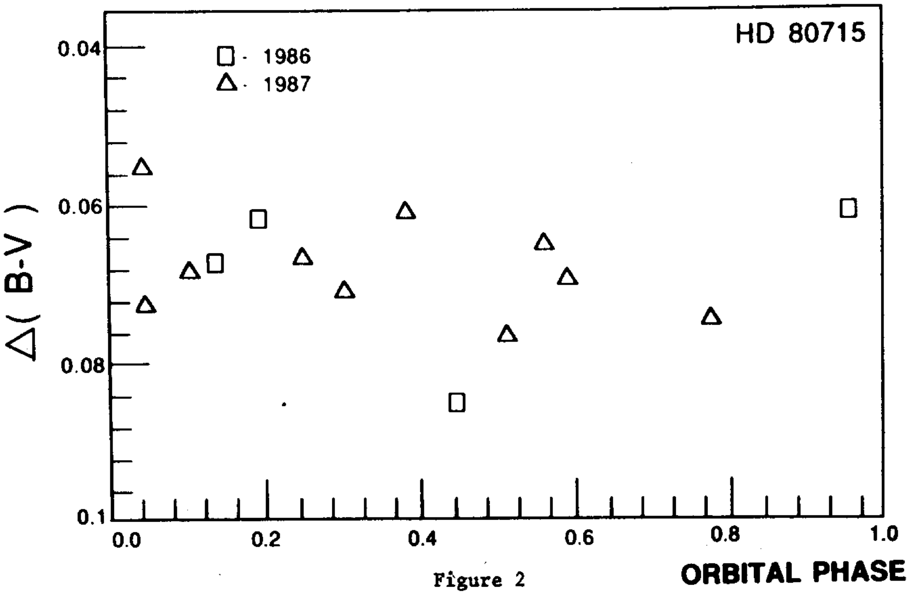

Figure 2

finds significant evolution on a timescale of about 10 orbital periods. Our 1987 light curve differs from the curve by Nations; so HD 80 715 continued to evolve. From a preliminary analysis of second quarter 1987 APT data, Nations also finds continued evolution. Combining the 1986 and 1987 data indicates that this evolution continued for a period of at least 2 years.

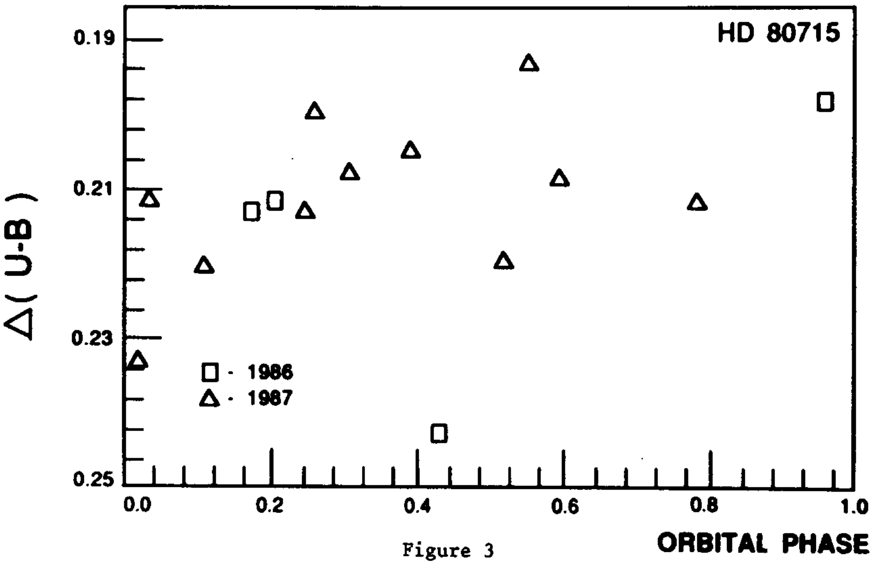

Figure 3

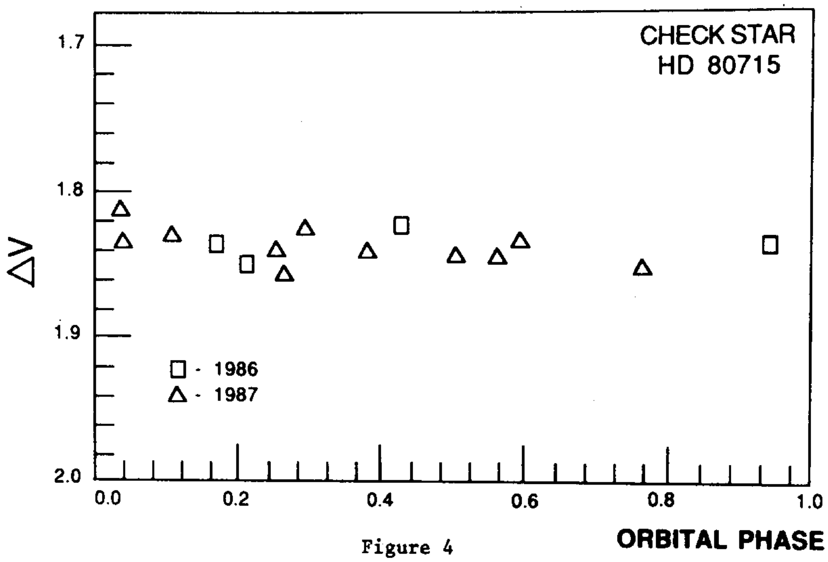

Figure 4

Our Δ(B-V) and Δ(U-B) color curves show maxima and minima at roughly the same phase as the ΔV light curve. The star is reddest at minimum light, as would be expected if cool spots cause the observed minima.

The color curves also evolve rapidly. For example note that at about phase 0.03 there are two points on the color curves with nearly identical phase but different magnitude. The corresponding points on the ΔV curve agree fairly well. One might initially conclude that there is a great deal of scatter in the color curves. However this star has a history of rapid evolution and the reported 1987 observations span almost 3 months. These apparent color discrepancies actually represent observations near the beginning and end of this time interval. Specifically, the phase 0.035 data were taken on 1 April 1987 (Δ(B-V)= 0.072). Near the end of this interval, the phase 0.032 data were taken on 16 June 1987 (Δ(B-V) = 0.054). During this interval the ΔV brightness did not change much but the colors did. Apparently the total area covered by starspots changed only a small amount but the spot temperatures changed significantly. One might be able to explain some of the apparent scatter in the curves by separating the April and June light curves, however the data points would then become very sparse. We do however present our data in Table 1 giving both Julian Day and phase so our data can be more easily compared to data at other epochs. It is clear that future work on this rapidly evolving system will require light curves taken in a short time period and near continuous monitoring to sort out the evolutionary trends in this rapidly changing system.

In conclusion, HD 80 715 shows rapid evolutionary changes in the amount of starspot activity and in the spot temperatures. Changes in the light curve take place on time scales as small as a month (∿10 orbital period) and have persisted for at least 2 years. We plan to continue monitoring this system to determine long term cycles.

Ron Angione scheduled generous amounts of time on the Mt. Laguna 24" telescope for this work. Harold Nations suggested observing this system.

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A MAJOR PERIOD CHANGE IN THE SYSTEM TZ BOOTIS

The late spectral type W UMa system TZ Bootis is well known for its unusual photometric behaviour. The extensive investigations of Hoffmann (1) revealed strongly varying lightcurve irregularities attributed partly to underluminous regions on the main component. Further observations (2) showed also the cyclic nature of the variations in the depth of both minima and lead to the assumption of a 3,5 years secondary cycle attributed to a solar like activity cycle.

A crucial point for the interpretation of lightcurve changes in close binary systems is the question of the constancy of the period. The interpretation of the presented (O-C) diagram remained ambiguous. Eventually present period changes were obscured by fictitious fluctuations caused by changes in the shape of the lightcurves. These fluctuations showed up in an increased scatter in the (O-C) diagram amounting up to ±10 min. This was particularly evident in an observational run by Güdür et al.(3). This fact determined us in 1969 to add this star to our regular photoelectric minimum timing program at Nürnberg Observatory. Since 1984 we were able to secure at least one minimum per year.

These minima helped to reveal that the period change suspected by Hoffmann (5) is in fact not spurious and represents the first well documented period shortening observed in that system (fig.1), so that the ephemeris

(I) JD hel. Min I = 24 39632.8418 + $0.^{d}2971620$ * E. (2)

is no longer valid.

If we limit our study at the onset of a quasi regular photoelectric survey since the observations of Binnendijk (4) in 1967, the (O-C) diagram (fig.2) shows that the observations could be best represented by a set of two elements:

from JD 24 40300 to 24 43300

(II) JD hel. Min I = 24 40335.9188 + $0.^{d}29716356$ * E.
±9 ±18

since JD 24 43300

(III) JD hel. Min I = 24 43655.5278 + $0.^{d}29715665$ * E.
±13 ±22

No.	Min.(hel.)	Min.	Epoch I	(O-C)I	(O-C)II	Observer	Ref.
1	2439632.8418	I	0	0.0000	+0.0120	Bi	4
2	39636.8506	II	13.5	-0.0029	+0.0091	"	"
3	39643.8368	I	37	0,0000	+0.0119	"	"
4	40335.7710	II	2365.5	-0.0075	+0,0008	Ca	6
5	40335.9200	I	2366	-0.0071	+0.0012	"	"
6	40338.8920	I	2376	-0.0067	+0.0016	"	"
7	40345.7260	I	2399	-0,0074	+0.0008	"	"
8	40358.8025	I	2443	-0.0061	+0.0021	"	"
9	40358.9500	II	2443.5	-0.0071	+0,0010	"	"
10	40361,7725	I	2453	-0.0077	+0.0005	"	"
11	40361.9200	II	2453.5	-0.0088	-0.0006	"	"
12	41356,5284	II	5800.5	-0.0016	+0.0013	Gd/Gl/Hs	7
13	41392.4840	II	5921.5	-0.0026	+0,0002	Rk/Rn	"
14	41443.4479	I	6093	-0.0020	+0.0005	Bz/Ib	"
15	41450.4280	II	6116.5	-0.0052	-0.0027	"	"
16	41453.3970	II	6126.5	-0.0078	-0,0054	"	"
17	41462.3130	II	6156.5	-0.0067	-0.0043	Rk/Rn	"
18	41465.4360	I	6167	-0.0039	-0,0015	Rk/Hs	"
19	41484.4574	I	6231	-0,0008	+0.0014	Ib/Hs	"
20	42140,5910	I	8439	-0.0009	-0.0021	Ho	2
21	42151.5888	I	8476	+0.0019	+0.0008	"	"
22	42152.4803	I	8479	+0.0019	+0.0007	"	"
23	42152,6294	II	8479.5	+0.0024	+0.0012	"	"
24	42153.3690	I	8482	-0.0009	-0.0021	"	"
25	42153.5203	II	8482.5	+0.0018	+0.0006	"	"
26	42156.4917	II	8492,5	+0.0016	+0.0003	"	"
27	42470.4463	I	8549	+0,0046	+0.0016	"	"
28	42525,4206	I	9734	+0.0039	+0.0007	"	"
29	42525,5640	II	9734.5	-0.0013	-0.0045	"	"
30	42589.4550	II	9949,5	-0,0001	-0,0037	"	"
31	42867.4640	I	10885	+0.0138	+0.0088	"	"
32	42869.5375	I	10892	+0.0072	+0.0022	"	"

Table 1: Pe. minima from JD 40300 to 43300 with residuals against elements (I) and (II).

No.	Min.(hel.)	Min.	Epoch I	(O-C)I	(O-C)III	Observer	Ref.
33	2443655,5230	I	13537	-0,0008	-0.0048	Ho	2
34	43656,5640	II	13450.5	+0.0001	-0.0038	"	"
35	43657.4553	II	13543.5	0,0000	-0,0040	"	"
36	43893,5560	I	14338	+0,0054	+0.0058	"	"
37	43950.6000	I	14530	-0,0057	-0,0043	"	"
38	43974,3775	I	14610	-0.0011	+0,0007	"	"
39	43974.5225	II	14610.5	-0,0047	-0,0029	"	"
40	44013.4550	II	14741.5	-0,0004	+0.0021	Gb	8
41	44372.4211	II	15949.5	-0.0060	+0.0030	Ho	5
42	44372.5710	I	15950	-0,0047	+0,0043	"	"
43	44650.5625	II	16885,5	-0,0083	+0,0058	"	"
44	45165.384 :	I	18618	-0,020 :	+0,004 :	Gb	unpubl.
45	45814.3651	I	20802	-0.0406	-0.0054	"	9
46	46197.4065	I	22091	-0.0410	+0.0011	Gb/li	"
47	46212.4130	II	22141.5	-0,0412	+0.0012	Gb/Be	"
48	46610.4523	I	23481	-0,0504	-0,0007	Wu/Be/Li	"
49	46909,3909	I	24487	-0,0568	-0,0017	Gb/Li	present p.
50	47206,5461	I	25487	-0,0636	-0.0031	GB/Li/Wu	"

Table2: Pe. minima since JD 43300 with residuals against elements (I) and (III). (: uncertain minimum)

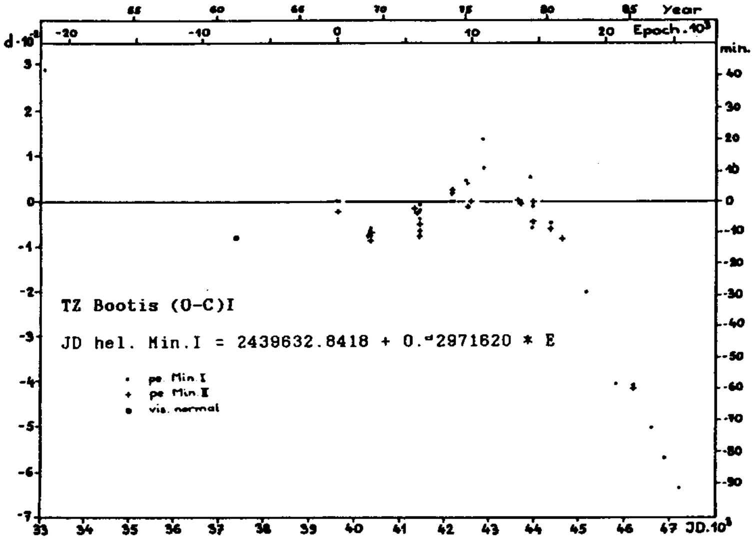

Figure 1. (O-C) diagram, elements I

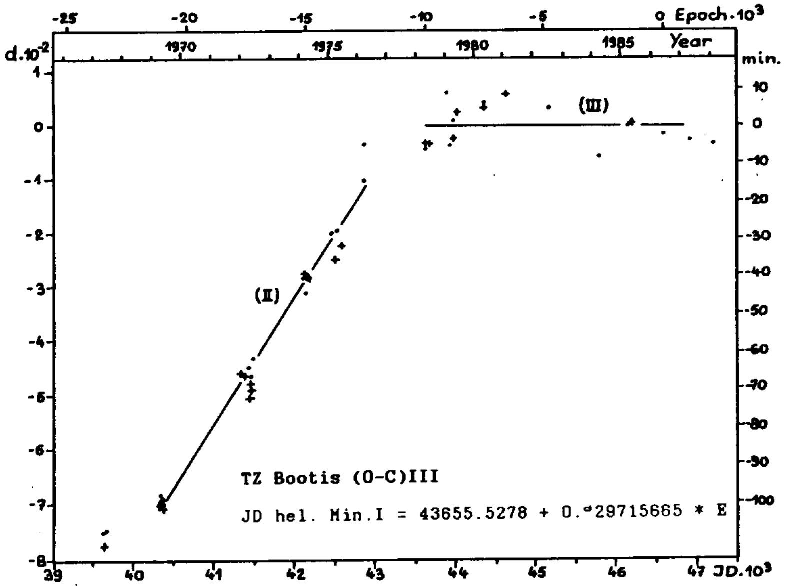

Figure 2. (O-C) diagram, elements III

A marked period shortening of $2.3 * 10^{-5}$ P or 0.6 s has taken place in 1977/78.
The minima of Binnendijk are not included in the calculations of ephemeris (II), because they lie well above the limits of the usual scatter. We presume that another period change has taken place around the year 1968, but this could not be ascertained with the available observational data.

Abbreviations of the observer's names:

Be = F. Betten
Ca = R.B. Carr
Gl = Ö. Gülmen
Ib = C. Ibanoglu
Rn = R. Pekünlü
Bi = L. Binnendijk
Gb = R. Gröbel
Ho = M. Hoffmann
Li = G. Lichtschlag
Wu = E. Wunder
Bz = S. Bozkurt
Gd = N. Güdür
Hs = H. Karacan
Rk = R. Akinci

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NO LIGHT VARIABILITY FOR ω GEM

The variability of ω Gem≡HR 2630 was announced by Henriksson (1977), who gave a period of 0.7282 d and an amplitude of 0.086 mag on the basis of 35 measurements made during a survey of 121 stars situated in the Cepheid instability strip. Hence, the Fourth Edition of the General Catalogue of Variable Stars classified ω Gem as a probable Cepheid. However, the announced period is not consistent with the observed spectrum, i.e. G5 III. To obtain an independent confirmation of its variability, ω Gem was put on the list of late spectral type giants under photometric monitoring at Merate Observatory. Because of the star's brightness, its observation was also proposed to a few amateur astronomical associations that had a possibility of using a photoelectric equipment. Three independent datasets were thus secured.

At Merate Observatory the star was observed in the y-Strömgren filter with the 50-cm reflector equipped with the instrumentation described by Cereda et al. (1988). 8–10 measurements were carried out on four nights in March 1988. 37 and 39 Gem were used as comparison and check star, respectively. Grouping the measurements into normal points (standard deviation 0.005 mag), the mean magnitude was found to be rigorously constant from one night to the next. Assuming y=5.73 for 37 Gem the mean value for the four nights is 5.148 mag in the y-light. Observational errors were found to be equal to those noted for 39 Gem.

ω Gem was also observed at Locarno Monti by S. Cortesi with a pair of telescopes (50 and 26 cm) both equipped with identical solid state photometers (Cortesi, 1983 and 1985). $BVRI$ measurements were taken on 5 nights in 1987 and on 2 nights in 1988. 37 Gem was used as comparison star ($V = 5.73$, $B - V = +0.57$, $V - R = +0.45$, $V - I = +0.74$). The transformation into the standard system was ensured using mean coefficients and also by observing the standard star λ Gem, also used as a check star. Although the scatter observed on some nights is greater than expected, the mean magnitudes of each night are very close to each other and no variability could be reasonably inferred. In the standard system the following magnitudes were established: $V = 5.17 \pm 0.02$, $B - V = +0.90 \pm 0.03$, $V - R = +0.67 \pm 0.03$, $V - I = +1.13 \pm 0.03$.

A third dataset was provided by A. Bertoglio who observed with a 20-cm Newtonian telescope equipped with an OPTEC SSP 3 photometer and standard B and V filters (Persha and Sanders, 1983). The observations were carried out at Alma (600 m above sea level, Ligurian Alps). 37 Gem and 39 Gem were used

Table I

Band	Julian Day	mag.	Obs.
V	2446875.4	5.18	LM
	6900.4	5.15	LM
	6902.4	5.17	LM
	6907.3	5.18	LM
	7205.3	5.18	To
	7212.3	5.18	To
	7233.3	5.18	To
	7239.4	5.15	LM
	7243.4	5.16	LM
y	2447222.32	5.143	Me
	7223.30	5.147	Me
	7227.31	5.151	Me
	7228.30	5.150	Me

as comparison and check stars, respectively. A measurement was constituted by five consecutive integrations of 10 s each. The observing runs were carried out on three nights for 2-3 hours and no rapid variability exceeding observational errors (±0.01 mag) can be established. Moreover, the three mean magnitudes are very close to each other. The transformation into standard magnitudes was ensured by the mean coefficients established from the measurements of some standard stars. The mean observed values are $V = 5.18$ and $B - V = +0.91$.

We have reported in the table all the mean magnitudes in V and y-light: the measurements performed at the Osservatorio Astronomico di Merate, at the Specola di Locarno Monti and at Alma are marked with the sigle Me, LM and To, respectively. The systematic differences between the three datasets can be ascribed to uncertainties in the trasformation into standard magnitudes. ω Gem, quite definitively, does not display the amplitude and period reported by Henriksson (1977) and is probably not a variable star at all.

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