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Ca II H AND K LINE VARIABILITY IN THE Ap STAR HD 43 819

HD 43819 (HR 2258), which was classified as a B9IIIp Si,(Cr) star (Cowley 1972), is a single wave photometric variable with a period of 1.0785 days (Winzer 1974). I obtained several 4.3 Å/mm IIaO spectrograms with the 2.5-m telescope at Mt. Wilson Observatory and several 8.9 Å/mm IIaO spectrograms with the coude feed telescope at Kitt Peak National Observatory and borrowed additional spectrograms from the Mt. Wilson Observatory plate file and staff. While studying the intensity vs. wavelength tracings of these plates, I noticed that the Ca II H and K line profiles contained a second component on several spectrograms, my Mt. Wilson Observatory spectrograms Ce21999 and Ce22006 as well as the 4.5 Å/mm Palomar Observatory spectrogram Pb11415. But these lines are definitely single on my Mt. Wilson Observatory spectrogram Ce22576 as well as on two 9 Å/mm Palomar Observatory spectrograms (Pc8488 and Pc9981), a 10.4 Å/mm Mt. Wilson Observatory spectrogram (Ce15086), and three of my Kitt Peak Observatory spectrograms (D3899c, D6018, D6031). My Kitt Peak Observatory spectrogram D4410a suggests that the K line is single while the H line may contain a second component. The difference in midexposure times between Ce21999 and Ce22006 is 24 hours and 23 minutes which is consistent with Winzer's period. However, the uncertainty in the period does not permit the use of the midexposure times of the other spectrograms which show H and K lines with secondary minima to improve the period of variability.

A careful examination of the 4.3 and 4.5 Å/mm spectrograms did not reveal any evidence for second components in lines other than the H and K lines. The apparent rotation velocity is 14 km s^{-1} (Wolff and Preston 1978). But the maximum separation of the two components of the H and K lines is observed to be 19 km s^{-1}, which may well be a lower limit. If HD 43819 has a companion which produces the sharp-lined secondary mimima in the H and K lines, it must be rather weak-lined or of somewhat later spectral type and less luminous. On the other hand, if the profile variations are due to spectrum variability as seen in many other Ap stars, then the metal lines may be formed over only part of the visible hemisphere. This would reduce the observed line width and permit a reconciliation of the observed maximum separation of the H and K line components and the observed value of v sin i.

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BD+61°277 CONFIRMED AS AN ECLIPSING BINARY STAR

The star BD+61°277 was noted to be an eclipsing binary by Soloviev (1944), who found a preliminary period of $2^{d}.4$. Apparently no further observations have been made of this star. BD+61°277 was monitored on 10 nights during the 1983-1984 observing season and on 20 nights during the 1984-1985 observing season with the 41-cm reflector of the Morgan-Monroe Station of the Goethe Link Observatory. Differential measurements were made using BD+61°282 as a comparison star. The photometer employed a 1P21 photomultiplier tube cooled with dry ice and standard B and V filters. Observations of standard stars for determining extinction and transormation coefficients were made on two nights during the Autumn of 1984. From these it was found that V_{max} = 9.5 and (B-V) = +.58.

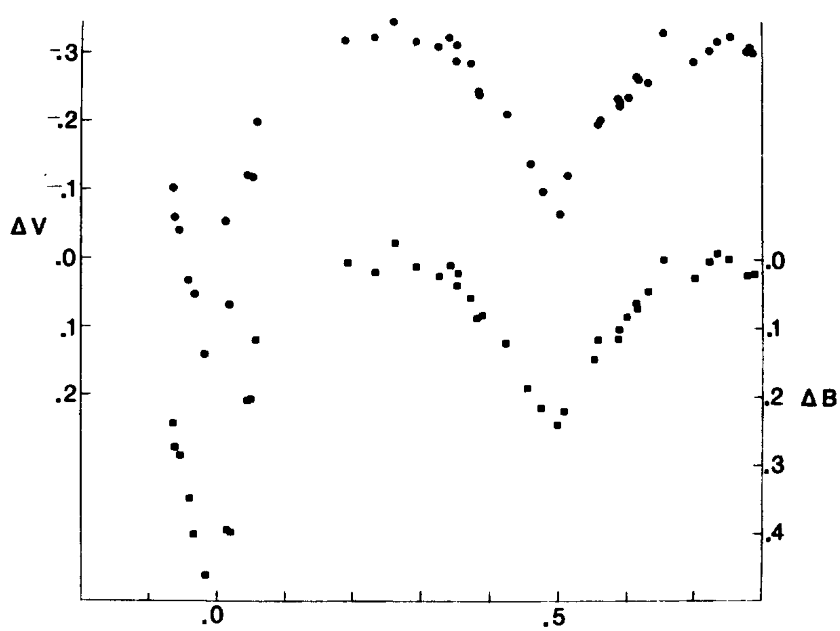

Figure 1

BD+61°277 was observed to be in eclipse on several nights, but the $2^{d}.4$ period did not fit the observations well. Plots of the observations were generated using various values of the period. The best fit occurred with a period of $6^{d}.1622$. The accompanying figure shows the observations folded on this period. The primary eclipse was found to be $^{m}.45$ deep and the secondary $^{m}.25$ deep. The duration of secondary eclipse is $1^{d}.7$. The sparseness of observations near primary eclipse made it impossible to determine a time of primary minimum light with any precision. It was possible to estimate the time of minimum light for one secondary eclipse, and this epoch may be used to predict future eclipses:

$$\text{HJD Min I} = 2446024.969 + 6.1622(E + .5).$$

Soloviev published 3 times of minimum light determined from photographic observations. It was not possible to reconcile these epochs of minimum light with the period determined in this study.

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PHOTOELECTRIC OBSERVATIONS OF NOVA CEPHEI 1971

Nova Cephei 1971 was discovered by Kuwano on July 10 at $\alpha = 22^h02^m46^s.85 \pm 0^s.01$, $\delta = +53^\circ15'48''.2 \pm 0''.1$ (1950.0) with $m_v = 8.0$.

The present photoelectric observations were carried out with the 40 cm refractor of the Teramo Astronomical Observatory, equipped with an EMI 9502 photomultiplier.

Our photometric data, unpublished up to now, help to fill some gaps in the light curve in that we have observed Nova Cephei for a total of 47 nights from July 13 up to December 17, 1971.

The photoelectric observations of the nova and the comparison stars were made between 1.020 and 1.337 air masses. The comparison stars are listed in Table I, and their magnitudes were determined by comparison with several Johnson's standard stars performed on many different nights of good quality.

Table I

			V	B−V
c_1	BD + 52°3095		8.73 ± .01	0.42 ± .02
c_2	BD + 53°2778		8.61 ± .01	1.51 ± .02
c_3	$\alpha=22^h02^m05^s.3$,	$\delta=53^\circ17'17''.2$ (1950.0)	10.69 ± .01	0.28 ± .01
c_4	$\alpha=22^h02^m30^s.0$	$\delta=53^\circ16'03''.6$ (1950.0)	11.54 ± .01	0.37 ± .02

The magnitudes of Nova Cephei are listed in Table II. These results are in good agreement with the data obtained by McConnell and Thomas (1972), Kohoutek and Klawitter (1973) and confirm that the nova can be classified as fast because the fall of 2 magnitudes occurs in less than 25 days from July 22 to August 14.

This consideration is confirmed by spectrophotometric studies about the large radial velocities both of absorption and emission systems, observed by Fehrenbach and Andrillat (1971), Bahng (1972) and Aikman et al. (1973).

During the transition stage starting after July 22 some oscillations are noticeable with decreasing amplitudes up to August 23.

Table II

U.T. Date 1971	V	U.T. Date 1971	V	U.T. Date 1971	V
Jul. 13.88	8.20±.01	Aug. 3.94	9.44±.01	Aug. 29.05	10.91
14.92	8.35	5.88	9.47	30.93	10.87
15.89	8.44	6.89	9.85	Sep. 11.84	11.11
16.84	8.64	10.89	10.13	18.79	11.22
17.99	8.63	12.89	10.54	23.78	11.47
19.86	8.71	13.95	10.55	24.77	11.48
21.90	8.68	14.92	10.69	Oct. 8.78	12.02
22.99	8.59	15.87	10.71	18.81	12.21
25.97	9.31	16.88	10.78	20.79	12.13
26.94	9.29	17.86	10.69	22.80	11.94
27.99	9.55	18.86	10.70	25.81	12.21
29.91	9.83	19.91	10.80	Nov. 12.72	12.30
30.93	9.94	20.86	10.76	16.79	12.45
31.98	9.99	23.90	10.73	Dec. 16.72	12.70
Aug. 2.00	9.68	25.86	10.80	17.77	12.66
3.00	9.50	27.96	10.84		

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CONFIRMATION OF THE REGULAR INTRINSIC VARIABILITY OF AU MONOCEROTIS

A few years ago the eclipsing binary AU Mon was revealed to be an unusual object in view of its discovered photometric peculiarities (Lorenzi, 1980 a, b). The analysis carried out on the available data allowed to separate the geometrical effects due to the eclipses from the intrinsic variation. Here new normalized photoelectric observations of the system are presented. Their combination with previous data confirm the existence of the periodic intrinsic variation ($P=411^d$) previously found. This confirmation is particularly meaningful in the context of recent IUE spectral analyses of AU Mon (Sahade and Ferrer, 1982, Peters and Polidan, 1984).

Such spectral analyses may offer an explanation to the aforementioned intrinsic variation.

During the period January-March 1983 and March 1984 new photoelectric observations in V light of AU Mon were obtained and combined in 82 normal points.

The resulting normalized observations are listed in Table I a, b. They refer to the same comparison star and to the same technique which follow from the previous work (Lorenzi, 1980a,b).

In Figure 1 these data show a rather smooth eclipsing light curve. In fact just at the end of January 83 and in March 84 the brightness minimum of the intrinsic variation occurred, being the cycle about 411 days long.

Referring to the previous solution (Lorenzi, 1980b), the new normal points have also been transformed by the formula

$$\overline{\Delta m}_V(\varphi_2) = \overline{\Delta V}_{obs}(\varphi_1,\varphi_2) + \alpha(\varphi_1) \qquad (1).$$

φ_1 and φ_2 are the phases of the eclipsing and intrinsic variation, respectively, according to the ephemerides

2442801.3752 + 11.1130371 E, for the former, and

2443105 + 411 E, for the latter.

The function $\alpha = \alpha(\varphi_1)$ represents the available mean light curve of the eclipsing variation, with its sign changed. Instead the expression (1) is

Table Ia

N_R	N_p	$\Delta\varphi_1$	J.D.	φ_1	φ_2	$\overline{\Delta V}$	$s_{\overline{\Delta V}}$	$a(\varphi_1)$	$\overline{\Delta V}+a$
60	13	.003	2445343.4114	.7436	.446	-.657	.002	+.108	-.55
61	11	.003	45346.3339	.0066	.453	+.100	.007	-.657	-.56
61	11	.002	.4262	.0149	.454	+.011	.003	-.518	-.51
62	9	.001	45351.4059	.4630	.466	-.622	.001	+.015	-.61
62	8	.001	.4202	.4643	.466	-.619	.003	+.015	-.60
63	19	.003	45353.3960	.6421	.471	-.646	.006		
64	15	.001	45354.4233	.7345	.473	-.650	.002	+.108	-.54
65	13	.002	45355.3607	.8189	.475	-.652	.001	+.084	-.57
66	15	.001	45356.3618	.9089	.478	-.589	.001	+.040	-.55
67	12	.002	45357.2635	.9901	.480	+.081	.005	-.605	-.52
67	12	.001	.2823	.9918	.480	+.114	.005	-.635	-.52
67	11	.002	.3028	.9936	.480	+.128	.003	-.660	-.53
67	12	.001	.3205	.9952	.480	+.144	.003	-.670	-.53
67	11	.001	.3349	.9965	.480	+.143	.003	-.678	-.54
67	11	.001	.3471	.9976	.480	+.150	.003	-.685	-.54
67	11	.001	.3600	.9988	.480	+.151	.003	-.690	-.54
67	12	.002	.3739	.0000	.480	+.148	.002	-.692	-.54
67	11	.001	.3927	.0017	.480	+.155	.003	-.688	-.53
67	11	.001	.4045	.0028	.480	+.143	.003	-.683	-.54
67	11	.001	.4161	.0038	.480	+.132	.003	-.675	-.54
67	12	.001	.4287	.0049	.480	+.128	.003	-.670	-.54
67	11	.001	.4403	.0060	.480	+.118	.002	-.660	-.54
67	12	.001	.4565	.0074	.480	+.110	.002	-.644	-.53
67	11	.001	.4712	.0088	.480	+.098	.002	-.625	-.53
67	12	.001	.4851	.0100	.480	+.080	.002	-.605	-.53
67	11	.002	.5014	.0115	.481	+.067	.004	-.580	-.51
67	12	.002	.5234	.0135	.481	+.033	.003	-.545	-.51
67	11	.001	.5410	.0151	.481	+.012	.003	-.512	-.50
68	17	.002	45366.3099	.8041	.502	-.649	.002	+.090	-.56
69	15	.001	45367.3507	.8978	.505	-.618	.003	+.044	-.57
70	9	.001	45368.2710	.9806	.507	-.053	.004	-.445	-.50
70	9	.001	.2924	.9825	.507	-.025	.003	-.470	-.50
70	9	.001	.3144	.9845	.507	+.026	.005	-.505	-.48
70	9	.001	.3352	.9864	.507	+.059	.003	-.543	-.48
70	9	.001	.3589	.9885	.507	+.082	.003	-.580	-.50
70	9	.001	.3790	.9903	.507	+.107	.001	-.605	-.50
70	9	.001	.4041	.9926	.507	+.124	.003	-.648	-.52
70	9	.001	.4284	.9947	.507	+.137	.001	-.670	-.53
70	8	.001	.4385	.9957	.507	+.156	.002	-.675	-.52
70	9	.001	.4647	.9980	.507	+.184	.003	-.685	-.50
70	7	.001	.4766	.9991	.507	+.180	.002	-.690	-.51

Table Ib

N_R	N_p	$\Delta\varphi_1$	J.D.	φ_1	φ_2	$\overline{\Delta V}$	$s_{\overline{\Delta V}}$	$a(\varphi_1)$	$\overline{\Delta V}+a$
70	9	.001	45368.4870	.0000	.507	+.183	.003	-.692	-.51
70	7	.001	.4991	.0011	.507	+.176	.003	-.690	-.51
70	7	.001	.5064	.0018	.507	+.188	.002	-.688	-.50
70	7	.001	.5137	.0024	.507	+.186	.003	-.682	-.50
71	15	.001	45369.3508	.0777	.509	-.585	.002	+.030	-.56
72	15	.001	45370.3481	.1675	.512	-.616	.003	+.082	-.53
73	9	.001	45377.3721	.7995	.529	-.640	.003	+.090	-.55
74	11	.001	45384.3068	.4236	.546	-.640	.002	+.015	-.62
75	10	.001	45385.2738	.5106	.548	-.587	.002	+.015	-.57
75	9	.001	.2816	.5113	.548	-.587	.001	+.015	-.57
75	10	.001	.2911	.5121	.548	-.587	.001	+.015	-.57
75	9	.001	.3613	.5184	.548	-.585	.002	+.015	-.57
75	10	.001	.3755	.5197	.548	-.590	.003	+.015	-.58
75	9	.001	.4429	.5258	.549	-.583	.002	+.015	-.57
75	10	.001	.4562	.5270	.549	-.588	.002	+.015	-.57
75	10	.001	.4697	.5282	.549	-.586	.002	+.015	-.57
76	11	.001	45396.2881	.5017	.575	-.587	.002	+.015	-.57
76	12	.001	.3032	.5030	.575	-.585	.002	+.015	-.57

Table Ib (cont.)

N_R	N_p	$\Delta\varphi_1$	J.D.	φ_1	φ_2	$\overline{\Delta V}$	$s_{\overline{\Delta V}}$	$a(\varphi_1)$	$\overline{\Delta V}+a$
77	9	.001	45397.3484	.5971	.577	-.609	.007		
77	7	.000	.3876	.6006	.578	-.626	.000		
78	10	.001	45401.2917	.9519	.587	-.578	.002	-.007	-.59
78	10	.001	.3032	.9530	.587	-.578	.002	-.010	-.59
78	9	.001	.3213	.9546	.587	-.582	.001	-.022	-.60
78	9	.001	.3507	.9572	.587	-.542	.003	-.038	-.58
78	10	.001	.3648	.9585	.587	-.536	.001	-.046	-.58
78	10	.001	.3783	.9597	.587	-.524	.003	-.066	-.59
78	10	.001	.3897	.9608	.587	-.510	.004	-.080	-.59
78	10	.001	.4011	.9618	.587	-.488	.003	-.100	-.59
78	10	.001	.4118	.9627	.587	-.468	.002	-.117	-.59
78	10	.001	.4245	.9639	.587	-.448	.004	-.135	-.58
79	11	.001	45403.3170	.1342	.592	-.608	.003	+.065	-.54
80	9	.001	45766.3845	.8046	.475	-.643	.005	+.090	-.55
80	8	.001	.3982	.8058	.475	-.648	.003	+.090	-.56
81	13	.002	45778.2968	.8765	.504	-.629	.004	+.060	-.57
81	12	.002	.3189	.8785	.504	-.647	.013	+.060	-.59
82	11	.002	45789.3358	.8698	.531	-.639	.003	+.064	-.57
82	10	.001	.3531	.8714	.531	-.640	.003	+.064	-.58
83	9	.001	45790.3141	.9579	.534	-.522	.002	-.045	-.57
83	10	.002	.3302	.9593	.534	-.509	.006	-.055	-.56
83	9	.001	.3473	.9609	.534	-.473	.002	-.034	-.56
83	10	.001	.3609	.9621	.534	-.458	.004	-.100	-.56

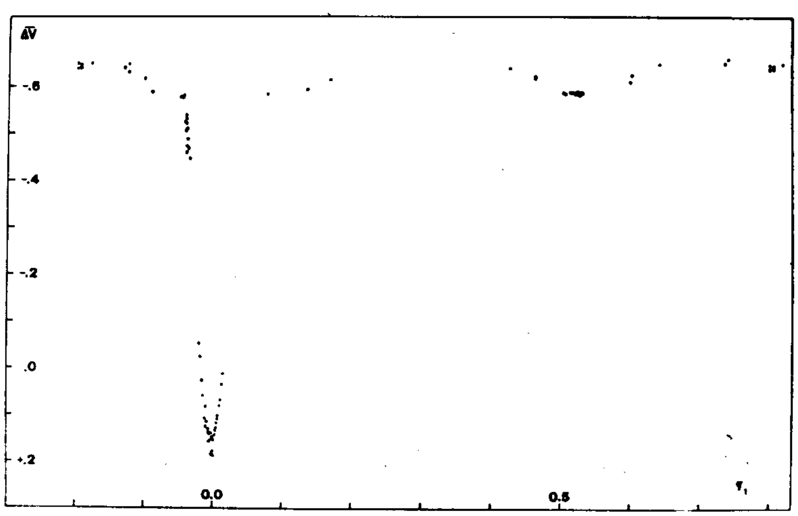

Figure 1 : Plot versus φ_1 of new V normalized observations of AU Mon, carried out during January-February 1983 and March 1984, just in the period of the intrinsic variation cycle, around φ_2=0.5

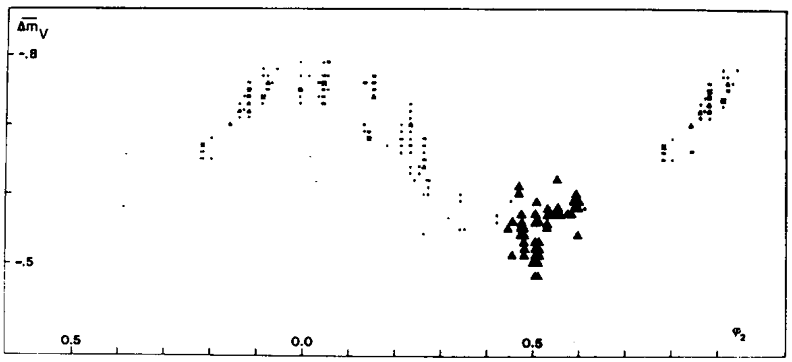

Figure 2 : The light curve of the intrinsic variation by the old observations (• 1976-1979) and by the new ones (▲ 1983-1984). The inserted normal points follow from the formula $\overline{\Delta m}_V(\varphi_2)=\overline{\Delta V}_{obs}+\alpha(\varphi_1)$

representing the calculated mean light curve of the intrinsic variation.

The new Δm's, which follow from (1), appear to fit very well the above mentioned intrinsic light curve (see Figure 2), and this confirms strongly the regular behaviour of the intrinsic variability of the system. To emphasize this fact, we wish to remember that the light curve of Figure 2 results from the overlap of 7 cycles, more precisely a time interval 3000 days long.

The physical scenario of such a binary system was recently enriched by extended spectral investigations (Sahade and Ferrer, 1982 - Peters and Polidan, 1984). From the photometric point of view, the author attempted an average photometric solution (Lorenzi, 1982a) and, in order to obtain more faithful and complete results, he suggested to work on a three-dimensional photometric representation of the involved light changes (Lorenzi, 1982b). In particular Peters and Polidan interpret their IUE observations in terms of a "high temperature accretion region" (HTAR) around the primary of AU Mon (B5 + F-G), as due to the existence of nonthermal sources of energy.

Such HTAR shows to fade over a time scale of a few orbital cycles, while it seems to be present only when AU Mon is faint, that is during the intrinsic brightness decrease of the system. Possibly a change in the radius and / or stellar effective temperature induced by mass accretion is responsible.

Alternatively, according to Peters and Polidan, an increase in the mass transfer rate could obscure more of the star and reduce the observed flux.

Now the photoelectric observations presented in this paper, confirming the existence of the periodic intrinsic variation in AU Mon ($P=411^d$), strengthen the suggestion that a positive correlation may be found between HTAR and the long brightness cycle.

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A FLARE ON THE CONTACT BINARY CN And

About twenty years ago a large flare event was observed on the prototype contact binary W UMa by Kuhi (1964). Similar events have been reported on 44i Boo (Eggen, 1948), U Peg (Huruhata, 1952) and VW Cep (Egge and Pettersen, 1982). This is the first event of this kind to be reported for CN And. This star is an eclipsing binary, classified to be in contact, showing asymmetric light curve (Kałuzny, 1983). The orbital period is 11^h06^m. The absolute magnitude is about $3^m.41$ at maximum light (Dworak, 1975).

The photoelectric observations were made with the 106 cm telescope at Yunnan Observatory using an integrating photometer on the night 25/26 November, 1981. Data were taken through a yellow filter with the effective wavelength 5420Å. BD+39°0069 and BD+39°0076 were used as the comparison star and the check star, respectively. The sequence of the observation was: sky-background-comparison star-variable star- sky-background. Integration time of each measure is 16 seconds. The check star was measured at intervals of 30 minutes. The possible error of the magnitude difference between the check star and the comparison star is $\pm 0^m.007$. The magnitude differences between the variable star and the comparison star were corrected for differential extinction and were transformed to the standard UBV system.

Figure 1 shows portions of the light curve, observed in the V filter. The light curve of the flare itself, corrected for the effects of eclipses is shown in Figure 2. The flare is detected from about phase 0.21 to about phase 0.24. The total duration of the flare is about 22 minutes. The flare rises to half of the peak value in 4 minutes, and decays to one half of the peak value in 14 minutes. The magnitude of the peak value of the flare is about $0^m.11$. The obvious dispersion of the light curve from phase 0.18 to 0.30 seems to show that also some activity on CN And occurs before and after the flare.

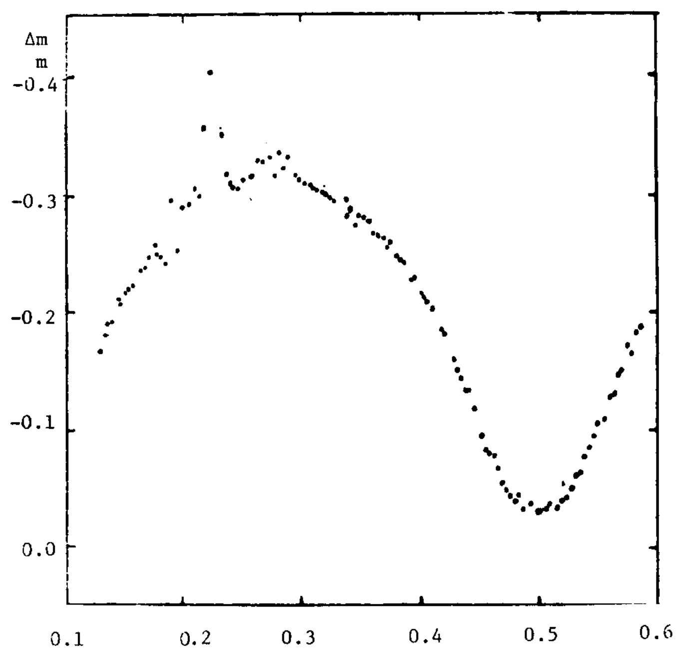

Figure 1 : a portion of light curve on CN And displaying a flare

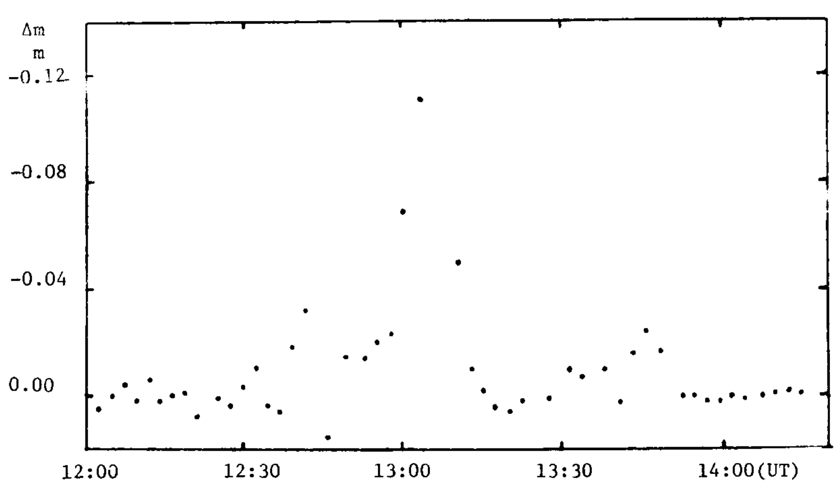

Figure 2 : a flare on CN And at V wavelength

Adopting the absolute magnitude of $3\overset{m}{.}41$ for CN And (Dworak, 1975), we estimate 1.5×10^{33} erg/s(V) for the peak fluxes of the flare. Integrating numerically under the light curve we obtain for the total energy during the flare 8.8×10^{35} erg(V).

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COMPARISON STARS FOR SOME ECLIPSING BINARIES

As part of a continuing photometric program of mostly long-period interacting eclipsing binaries, comparison and check stars have been observed for constancy. Observations were made with u,v,b,y, and I intermediate-band filters, and transformed to the standard Strömgren-Crawford and Kron systems. Most observations were made with the 1-m Prairie reflector located at the Mount Laguna Observatory. All were made with a pulse-counting photometer with refrigerated RCA 31034A-02 photomultiplier.

TABLE I

Constant Comparison and Check Stars

Binary	Comparison Star	Check Star	n
AQ Cas	+ 61° 223	+62° 229	6
RS Cep	+ 80° 156	+79° 159	12
RZ Cnc	+ 31° 1848	+31° 1857	7
KU Cyg	+ 46° 2879	[1]	26
RX Gem	+ 33° 1417	+33° 1421	6
AU Mon	- 01° 1413	-01° 1446	7
RZ Oph	+ 06° 3917	+06° 3918	24
DN Ori	+ 10° 973	+09° 1016	3
RW Per	+ 42° 938	+41° 844	21
RZ Sct	- 08° 4606	-08° 4605	10
RW Tau	+ 27° 628	+27° 618	3

[1] Star 'd', Popper (1964)

TABLE II

Non-Constant Stars

Binary	Star
AQ Cas	+61° 240
RS Cep	+80° 159
RZ Cnc	+32° 1776

TABLE III

Comparison Star Colors

Comparison to:	(V-I)	(b-y)	(v-y)	(u-b)	n
AQ Cas	0.294±0.005	0.279±0.004	0.688±0.004	1.313±0.005	1
RS Cep	-0.130±0.007	0.047±0.003	0.242±0.005	1.462±0.014	4
RZ Cnc	1.052±0.013	0.777±0.003	2.149±0.006	3.206±0.009	6
KU Cyg	1.008±0.017	0.729±0.005	1.823±0.016	2.730±0.020	5
RX Gem	-0.234± .023	0.000±0.002	0.123±0.003	0.964±0.005	3
AU Mon	-0.143±0.005	0.027±0.008	0.181±0.008	1.269±0.008	2
RZ Oph	0.520±0.006	0.415±0.004	1.034±0.005	1.700±0.008	11
DN Ori	0.014±0.010	0.095±0.017	0.396±0.012	1.629± .012	1
RW Per	0.348±0.005	0.315±0.006	0.773±0.009	1.437±0.012	3
RZ Sct	(:)	0.184±0.004	0.442±0.011	1.678±0.005	2
RW Tau	-0.067(:)	0.088±0.026	0.310±0.024	1.484±0.027	3

Those binaries whose comparison and check stars were constant at all observed wavelengths to better than 0.01 mag. are listed in Table I. The last column gives the number of nights on which comparison/check star observations were made. Table II lists other stars, close to three binaries, which are variable with amplitude > 0.01 mag.

Colors of the constant comparison stars of Table I were found for those nights on which more than a dozen standard stars were observed. These results are given in Table III. Transformation equations for (v-y) and (u-b) are (Olson, 1981):

$$(v-y) = P + I' C (cl) + RC (vy)$$

$$(u-b) = L' + J'' C (cl) + M' C (ub).$$

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NEW TIMES OF MINIMA, AND A RECENT PERIOD INCREASE, IN U CEPHEI

The very considerable data on period changes in U Cep was last summarized by Olson et al. (1981). Since then, Faulkner and Kaitchuck (1983) have determined three more times of minimum. We now give eight additional photoelectric times, determined with the 0.4-m and 1.0-m reflectors at Mount Laguna Observatory. The same uvby filter set was used for all observations, and I observations were also made with the 1.0-m telescope. Focal-plane apertures were either 20 or 25 arc-sec, and excluded both nearby visual companions (ADS 830 BC). Times of minima were determined using the Kwee, Van Woerden method, as programmed by R. C. Crawford.

TABLE I

NEW PHOTOELECTRIC TIMES OF MINIMUM LIGHT

JD (hel) -2440000.	E	O-C (days)	d (days)	Observer
4633.8455	2544	+0.0472	0.082	O
4658.7768	2554	0.0481	0.074	H
4840.7686	2627	0.0479	0.082	H
4850.7413	2631	0.0484	0.081	H
5179.8252	2763	0.0509	0.081	H
5558.7746	2915	0.0581	0.089	P
5720.8302	2980	0.0660	0.066[1]	Hu
6049.9151	3112	0.0695	0.090	O

[1] Disturbed eclipse.

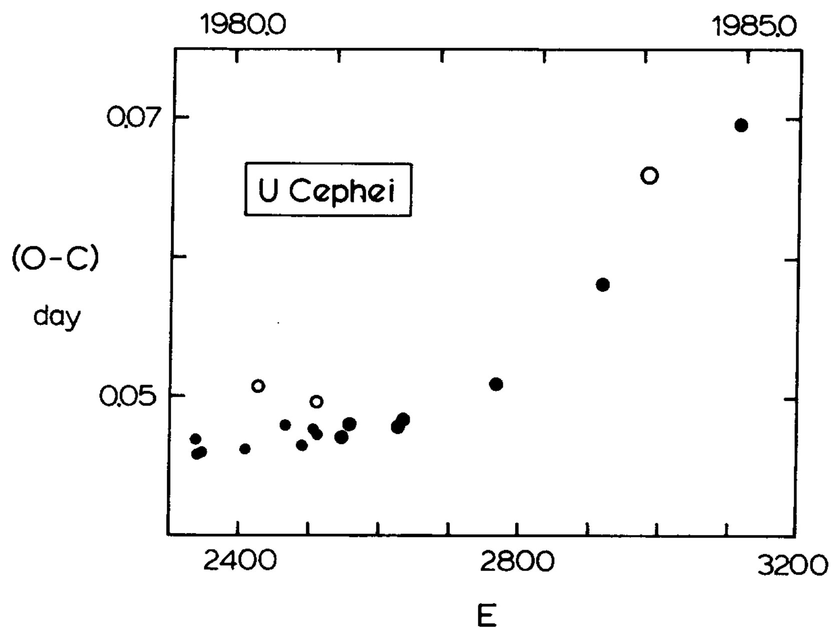

Figure 1 - Observed minus calculated times of minimum for U Cephei over the past six years. Large circles are new observations. Filled circles are from undisturbed eclipses, and open circles for disturbed eclipses (for which d $\lesssim$ 0.075 day).

TABLE II

SUMMARY OF RECENT ABRUPT PERIOD CHANGES IN U CEPHEI

Cycle Count of Change	Year	$\Delta P/P$
1315	1972	-2.5×10^{-5}
1599	1974	$+1.0 \times 10^{-5}$
2284	1979	-0.8×10^{-5}
2750	1982	$+1.9 \times 10^{-5}$

As noted by Crawford and Olson (1979), we assume that only those eclipses with apparent totality, d, $\gtrsim$ 0.075 day were undisturbed by circumstellar light, and therefore gave true times of conjunction.

New times of minimum are listed in Table I, and all but one are undisturbed. We continue to calculate cycle count and (O-C) from the ephemeris JD(hel), I = 2438291.5020 + 2.493 0410E. Fig. 1 is a plot of residuals from this ephemeris, and includes previously published data back to the last period decrease. An 'abrupt' period increase occurred near E $\sim$ 2750. Adding the four new observations before this increase to the eight undisturbed times since the last period decrease gives a refined ephemeris for the interval E = 2335-2631: JD(hel),I = 2438291.5324 ± 0.0005 + (2.4930478 ± 0.0000014) E. Combining our three undisturbed minima after the increase with those of Faulkner and Kaitchuck (1983) gives the post-period increase ephemeris: JD(hel),I = 2438291.4048 ± 0.0059 + (2.4930945 ± 0.0000015) E.

Recent period changes in U Cep are summarized in Table II. Both Fig. 1 and the corresponding figure in Olson et al. (1981) support the interpretation that abrupt period changes interrupt relative long intervals (a few years) during which the orbital period is sensibly constant. The abrupt period changes are of alternating sign. Though in the long run the period of U Cep has been increasing, there has obviously been a slight decrease over the interval covered in Table II. Disturbed eclipses continue to be spuriously late, as described by Crawford and Olson (1979). Finally, there continues to be no evidence whatsoever that these abrupt period changes have anything to do with sporadic episodes of mass transfer in U Cep.

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ÉTOILES À HELIUM FAIBLE PHOTOMÉTRIQUEMENT VARIABLES

La première phrase de l'I.B.V.S. No. 2662 (Landis et al., 1985) signale que l'étude photométrique de l'étoile HR 1063 = V396 Per est importante parce que celle-ci serait "the only helium-weak star known to be photometrically variable". Les auteurs ont certainement été mal renseignés, car au moins une quinzaine de telles étoiles sont connues. Nous en donnons la liste ci-dessous, avec les périodes (valeurs arrondies) et les références pour les variations photométriques. Les périodes P sont les mêmes que celles des variations spectrales, lorsqu'elles ont été observées, notamment pour les raies d'hélium. La valeur donnée entre parenthèses pour certaines étoiles est une seconde possibilité proposée par les auteurs à cause d'éventuels battements avec la période d'1j qui module trop la distribution des observations. Pour HR 1441, l'ambiguité a été levée par des mesures spectrographiques ultérieures et nous n'indiquons donc que la première possibilité, celle qui a été confirmée. De même, la période indiquée pour HD 37058 est celle qui a été précisée grâce aux mesures spectrographiques ultérieures et qui est d'ailleurs dans les limites d'erreur de la valeur 15,3 ± 0,8j obtenue dans l'article cité. Pour HR 5912 = 3 Sco, la valeur de P retenue, qui était considérée seulement comme la plus probable dans le premier article cité, a été confirmée ultérieurement par des mesures du champ magnétique et par les mesures photométriques de l'auteur du second article cité ci-dessous pour cette étoile.

HD	HR	var.	P	réf.
21699	1063	V396 Per	2,5(1,7)j	Winzer 1974, Mallama et Molnar 1974
28843	1441	DZ Eri	1,37j	Pedersen et Thomsen 1977
35298			1,85j	North 1982,1984
36526		V1099 Ori	1,54j	North 1982,1984
36540		V1101 Ori	2,17j	North 1982,1984
37058		V359 Ori	14,6j	Pedersen et Thomsen 1977
37140		V1130 Ori	2,71j	North 1982,1984
49333	2509	HK CMa	2,18j	Pedersen et Thomsen 1977
125823	5378	V761 Cen	8,82j	Norris 1971, Pedersen et Thomsen 1977
142301	5912	V927 Sco	1,46j	Pedersen et Thomsen 1977, North 1984
142990	5942	V913 Sco	0,5j ?	Pedersen et Thomsen 1977
144334	5988	V929 Sco	1,5(0,6)j	North et Waelkens 1983
162374	6647		1,66j	North 1984
191980		V1357 Aql	20(1,05)j	Burke et Lady 1977, Vetö et al. 1980
217833	8770	V638 Cas	5,4j	Vetö et al. 1980

Presque toutes ces étoiles à hélium faible étaient en fait déjà renseignées comme photométriquement variables dans le Catalogue des périodes observées pour des étoiles Ap (Catalano et Renson, 1984). Il suffisait donc de se référer à cette compilation pour voir qu'il y en avait plus d'une. Les variations photométriques de deux d'entre elles seulement, HR 5988 et HR 6647, n'ont été connues qu'après la transcription du fichier d'où a été tiré ce Catalogue. Pour la seconde toutefois, des observations spectrographiques avaient été faites (v. le Catalogue) et la première période qui en avait été déduite est bien celle qui a été confirmée photométriquement.

Nous profitons de l'occasion qui nous est donnée ici pour signaler des corrigenda relatifs à l'étoile HR 1063 dans ce catalogue, à savoir l'ommission de son nom d'étoile variable et de la seconde référence, ainsi qu'une erreur dans la première : la référence pour Winzer est en réalité celle qui est indiquée ici et qui est d'ailleurs correctement donnée aussi dans la note de Landis et al. (1985).

Toutes les étoiles de la liste ci-avant sont effectivement connues comme étoiles à hélium faible. Deux d'entre elles, HD 36526 et HD 37140, ont toutefois également été citées comme étoiles Si-Sr (Schild et Chaffee, 1971), bien qu'elles aient été aussi reconnues comme étoiles à hélium faible (Bernacca et Ciatti, 1972; Abt et Levato, 1977). En fait, la distinction entre étoiles Ap au sens ancien (étoiles au Si, etc.) et étoiles à He faible est difficile, car les premières montrent déjà une sous-abondance d'hélium et les secondes ont en général aussi les raies de certains éléments anormalement intenses, dans la mesure où la température de leur atmosphère permet d'en juger. Notamment la variable Ap au silicium HD 36668 = V1107 Ori (P=2,12j) a aussi été considérée comme étoile à hélium faible (Ciatti et Bernacca, 1971).

Toutes ces étoiles ont d'autre part reçu un nom d'étoile variable (3e col. de la table ci-avant), sauf deux de celles dont les variations photométriques n'ont été connues que récemment (travaux de North).

Il est remarquable que l'une d'elles, HD 37058, avait un nom d'étoile variable, V359 Ori, avant qu'on ait observé ses variations périodiques. Dans le Catalogue général des étoiles variables (Kukarkin et al., 1970), elle est renseignée comme variable irrégulière : type In a s, avec des magnitudes extrêmes 6,9 et 9,8. Effectivement, déjà Parenago (1954) dans sa grande étude des étoiles de l'association d'Orion, estimait sur la base de ses observations et d'observations antérieures, que la magnitude photographique varie de 6,9 à 8,1 et la magnitude visuelle de 7,3 à 8,4 (No.2083, p.184). Les deux phénomènes sont probablement superposés. De ce point de vue, il serait intéressant d'observer cette étoile de manière systématique et prolongée. Notons que l'étoile à hélium faible HD 36958 = KX Ori est aussi renseignée comme variable In a.

Pour les étoiles à hélium faible de la liste ci-avant, la grandeur de la variation est en général de 0,02 à 0,04 mag. dans le jaune (*V* ou *y*) et de 0,05 à moins de 0,1 mag. dans l'ultraviolet proche. La variation est un peu plus grande pour

HR 1441, au moins en *y*. Pour HR 6647, elle est au contraire plus petite. Ces amplitudes de variation sont tout à fait normales pour des étoiles Ap; elles sont même semblables à ce qu'on trouve parmi les étoiles au Si, celles qui varient le plus parmi les Ap. Dans la mesure où on peut en juger sur un aussi petit échantillon, la répartition des périodes est aussi tout à fait semblable à celle qu'on a trouvée (Hensberge, 1983, fig.1, p.11) pour l'ensemble des étoiles Ap, avec sa forte concentration entre 1 et 3 j et sa décroissance lente vers les périodes plus longues.

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GENERAL CATALOGUE OF VARIABLE STARS

The following information has been received from Dr.N.N. Samus' of the Astronomical Council of the USSR Academy of Sciences:

Publication of the fourth edition of the General Catalogue of Variable Stars (GCVS IV) is now underway. It will be available on magnetic tape as well as in book form. The first stage of the work on GCVS IV, the New Catalogue of Suspected Variable Stars (NSV), was published in book form by the "Nauka" Publishing House in early 1982. The magnetic tape of NSV is now available from the astronomical data centers.

The magnetic tape of the first volume of GCVS IV is now ready, and has been sent to the Strasbourg Center of Stellar Data. The book of the first volume (Andromeda-Crux, about 7900 stars, with a foreword containing a description of the catalogue and the classification system) is also available. The second volume (Cygnus-Orion, about 10240 stars) is also almost ready and will probably be available, as a book and as a magnetic tape, by the time of the XIXth General Assembly. There will be five volumes in GCVS IV. Three volumes comprise the main body of the catalogue; data on variables in external galaxies will appear in Volume IV; a list of the variables arranged by right ascension, cross identification tables, etc., will be in Volume V.

The 66th Name-list of variable stars printed in November 1981 (IBVS No. 2042) was the last one belonging to GCVS III.The 67th Name-list, the first one in the system of GCVS IV, has now been compiled (IBVS, No. 2681, 1985).

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President, Commission 27

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A NEW SHELL STAR : HD 50845

The star HD 50845 (K0) = BD $-1^{\circ}1447$ = SAO 133883 ($\alpha_{1950}=6^{h}52^{m}16\overset{s}{.}57$, $\delta_{1950}=-1^{\circ}13'05\overset{''}{.}3$, $m_{v}=8.2$) was observed by us with the 1.50 m-coudé spectrograph of the Cerro Tololo Interamerican Observatory, in Chile, on February 18 and 19, 1984 (UT). The material obtained - which was rather weak - is listed in Table I. The plates were calibrated by means of a spot sensitometer.

Table I
Spectrograms of HD 50845

Date (UT)# JD (2,445,000+)	Exposure Time (minutes)	Emulsion (Kodak)	Dispersion* ($A\ mm^{-1}$)
748.633	177	IIIa-F	18.6/37.2
748.738	99	098-04	18.6/37.2
749.665	289	IIa-0+098-04	9.0/18.0

Mid-exposure
* second order blue (3900-5000 A)/first order red (5700-7000 A)

The striking feature on our spectra of HD 50845 is that Hα displays a complex structure (see Fig. 1): a broad, shallow absorption line with superimposed incipient emission cut into by a strong, deep, sharp absorption core.

If we compare our spectra of HD 50845 with the reproductions of stellar spectra published in An Atlas of Representative Stellar Spectra (Yamashita et al. 1977), we find that the former resembles that of a K0 Ib object. The strongest lines correspond to Fe I, Ca II and Na I - which are sharp - and to H. The lines of Ca II display the deepest cores.

The radial velocity values that we have derived from our material are given in Table II. The mean square errors have been estimated in around $\pm$ 4 km s^{-1}.

The line profiles of most of the spectral lines, the radial velocity behavior and the fact that the Fe I lines arising from metastable levels are the most conspicuous ones, suggest that the spectrum of HD 50845, at least in the region represented on our plates, is that of a shell. In consequence,

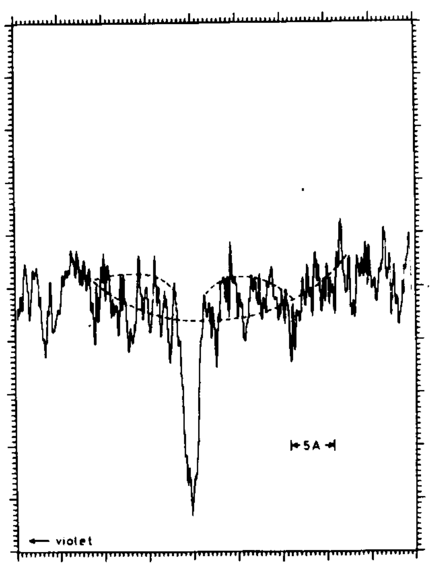

Figure 1: The Hα profile in the spectrum of HD 50845. We have schematically drawn the broad absorption and the incipient emission that appear to be present.

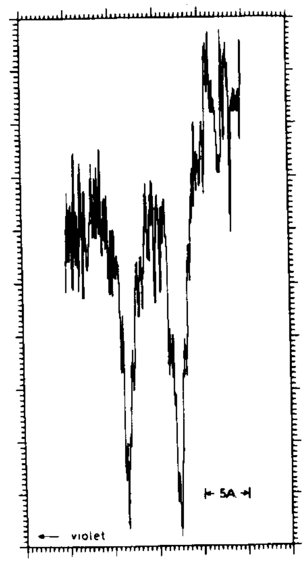

Figure 2: The Ca II-K and H lines in the spectrum of HD 50845. Each profile suggests the presence of a broad absorption component in addition to the sharp core.

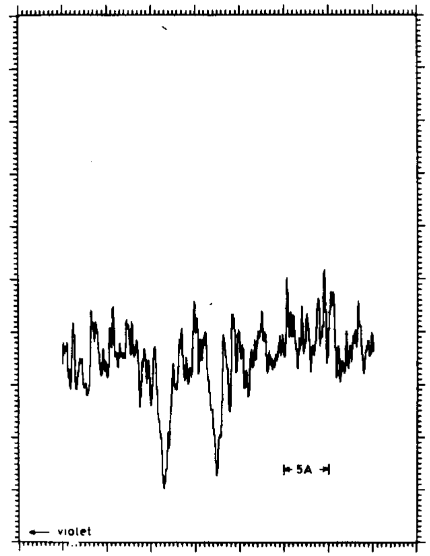

Figure 3: The Na I-D lines in the spectrum of HD 50845.

the KO spectral classification assigned to the object does not correspond to a star, it merely describes, in a rough way, the physical characteristics of the shell around HD 50845.

Table II

Radial Velocities of HD 50845

Element/Feature		Radial Velocity ($km\ s^{-1}$)	
Hα	sharp core	+10.4	
Hγ	sharp core	+ 7.9	
Fe I		+10.4	average of 8 values
Na I		+ 3.9	
Ca II		-10.1	

The stellar spectrum appears to be represented by the broad Hα absorption, which seems to be red-displaced by approximately 1 A with respect to the laboratory position. There is also some indication of a broad stellar component at Ca II (see Fig.2). It seems ,therefore, in order to conclude that the stellar object is probably on the main sequence or quite close to it; as for its spectral type, it ought to be earlier than KO.

Figure 3 illustrates the Na I-D lines.

An attempt will be made to secure better exposed spectra of HD 50845 to improve our knowledge of the object.

We are indebted to the Director and staff of the Cerro Tololo Interamerican Observatory for their hospitality and efficient help that permitted us to secure the observations reported here. We are also indebted to the Centre de Données Stellaires, Strasbourg, for informing us of the lack of previous spectroscopic studies of the star. Mrs.Margarita Trotz kindly prepared the illustrations.

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STARSPOTS AND THE Mg II EMISSION OF VW CEPHEI

The idea that dark starspots make the more massive components of cool W UMa binaries appear cooler is an attractive explanation of light curves (Mullan 1975; Eaton, Wu, and Ruciński 1980; Eaton 1985). Observed light curves require the spots to be spread quite uniformly over one component of the system, a distribution that may show up in chromospheric heating. The chromospheric emission observed in the ultraviolet, however, seems to be practically independent of phase in several systems (Vilhu and Ruciński 1985; Ruciński, Vilhu, and Whelan 1985; Eaton 1985), and this might be taken to indicate that the active regions associated with spots are spread evenly over both components.

If evenly distributed spots are the cause of W-type light curves, we can predict their effects on chromospheric emission through analogy with RS CVn binaries. In the RS CVn system II Peg, Marstad et al. (1982) observed a particularly luminous active region that enhanced Mg II λ2800 emission by ~30% and transition-region emission by an order of magnitude. This region was visible when the star was faintest, as might be expected from the sunspot analogy, but Poe and Eaton (1985) find spots were visible at all phases, not just when the active region was in view. Further, the active region producing the enhanced emission was found by Marstad to cover only ~6% of the stellar surface, much less than the coverage by spots (Linsky 1984). This suggests that changes in the spot distribution act to excite strong active regions, probably by tearing closed magnetic flux tubes as spots move past one another. Further evidence for changing spot distributions producing the enhanced chromospheric and transition-region emission of active stars comes from a flare observed on UX Ari (Simon, Linsky, and Schiffer 1980). In this case the flare seemed to be associated with interaction of active regions on different components of the binary. Simon, Linsky, and Schiffer proposed that it is this sort of interaction that gives the episodic giant flares observed in RS CVn systems.

The importance of this result is that it predicts W UMa systems, which would have many relatively small spots being dragged about by differential rotation, should be literally covered with material producing strong chromospheric as well as transition-region lines. The bulk of the line emission should be confined to the spotted component. On the other hand, if most of the chromospheric emission does not come from such active regions (perhaps it comes from an enhanced chromospheric network), the surface flux in Mg II would not be especially elevated over the quiet phases of RS CVn binaries. We have already seen in SW Lac, which has the most extensive observations of any system studied to date, that Mg II surface flux is not highly correlated with phase (Eaton 1985). VW Cep, with a later spectral type and stronger Mg II emission, is an even better star to compare with II Peg.

We have used 30 IUE spectra of VW Cep, obtained at three different epochs as part of observing programs CBDJE and CBEJE, to investigate the Mg II emission. Emission strength is measured by an index formed by taking the ratio of average flux in a 22 A band at 2799 A to average flux between 2585 and 3200 A (Mg II omitted), expressed as a magnitude difference. The ultraviolet continuum flux is roughly proportional to surface area, so the Mg II index is a measure of surface flux. Figure 1 shows the phase dependence of Mg II emission, which is very slight indeed. Not only is there little phase dependence, but the average level seems to be roughly constant from year to year. If we compare flux in the 22 A Mg II band to flux at V, we get (MgII-V) ≈ 2.5. The

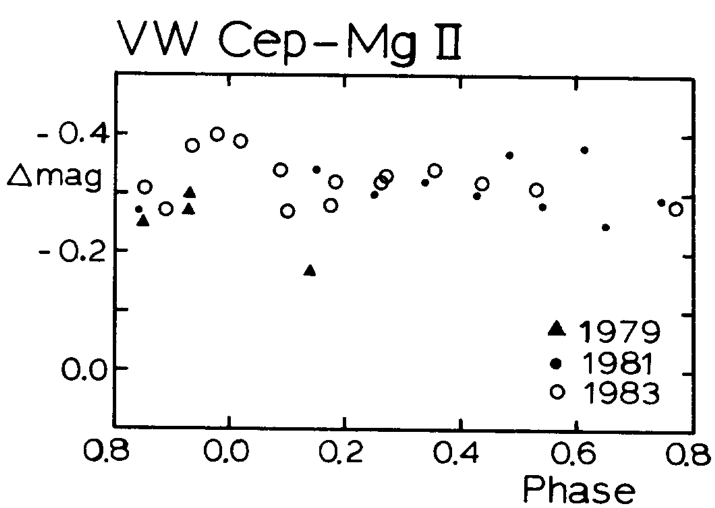

Figure 1. VW Cep: Strength of Mg II emission relative to average brightness of continuum between 2580 and 3200 A. This is roughly a measurement of surface flux in the emission lines. Observations were obtained with the IUE satellite.

observations of II Peg by Marstad et al. yield (MgII-V) = 2.2 for epochs of weak emission. The cooler II Peg [(B-V) = 1.0, vs. 0.87 for VW Cep] has a larger bolometric correction by -0.4 mag, and (MgII-M_{bol}) for the two stars must therefore be equal. Differences in calibration noted, this equality of F(MgII)/F(bol) means that VW Cep is not covered with the very many strong active regions predicted for extensive numbers of starspots. Note also that Vilhu and Ruciński (1983) and Ruciński (1985) find that W UMa binaries are no stronger emitters of Mg II on the average than other late-type rapidly rotating stars.

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LIMITS ON THE VARIABILITY OF EPSILON ERIDANI AND DELTA ERIDANI

The star ε Eri (K2 V) has often been cited as an example of a single K star with moderate chromospheric activity (e.g., Linsky et al. 1978). However, D. S. Hall (1981) has pointed out that, according to the 3rd edition of the Bright Star Catalogue, the star is a 17-day spectroscopic binary. In retrospect this was probably a mistake, since the information has been omitted from the 4th edition of the catalogue, and since the range of radial velocities collected by Abt and Biggs (1972) is less than 2 km/s. Thus with its late spectral type, moderately high chromospheric activity, and purported membership in a binary system, we might expect it to be similar to the RS CVn-type variables (Hall 1976). For this reason we have observed it photometrically on two occasions with the No. 4 16-inch telescope at Kitt Peak National Observatory. HD 22799 (HR 1117) was used as the comparison star; δ Eri as the check star. In 1983 the brightness in the V band of ε Eri was measured on four nights (February 24, 26, 27 and March 9 UT), to give $\Delta V = -2.452 \pm 0.010$. Poor weather conditions during this run resulted in the low precision of the average brightness. In 1984 conditions were better, and the star was observed on 8 nights (in the range September 14-30). Data are being deposited in the IAU Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1979). Magnitude differences are plotted in the top panel of Figure 1. The star appears to have been relatively constant, varying at no more than the 0.01 mag level over this interval, and to have had the same mean brightness as in 1983 ($\Delta V = -2.454 \pm 0.003$).

A further estimate of the constancy of ε Eri is afforded by the photometry of Fisher et al. (1983). They were studying delta Eri (K0 IV) as a possible RS CVn variable (with ε Eri as the comparison star) and found roughly a 2% light variation on a timescale of 10 days. The mean magnitude difference, delta minus epsilon, was $\Delta V = -0.205$. This may be compared with the difference for 1984 since we used δ Eri as a check star. We find $\Delta V = -0.199$ for September 1984, which suggests that both epsilon and delta have been constant to within about 1% in mean brightness over the interval that they were observed. It is also consistent with the photometry given in the 4th edition of the Bright Star Catalogue (Hoffleit and Jaschek 1982) for which $\Delta V = -0.19$. We have plotted the magnitude differences for δ Eri in the lower panel of Figure 1. Again, the star

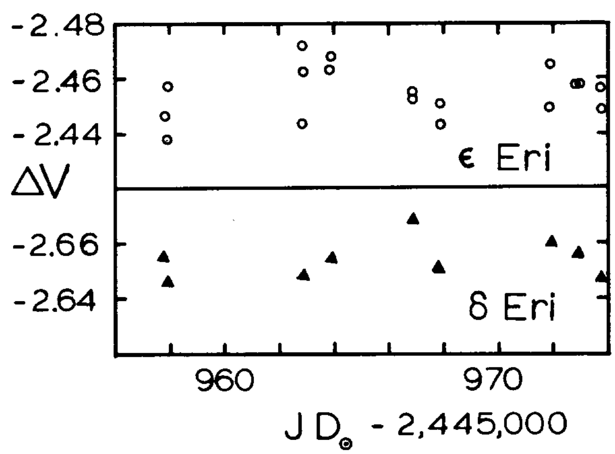

Figure 1. Differential photometry of ε and δ Eridani. In the top panel we plot the visual magnitude difference for ε Eri minus the comparison star for observations obtained in September 1984; in the bottom panel, δ Eri.

appears to have been constant to 1% over the interval and not to have had the 2% variation seen in 1981 by Fisher et alii.

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DRAMATIC CHANGES IN THE POLARIZATION OF AR Pup

AR Pup is supposed to be a carbon rich RV Tauri star of period around 75 days and it shows large infrared excess (Gehrz and Ney 1972). This star is included in our programme of polarization observations of carbon variables and has been observed on three different occasions with the PRL polarimeter (Deshpande et al., 1985) attached to the 40-inch telescope at Kavalur Observatory. Although on these occasions the visual magnitudes were roughly the same (~9.3 mag) there were dramatic changes in the wavelength dependence as well as in the amount of polarization. The position angles also showed large changes.

The observations along with their probable errors are shown in Figure 1. No recent photometric light curves seem to be available for this object for accurately knowing the photometric phases corresponding to these epochs. But from the old photometric data on the observed visual magnitudes, we guess that the polarimetric observations might be outside the minima. The infrared magnitudes of AR Pup are also variable. The JHKL magnitudes obtained with an InSb photometer with the 40-inch reflector in February 1981 are: J=6.94, H=5.27, K=3.61 and L=1.31. Gehrz and Ney (1972) give K=4.37 and L=1.98, quite different from the values observed. But the K-L colours obtained on both these occasions are essentially the same.

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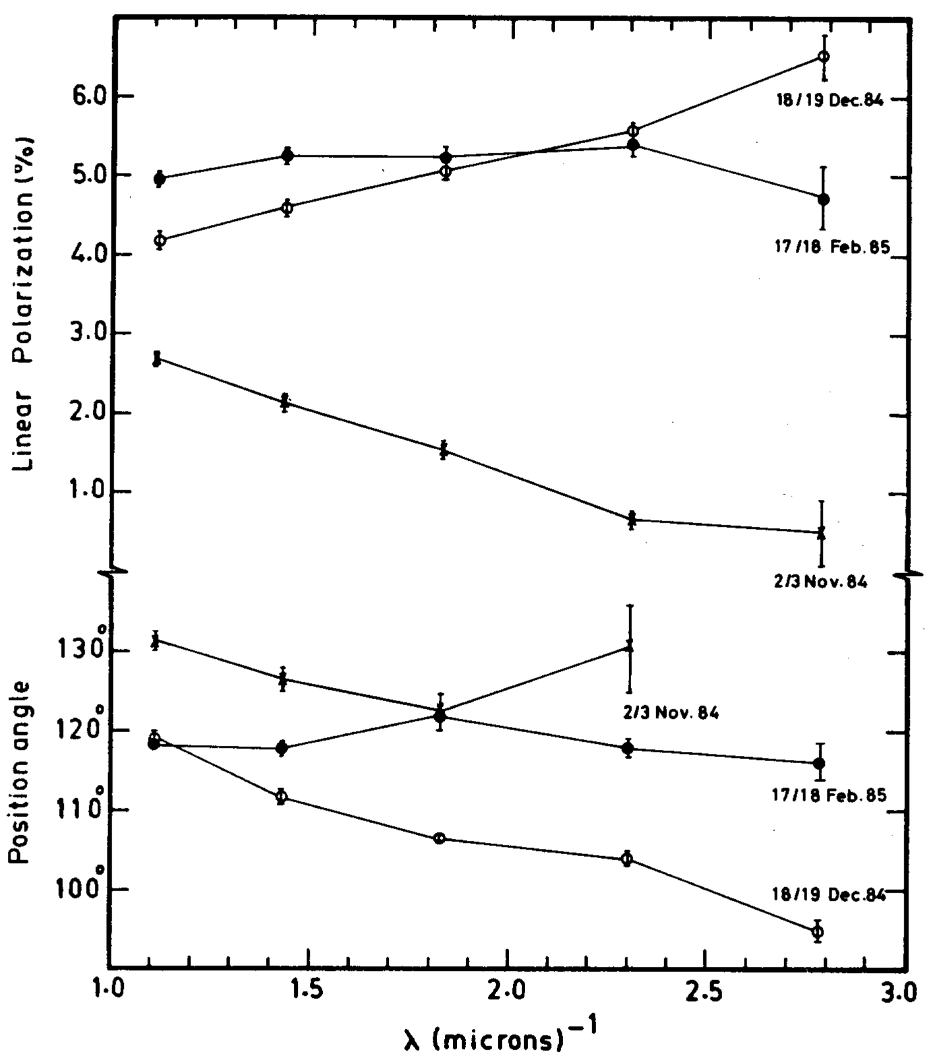
6.0
5.0
4.0
3.0
2.0
1.0
Linear Polarization (%)
18/19 Dec.84
17/18 Feb.85
2/3 Nov.84
130°
120°
110°
100°
Position angle
2/3 Nov.84
17/18 Feb.85
18/19 Dec.84
1.0
1.5
2.0
2.5
3.0
λ (microns)⁻¹

Figure 1

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ON THE CYCLE-LENGTH OF RZ LEONIS

According to Mattei (1985) and Christiani et al. (1985) RZ Leo, which has undergone a nova-like outburst in 1918, erupted again in the last days of 1984; its spectral behaviour suggests a membership of the WZ Sagittae sub-class of dwarf novae. If this classification is accurate, then the object is the dwarf nova with the largest observed interval of 66 years between outbursts. For understanding the physics of the WZ Sagittae phenomenon the true cycle-length of RZ Leo is of great interest. To find an estimate, altogether 1461 plates of the Sonneberg sky patrol, taken by H. Huth and predecessors, of the fields $\alpha = 11^h$, $\delta = -4^\circ$, 0°, and $+10^\circ$ and $\alpha = 12^h$, $\delta = -4^\circ, 0^\circ$, and $+10^\circ$ were inspected for eruptions. The time covered is from 1928 to 1984, with only 1 plate in 1928 and 3 plates in 1938. The limiting magnitudes of the plates are about 12^m to 14^m. But, being in the vicinity of a relatively bright star, RZ Leo could be followed up only to the brightness of 13^m.

In this time interval no certain outburst could be observed. On some plates there are impressions at the very plate limit, their reality, however, cannot be guaranteed. The dates of the plates with a suspected eruption are as follows:

Date			JD	Magnitude	Remarks
1934	Feb.	14	242 7483.541	12??	1
1935	Mar.	25	242 7887.345	12::	
1940	Apr.	6	242 9726.432	13::?	2
1950	Mar.	20	243 3361.487	13::?	3
1952	Apr.	16	243 4119.426	13??	1
	Apr.	17	243 4120.417	13:?	4
1959	Feb.	5	243 6605.556	13	5
1967	Feb.	7	243 9529.611	13.5	6
1976	Mar.	1	244 2839.528	[13	
	Mar.	2	244 2840.475	13??	1
			40.475	13:	7

Remarks

1 very questionable

2 April 7 invisible [13^m

3 March 23 invisible [13^m

4 April 18 and 19 invisible [13^m

Remarks

5 Probably not real (not exactly at the position of RZ Leo)

6 Probably plate fault

7 On two plates of February 29 invisible $[12^m$ and on two plates of March 3 invisible $[13^m$

As can be seen from the table the only observations likely to be real are those from 1935 March 25, 1952 Apr. 17, and 1976 March 2. Provided those 3 dates are positive observations of RZ Leo, then from 1928 to 1984 there occurred 3 eruptions. Taking into account that no plates exist from the months June to September and making the assumption that half of the eruptions could not be detected on account of bad weather or moonlight (so, for example, the eruption of 1984 could not be followed up on Sonneberg plates), one may conclude that the cycle-length of RZ Leo could be as short as 6 years!

To sum up, it can be said that the cycle-length of RZ Leo must be somewhere between 6 and 66 years. The true value of the cycle-length will probably be near the smaller limit because of the relatively small brightness amplitude of about 6 mag.

The table given above is to prompt observers having access to plate collections to confirm the suspected outbursts and search for further ones.

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UBV PHOTOMETRY OF HR 8752

The variable G-type hypergiant HR 8752 (= HD 217476 = V509 Cas) is among the brightest stars in the Galaxy (Humphreys, 1978). Its spectrum has undergone remarkable changes recently (Lambert and Luck, 1978).

We present here photoelectric UBV photometry of this star. The observations were made in 1978-81 and 1984-85 with the 60 cm telescope in Budapest and the 1 m telescope in Piszkestetö, respectively. The star used for comparison was HR 8761, with V = 6.20, B-V = 1.50 and U-B = 1.53 (Argue, 1966). The observations are given in the Table (the magnitude differences are in the sense variable minus comparison).

Table

J.D.	ΔV	Δ(B-V)	Δ(U-B)
2443739.544	-1.327	-0.029	
3797.325	-1.333	-0.011	
3848.210	-1.341	-0.040	
4083.526	-1.399	-0.062	
4113.444	-1.409	-0.138	
4128.340	-1.471	-0.133	
4133.562	-1.471	-0.125	-0.428
4158.431	-1.463	-0.144	-0.364
4166.508	-1.448	-0.145	-0.382
4172.296	-1.454	-0.134	-0.393
4499.565	-1.344	-0.172	-0.433
4511.437	-1.343	-0.175	
4514.385	-1.349	-0.163	-0.473
4541.289	-1.343	-0.142	-0.450
4854.535	-1.317	-0.070	-0.296
5952.458	-1.372	-0.209	-0.522
5957.471	-1.386	-0.224	-0.461
5989.434	-1.365	-0.233	-0.492
5990.358	-1.367	-0.237	-0.553
5990.366	-1.369	-0.227	-0.554

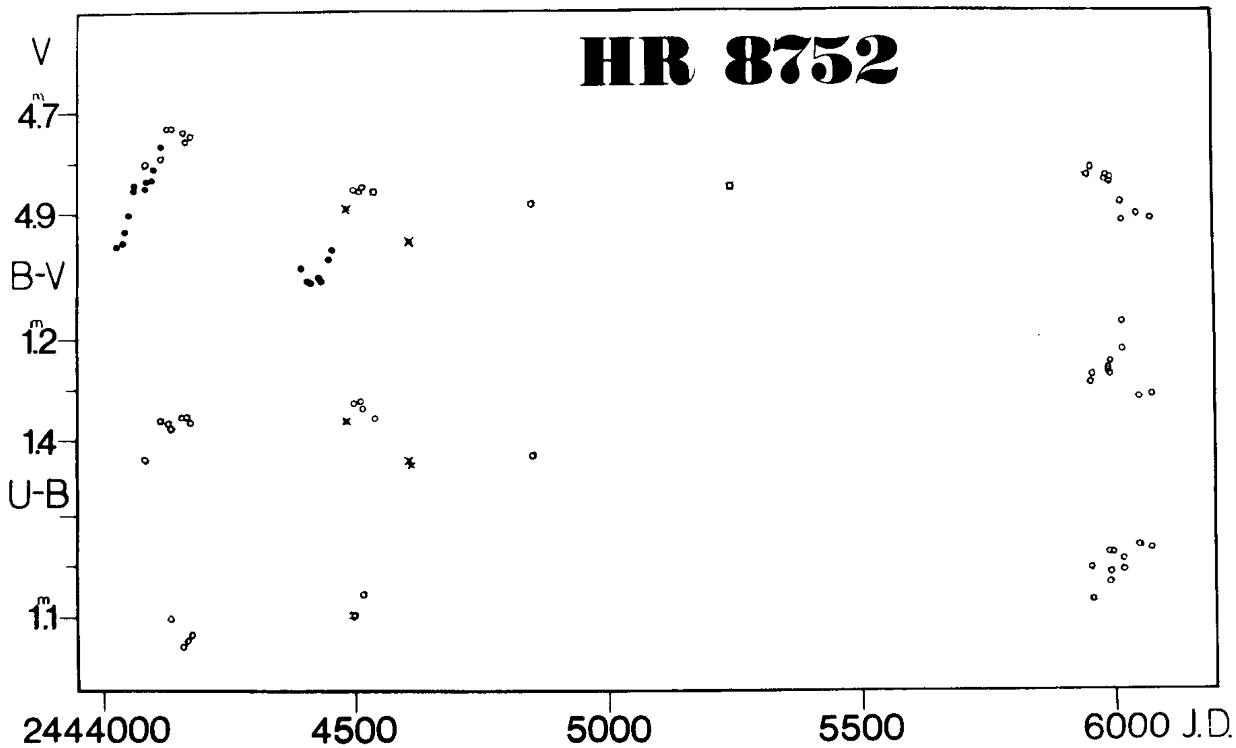

Figure: Light and colour curves of HR 8752 vs. J.D.; Symbols: dots - Percy and Welch(1981), crosses - Parsons and Montemayor(1982), square - Walker (1984), circles - present paper.

Table (cont.)

J.D.	ΔV	Δ(B−V)	Δ(U−B)
5991.373	−1.366	−0.232	−0.554
5993.370	−1.353	−0.249	−0.512
6018.306	−1.321	−0.276	−0.539
6019.245	−1.279	−0.329	−0.510
6049.508	−1.294	−0.179	−0.564
6074.222	−1.288	−0.183	−0.551

The light curve contains points from five cycles from mid-1979. It is, however, evident from the Figure that neither the period (about one year, obtained by Percy and Welch, 1981), nor the amplitude of the variation remains constant.

According to Lambert et al. (1981), HR 8752 has been pulsating. They compared the star with models of long-period variables. The spectrum of HR 8752 shows, however, features characteristic for stars earlier than those. Smolinski et al. (1982) found the shape of the Hα profile to be similar to that in long-period cepheids. Similar phenomenon was observed at the beginning of this century: Adams and Joy (1919) found the spectrum of HR 8752 to be nearly the same as that of δ Cephei and ζ Geminorum.

The pre-1979 behaviour of HR 8752 seems to be quite different. The 1976-78 observations of Walker (1983) and the first three lines in the Table (which are not plotted in the Figure) apparently do not show the same type of variation. It may be in connection with the shell ejected sometime between 1973 and 1975 (Lambert et al., 1981).

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FS Lup

VARIABLE STAR TYPE EA OR EB?*

The star FS Lup was detected by Hoffmeister (1963) and first listed under number S7620. It has been referred to as a variable of type EA, its brightness ranging between 11.5 - 12.5 (photographic).

The equatorial and galactic coordinates of this star are:

$\alpha = 14^h\ 48^m\ 45^s$ (1950.0) $l = 321\overset{\circ}{.}36$

$\delta = -51°\ 13\overset{'}{.}3$ $b = +\ 7\overset{\circ}{.}07$

Figure 1 reproduces the identification chart.

Until now FS Lup has not been put under systematic observation so as to confirm or refute its type of variability or determine the graph of its light curve so that the period of variation of its brightness could be defined (Kholopov, 1985).

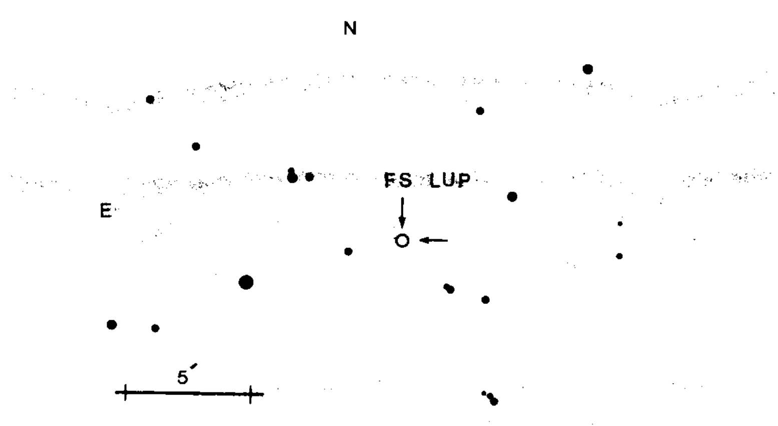

Figure 1.Finding chart (in B) for the variable star FS Lup

* based on observations collected at ESO/LA SILLA, CHILE.

In Table I we mention the periods of observation and the means of investigation.

Table I

Period	Telescope	No of nights	Photometry	Observer
May 1982	T61cm, Bochum/ESO	5	U.B.V.	TERZAN, A.
May 1983	T61cm, Bochum/ESO	3	U.B.V.	TERZAN, A.
June 1984	T1m / ESO	4	U.B.V.	DIDELON, P.

The light curve in V (Figure 2) resulting from the collection of all the observational data in one single phase seems to point out that star FS Lup is more likely to be an eclipsing variable star of type EB, not EA.

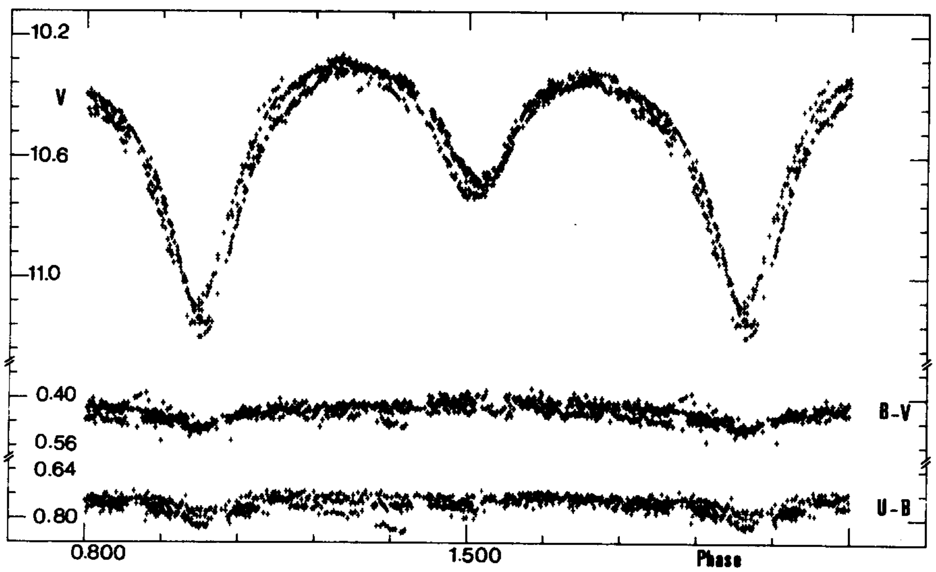

Figure 2. Light curves V, B − V, U − B for the variable star FS Lup

The ephemeris of the variation of its brightness is:

$$P_{JJ_{\odot}} = 2\ 445\ 108^{d}.56035 + 0^{d}.3813973.E.$$
$$\pm 5$$

with amplitude about 1 mag_V and depth of the secondary minimum in the order of 0.5 mag_V.

Besides, we note that the period $P_{JJ_{\dot{0}}}$, graphed between two principal maxima varies very little (± $0^d.0000005.\dot{P}$). It is relatively short ($0^d.3813973$) for a star type EB.

In fact, the histogram graphed by Petit(1982) after the data collected from the "General Catalogue of Variable Stars" (Kukarkin et al., 1969) on the eclipsing variable stars type EA and EB points out that the number of EA or EB with a period inferior to $0^d.4$ does not exceed 5.

The determination of other different parameters as well as the discussion on the variability of the period of this star will be the aim of our further research.

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CD $-30^{\circ}5135$

Further photographic UBV magnitudes have been measured for this peculiar, variable emission-line F supergiant on plates taken by Dr. B. Pettersson with the Uppsala Southern Station Schmidt telescope at Siding Spring Observatory, Australia. The results are, with an estimated error of ± 0.1 mag.:

Date	V	B	U
17 Nov. 1984	9.3	10.2	11.0
20 Dec. 1984	9.1	9.8	10.6
28 Dec. 1984	9.1	9.9	10.7

These results support the earlier finding (Welin 1981) that the colours of the star are not directly related to its brightness.

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Reference:
Welin, G. 1981, Inf. Bull. Var. Stars No. 1940

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PHOTOMETRIC BEHAVIOR OF HR 8752 = V509 Cas

One of the most luminous of all galactic stars, the supergiant HR 8752 is a known light and spectrum variable. The spectral type has been observed to change from G0 Ia in 1950 to G5 in 1970 (Keenan, 1971) to K2-5 Ia in 1973 and finally to late F by 1977 (Lambert and Luck, 1978). Evidence for a hotter companion (approximate spectral type B1 V) was found in IUE low resolution spectra by Strickland and Harmer (1978). Shorter term variations in various spectral features have been reported by various observers (e.g., Smolinski et al., 1979 and Barden and Ramsey, 1980).

Photometrically, the star varies in V and (B-V) magnitudes in a manner which appears to be uncorrelated with the spectral changes. The previous photometric behavior is well summarized by Walker (1983). Briefly, the star has been found to slowly vary in an irregular fashion from V = 4.6 to 5.4 and in (B-V) from +1.29 to 1.73. Shorter variations on the time scale of days are not ruled out.

HR 8752 was observed on 22 nights during July, 1984 to February, 1985 in B and V magnitudes with the 0.6-m telescope of the Corralitos Observatory. The single channel photon-counting photometer is equipped with an uncooled EMI 9924A photomultiplier tube. Comparison stars were HR 8761 (V = 6.20; B-V = +1.50) and HR 8778 (V = 6.43; B-V = +0.90). The observations were corrected for extinction and converted to BV magnitudes by observations of standard stars. Standard errors for the comparison stars of ± 0.01 in both ΔV and Δ(B-V) for each night's observations were noted.

Table I

JD (2440000+)	V	(B-V)	JD (2440000+)	V	(B-V)
5911.9045	4.86	+1.35	6025.6938	4.88	+1.31
5939.7865	4.81	1.32	6029.6028	4.89	1.32
5957.7778	4.81	1.33	6031.5931	4.88	1.33
5959.8042	4.82	1.32	6034.6069	4.90	1.33
5961.7111	4.82	1.33	6050.6201	4.90	1.38
5962.7802	4.82	1.32	6082.5951	4.91	1.37
5964.7243	4.83	1.28	6083.5878	4.93	1.39
5967.7049	4.82	1.30	6084.6024	4.94	1.37
5985.6639	4.83	1.31	6085.5990	4.94	1.37
6009.6368	4.86	1.30	6101.5854	4.97	1.38
6012.6170	4.87	1.31	6102.6066	4.98	1.38

Over the period in question, HR 8752 was found to vary in a smooth fashion from a maximum of V = 4.81 to a minimum of 4.98 and in (B-V) from +1.28 to +1.39. Figure 1 shows these changes and Table I their values. The variation in (B-V) appears to approximately follow the V magnitudes.

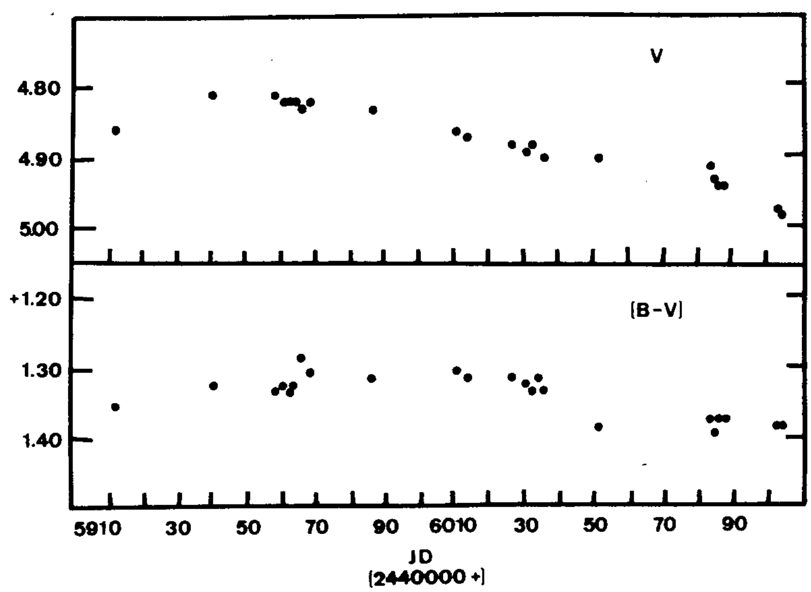

Figure 1: Variations in V and (B-V) magnitudes for HR 8752 = V509 Cas.

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NO CEPHEID-LIKE VARIABILITY IN SAO 096478 = NSV 03374

SAO 096478 (9.2, KO) is the star designed as "O" in the C4 Harvard Standard Region. Its variability was suspected by Balz Jr. and Vyssotsky(1958) : "Both the photographic and photovisual magnitudes of this star show larger than average residuals (...). The star is probably a Cepheid". The spectrum varies from F5 to KO (Balz Jr. and Vyssotsky and references therein). The star is named NSV 03374 as a suspected variable (Kholopov, 1982).

Taking into account the wide spectral variation, a period longer than 15 d and an amplitude of about 1.0 mag. is expected from a classical Cepheid, but a first contradiction arises from the G5 V spectrum recorded by Nassau and Mac Rae (1955).

Such an amplitude is large enough to allow detection by a visual observer: a tentative visual survey conducted by one of us (Le Borgne, 1983) during 1983 spring failed to show evidence of any significant variation (probable error : 0.2 mag.) discouraging further visual monitoring on larger scale by GEOS observers.

In order to have a definitive answer, NSV 03374 was photoelectrically observed in 7 nights with the 50 cm telescope of Merate Observatory, in a program concerning the study of variable stars of intermediate and late spectral type.

SAO 096482 (8.5, KO) was used as comparison star, SAO 096459 (9.2, G5) as check star. The integration time was set to 20 sec. Table I shows ΔV values in the sense 'comparison minus variable' ; σ is the standard error. If any, the variation is smaller than 0.02 mag., but NSV 03374 is probably constant since the same scatter is observed for the check star.

The puzzle of the spectral variation cannot be solved with a simple misidentification, because SAO 096469 (9.1, F5) and SAO 096494 (9.3, F5) are 30' northern to NSV 03374. In any case, the spectral features are not typical of a Cepheid (or SRd) variable or of an RS CVn activity.

Acknowledgements : thanks are due to Dr. A.Figer for advice about visual results.

Table I

ΔV values for NSV 03374 and the check star

	NSV 03374		SAO 096459	
JD	ΔV	σ	ΔV	σ
46069.44	−0.867	0.006	–	
46095.50	−0.872	0.008	−0.942	0.008
46096.43	−0.849	0.006	−0.929	0.007
46116.47	−0.882	0.007	−0.951	0.006
46118.34	−0.854	0.013	−0.933	0.006
46119.35	−0.857	0.007	−0.915	0.006
46144.36	−0.863	0.006	−0.936	0.007

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PHOTOELECTRIC OBSERVATIONS OF PW Vul

A set of photoelectric observations of Nova Vul 1984. No. 1 (now designed as PW Vul) was carried out at the University Observatory in Brno on 4 nights during August - September 1984. The observations were made with the 60 cm reflector and photoelectric photometer equipped with UBV filters and EMI 6256S photomultiplier. The data of the comparison stars are given in Table I. The UBV data of all comparison stars were derived in the usual way from UBV standards near PW Vul. From our measurements it follows that all these comparisons are constant.

Table I

Object	BD	SAO	V	B-V	U-B
Comparison star A	$+27^{\circ}3391$	87213	7.460	+0.550	-0.040
Comparison star B	$+27^{\circ}3400$	87257	8.987	+0.153	-0.158
Comparison star C	$+27^{\circ}3390$	87211	9.675	+0.210	-0.325

The mean errors of the photometry are 0.007 mag for comparisons A and B, and 0.011 mag for comparison C, respectively.

The Nova PW Vul was measured differentially to comparison A. The means of individual observations were grouped into normal points and are listed in Table II. Our measurements in V colour are plotted in Figure 1 , where other published UBV observations are plotted too.

From Figure 1 it is clear that after the first outburst the brightness of PW Vul changed with an amplitude of about 1.5 mag on the time scale 6-7 days.

Individual observations in V colour (on the night 28/29.8) are plotted in Figure 2. Two different changes in brightness are present here:

1. small fluctuations in the range 0.03-0.04 mag during 5-6 minutes
2. changes in the range 0.15-0.20 mag during 2-3 hours (observed by Noskova (1984) and Schult (1984), too).

The character of the light variations in B and U colours is the same as in V.

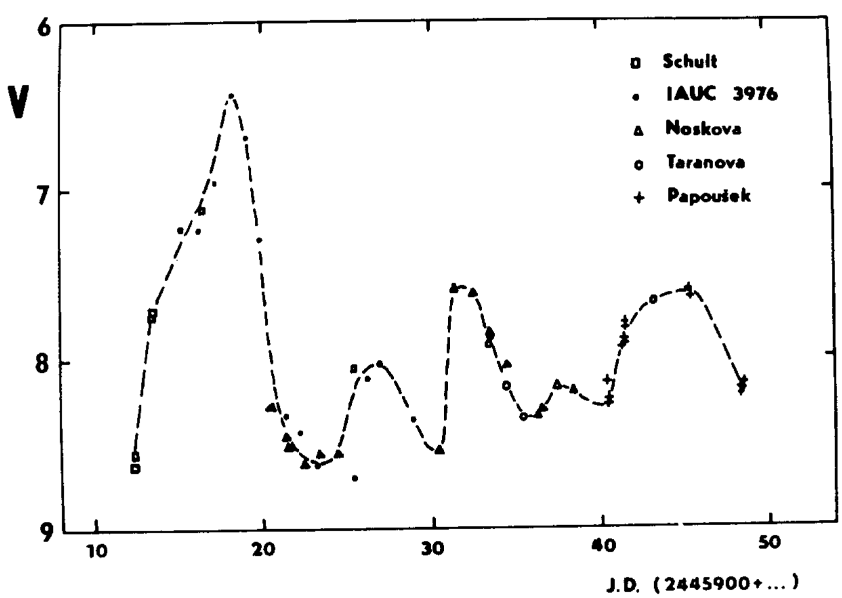

Figure 1
The light curve of PW Vul in V colour

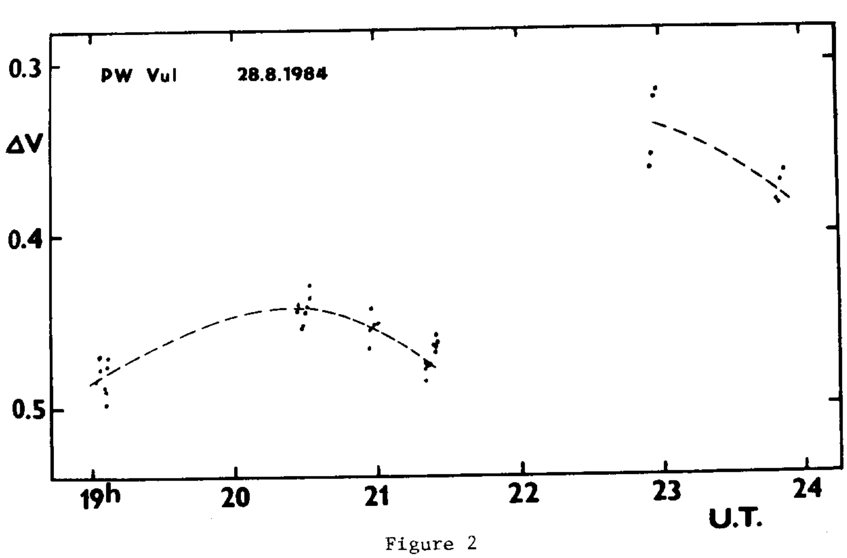

Figure 2
The light changes of PW Vul during one observational night

Table II

J.D. 2440000+	V	B−V	U−B	N
5940.384	8.146	+0.543	−0.476	13
.392	8.265	−	−	14
.411	8.257	+0.431	−	22
5941.299	7.931	+0.410	−0.544	27
.361	7.898	+0.413	−0.540	32
.375	7.902	−	−	5
.396	7.927	+0.404	−0.551	21
.433	7.912	−	−	7
.453	7.789	+0.422	−0.493	15
.489	7.818	+0.406	−0.514	14
5945.299	7.605	+0.430	−0.512	21
.325	7.643	+0.444	−	17
.333	7.643	−	−	9
5948.299	8.178	+0.375	−0.550	34
.317	8.214	+0.356	−	18
.371	8.182	+0.370	−0.600	26
.442	8.160	+0.361	−0.570	22

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PHOTOMETRIC OBSERVATIONS OF THE RS CVn BINARY σ Cr B

The bright component (HD 146361) of the visual binary σ Cr B (ADS 9979 AB) is a double - line spectroscopic binary with period of 1.14 day (Batten et al., 1978) which has all the characteristics of an RS CVn system. It shows intense chromospheric, transition region and coronal activity as seen in the optical, UV and X-ray bands (Young and Koniges 1977, Tarafdar and Agrawal 1984, Agrawal et al. 1980). Bopp (1984) has recently concluded that σ Cr B is the most chromospherically active main-sequence system once observed.

Based on their photometric observations Skillman and Hall (1978) concluded the presence of a wave-like distortion with an amplitude of $0\overset{m}{.}05$ (V) with a minimum at 0.4 phase. They also found evidence for a short-time variability similar to that of δ Scuti type stars superposed on the distortion wave. In order to verify this result we carried out photometric observations of this system with the 1.2 m telescope of Japal-Rangapur Observatory in the UBV bands during 1981 and 1982 using 20 arc second diaphragm.

We observed this system on 11 nights in UBV passbands and used HR 6043 and HR 6108 as comparison and check stars, respectively. The photometric equipment, method of observations and the reduction techniques employed for deriving Δ m (variable minus comparison) have been described in a previous paper (Vivekananda Rao and Sarma, 1983). The r.m.s. error of Δ m (check minus comparison) was found to be $\sim 0\overset{m}{.}02$ in UBV passbands indicating that the comparison star is constant in brightness during the period of observations within these limits. The phases of observations are calculated using the following ephemeris given by Tanner (1949).

$$JD\ (Hel) = 2423869.105 + 1\overset{d}{.}139789E$$

Figure 1 shows the plot of Δm versus phase for the observations obtained in the UBV passbands. Unfortunately our observations do not cover the phase range 0.45 to 0.75. Due to this gap in the light curves, no firm conclusion regarding the presence of a wave-like distortion in this system can be made. However, from the remaining phase coverage (0.00 to 0.20, 0.30, 0.45 and 0.75 to 0.00) we conclude that within the limits of observational errors σ Cr B is nearly constant in brightness in each of the three passbands.

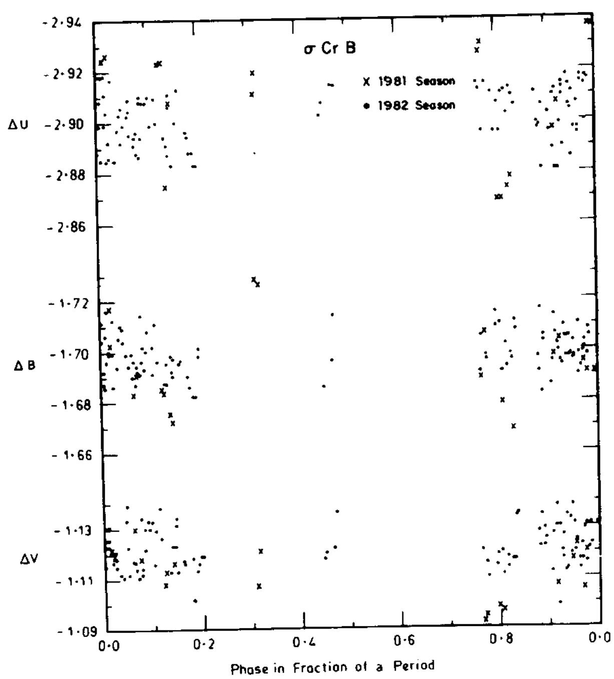

Figure 1: Observed values of Δm in UBV bands plotted as a function of binary phase using the ephemeris of Tanner (1949)

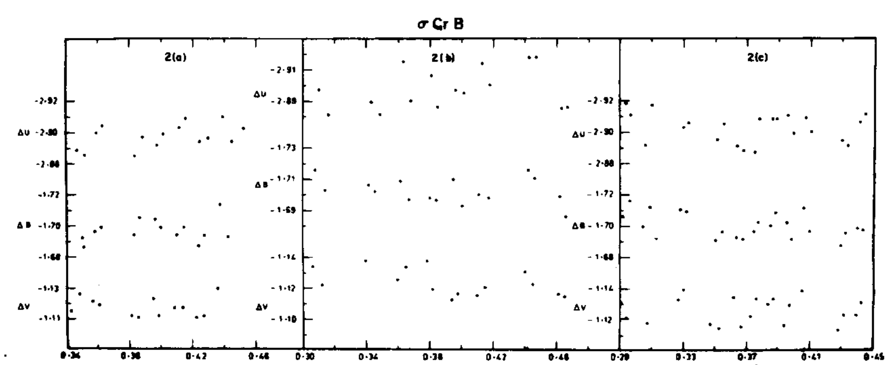

Figure 2: Photometric data in UBV bands for three of the nights.

To determine the nature and periodicity of the δ Scuti type variability if any, we have monitored this system on a few nights for more than 2.5 hrs. continuously. These observations are shown in Figure 2(a)- 2(c) for 3 of the nights. From these figures it is very clear that σ Cr B does not exhibit any δ Scuti type variability of period 0.1 day except for a small scatter which is comparable to the spread in the (check minus comparison) observations. Skillman and Hall (1978) suggested the possibility of the comparison star being the source of variations in σ Cr B. They could not confirm this in the absence of a check star. However, during the present observations, we used the same star for comparison (HR 6043) as was used by Skillman and Hall (1978) along with a suitable check star (HR 6108). From our (check minus comparison) star observations it was found that the comparison star used by us and Skillman and Hall (1978) was constant in brightness within the limits of observational errors ($\pm 0\overset{m}{.}02$). Hence, the suspicion of Skillman and Hall (1978) about the possible variable nature of the comparison star is not confirmed by our observations. We conclude by stating that there is no indication of any δ Scuti type variations in our observations of σ Cr B.

We, however, suggest that further photoelectric observations of σ Cr B with small diaphragms should be made to study the variable nature of HD 146361. Such observations obtained over long periods will be valuable in interpreting the distortion wave properties of HD 146 361 and its similarity to other members of the RS CVn group.

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ANALYSIS OF THE NON-VARIABILITY IN THE 78-DAY BINARY HR 503

Lloyd Evans (1977) listed 24 binary systems containing giant stars that have periods short enough for the components to interact tidally. Of these, most with periods shorter than 40 days appear to be RS CVn binaries (Hall 1976), with enhanced surface activity resulting from tidally forced synchronous rotation. Others are clearly Algol systems with the less massive component filling its Roche lobe. Examples are RZ Cnc and AR Mon (Popper 1976), possibly also AL Vel (Wesselink 1963). The rest represent a fertile and, as yet, little explored field for studies of binary star evolution: systems with giant stars that are just beginning to initiate mass exchange or which will soon begin to do it. Depending on their masses and mass ratios, these binaries can be identified by the tidal distortion of the brighter member. A good example not included in Lloyd Evans' list is 5 Ceti, whose ellipsoidal light variation has been detected by Lines and Hall (1981). Another is HD 207739 for which ellipsoidal variation was found by Bloomer (1984).

Because of its similarity to 5 Ceti in period, spectral type, and radial-velocity variations (Northcott 1949), HR 503 (G8 III-IV, V = 6.31) might be expected to have the properties of this group. Consequently we have observed it photometrically on 109 nights at two observatories, obtaining 135 differential measurements. Most of the data were obtained at Fairborn Observatory (UBV) over a period of more than a year with an automatic photometric telescope (Boyd, Genet, and Hall 1984). In addition, Eaton observed it over an interval of two weeks at Kitt Peak National Observatory (BVRI -- Cape R and I bands) with the No. 4 16-inch telescope, obtaining 16 data on 8 nights.

The colors of HR 503 are as follows: (U-B) = 0.47, (B-V) = 0.89, $(V-R)_C$ = 0.47, and $(V-I)_C$ = 0.90. The colors do not match the G8 III spectral type especially well; rather they correspond to G4 III or K1 V on the standard relations of Johnson (1966). The brightness was essentially constant over the period of observation, as is apparent from Figure 1. Fourier analysis of the photometry on the 78.0073-day period of the orbit shows that ellipsoidal variation ($\cos 2\theta$ and $\sin 2\theta$ terms) was less than 0.2%; RS CVn-type wave distortion ($\cos\theta$ and $\sin\theta$ terms), less than 0.2%. The system was 0.521 mag fainter in V than the comparison star (HR 523) used at Fairborn Observatory.

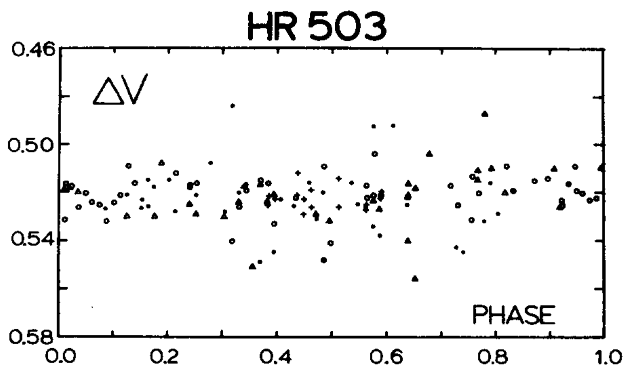

Figure 1. Differential photometry of HR 503 for the period JD 2,445,700 – JD 2,446,126. Plotted are magnitude differences, HR 503 minus HR 523. Phases have been computed with the spectoscopic ephemeris, $JD_{\odot}$(observed) = 2,431,730.5489 + 78.0073Phase (Northcott 1949). Data for three orbital cycles and for the two observatories are indicated with different symbols: dots for data before JD 2,445,757 (Fairborn Observatory), circles for data between JD 2,445,757 and JD 2,446,045 (Fairborn), triangles for data after JD 2,446,050 (Fairborn), and plusses for Eaton's Kitt Peak data between JD 2,445,957 and JD 2,445,974.

The colors, mass function, and low photometric variability of the star place stringent limits on the properties of the system. Since the radial velocity amplitude is fairly large (K_1 = 20.1 km/s –– Northcott 1949) for a 78-day binary, and since the system does not eclipse, the inclination cannot be extreme in either sense. We will assume that it has its most likely value, $i \approx 60°$. The lack of strong ellipsoidal variation requires the mass ratio to be fairly small, q ≈ 0.5–0.33. On the other hand, if q < 0.33, the masses become uncomfortably large for reasonable values of the inclination. A best estimate, then, is q = 0.4 ± 0.1, for which $R_1/a \leq 0.12$ to give the observed ellipticity. The radius of the G8 star is thus $R_1 \approx 13\ R_{\odot}$, consistent with its III-IV luminosity type. We thus have a system containing a 2.7 $M_{\odot}$ giant and a 1.2 $M_{\odot}$ dwarf. The position of the giant in the theoretical H-R diagram of Iben (1967) is consistent with this mass. The G giant will contribute roughly ten times as much light at V as a 1.2 $M_{\odot}$ F dwarf, and a combination of F5 V and G8 III stars with this light ratio and the intrinsic colors given by Johnson (1966) reproduces the observed colors of the system quite well. All colors agree to within 0.02 mag, except (U–B) where the agreement is a respectable 0.10 mag. The Roche lobe radius is large enough that the G giant could have already evolved through helium flash without initiating mass transfer.

The near constancy of HR 503 allows us to make an unbiased estimate of the quality of data coming from the automatic photometry program. Residuals of the Fairborn Observatory V-band data from the fitted curve in the Fourier analysis showed roughly a bimodal distribution, 85% of the data giving a roughly normal distribution with $\sigma = 0.006$ mag. The other 15% of the data formed a more extended distribution and probably represent nights that were not photometric. This degree of accuracy is comparable to the 0.004 mag shown by Eaton's data from the Kitt Peak 16-inch.

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PHOTOELECTRIC OBSERVATIONS OF γ Cas, X Per AND BU Tau

The three variable stars have been observed in the U, B, V - bands with a 165/1430 Newtonian telescope and a 1P21 PMT.

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
5962.346	2.23	6018.275	2.21
5975.358	2.21	6034.250	2.20
5990.271	2.20	6054.263	2.20
5991.275	2.19	6102.267	2.19
6002.250	2.18	6115.279	2.20
6005.300	2.18	6116.250	2.20
6006.263	2.18	6128.275	2.20
6017.271	2.15		

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
5621.321	6.37	+0.25	
5638.279	6.31		
5645.250	6.38	+0.27	
5647.254	6.37	+0.27	
5648.279	6.51:		
5651.279	6.43:	+0.20	
5663.229	6.32	+0.28	
5673.308	6.40	+0.23	
5683.258	6.42		
5691.250	6.48	+0.16	
5703.281	6.47		
5705.271	6.51		
5757.275	6.36:		
5759.283	6.40	+0.21	
5778.304	6.43	+0.20	
5780.292	6.35	+0.31	
5975.333	6.33	+0.27	-0.71

Hel. J. D. 2440000+	V	B-V	U-B
5994.304	6.43	+0.32:	
6005.292	6.43	+0.29	
6018.271	6.57	+0.31	-0.87
6034.263	6.58	+0.20	-0.80
6037.208	6.52	+0.14	
6054.292	6.53	+0.18	-0.71
6082.271	6.62		
6090.300	6.60	+0.19	-0.78
6094.217	6.60		
6095.263	6.62		
6100.279	6.65	+0.10	
6108.271	6.59	+0.19	
6109.279	6.61	+0.12	
6116.275	6.59	+0.12	
6128.271	6.57		
6138.296	6.78:		
6148.321	6.58	+0.15	-0.76
6149.350	6.57	+0.20	-0.81

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	U-B
5975.238	5.26		
6005.271	5.17		
6018.292	5.13		
6034.238	5.19	-0.13	-0.17
6037.250	5.18	-0.13	
6054.383	5.20	-0.14	-0.21
6082.250	5.12		
6090.271	5.09	-0.04:	
6095.258	5.10	-0.02	
6109.279	5.13		
6116.263	5.09	-0.01	
6128.271	5.17	-0.11	
6138.300	5.13		
6148.321	5.11		

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SPECTRA OF 10 SYMBIOTIC STARS

The spectra were obtained in July and October 1982 using the D spectrograph at the Cassegrain focus of the 80 cm telescope at the Observatoire de Haute Provence. The spectra have a dispersion of 93 Å/mm for Hγ. The spectrograph is equipped with an RCA tube, and the spectra were recorded on heated Kodak IIaO plates in the region λ 3600 - 5200 Å.

The exposure time for any given star in October was about twice as long as that used in July. We observed AG Peg, AG Dra and HBV 475 on 18th July 1982 only, AX Per and EG And on 26th October and MWC17 on 27th October 1982. The stars HM Sge, V 1016 Cyg, CI Cyg and Z And were observed both in July and in October using exposure times of the order of 30 minutes and 1½ hours.

The principal emission lines, together with the absorption bands which we detected in the ten spectra of symbiotic stars are presented in Tables I and II. Spectrophotometric analysis of these emissions and absorptions has yet to be performed.

HM Sge, V1016 Cyg : Have similar spectra both in July and October 1982. The emission lines associated with these stars have already been identified by Mammano and Ciatti (1975).

HBV 475 : We found fewer emission lines than in the two above mentioned stars. The forbidden lines are fewer in number.

AX Per, AG Peg : These two stars have some features in common but only AG Peg has FeII and [FeII] lines in emission.

Z And : On the date of our observations the [OIII] nebular lines did not appear, whilst the TiO bands appeared stronger in July.

Table I

Emission lines in 1982 for 10 Symbiotic stars

λ (Å)	Elements	Identification of lines in these stars
3587	He I(31)+[Fe VII] (3F)	V 1016 Cyg.
3784	H_{13}	V 1016 Cyg, Z And (Oct.), AG Peg.
3760	[Fe VII] (3F)	V 1016 Cyg, HM Sge, AX Per, Z And, AG Peg, CI Cyg, HBV 475.
3770	H_{11}	HM Sge, V 1016 Cyg, AG Peg, detectable in CI Cyg (July) and Z And (October)
3798	H_{10}	HM Sge, V 1016 Cyg, Z And, AG Peg and detectable in AX Per.
3835	H_9	HM Sge, V 1016 Cyg, HBV 475, AG Peg, Z And, AX Per.
3869	[Ne III] (1F)	HM Sge, V 1016 Cyg, CI Cyg, AX Per, very weak in AG Peg.
3889	H_8 + HeI (2)	Strong in the stars, weak in AG Dra, absent in EG And.
3970	H_ϵ + [Ne III]+Ca II	Strong in the stars, detectable in AG Dra, absent in EG And.
4026	He I (18)	HM Sge, V 1016 Cyg, HBV 475, Z And, AG Peg, very weak in AX Per.
4045	Hg	Atmospheric.
4069	[SII] (1F)	HM Sge, V 1016 Cyg, MWC 17, CI Cyg (Oct.)
4076	[SII] (1F)	HM Sge, V 1016 Cyg.
4102	H_δ	Present in the stars, except EG And,
4121	He I (16)	Z And (Oct.), AG Peg.

Table I(cont.)

4144	He I (53)	AG Peg, Z And (Oct.)
4179	Fe II (28)	V 1016 Cyg, HBV 475, Z And, AG Peg, HM Sge.
4200	He II (3)	V 1016 Cyg, HBV 475, Z And.
4233	Fe II (27)	V 1016 Cyg, Z And, HBV 475, MWC 17.
4244	[Fe II] (21F)	V 1016, Z And (July), MWC 17.
4276	[Fe II] (7F)	V 1016 Cyg.
4287	[Fe II] (7F)	V 1016 Cyg, MWC 17.
4340	$H\gamma$	in each star except EG And.
4359	[Fe II] (21F) + (7F)	MWC 17.
4363	[O III] (2F)	HM Sge, CI Cyg, V 1016 Cyg, HBV 475, AX Per, AG Peg.
4388	He I (51)	AG Peg, Z And, HBV 475, CI Cyg (July) and detectable in AX Per.
4415	[Fe II] (6F)	V 1016 Cyg, HM Sge, HBV 475, Z And, MWC 17, AG Peg.
4471	He I (14)	HM Sge, V 1016 Cyg, HBV 475, AG Peg, Z And, CI Cyg, AX Per, MWC 17.
4491	Fe II (37)	V 1016 Cyg, Z And, HBV 475, MWC 17.
4573	[Fe III] (3F)	HM Sge, V 1016 Cyg.
4583	Fe II (37) + (38)	HBV 475, Z And, MWC 17, V 1016 Cyg, AG Peg.
4629	Fe II (37)	MWC 17.
4634	N III (2)	HM Sge, V 1016 Cyg, HBV 475, CI Cyg, stronger in July, Z And, AG Peg, detectable in AX Per.
4640		
4650	C III (1)	CI Cyg (July), HBV 475.
4658	[Fe III] (3F)	HM Sge, V 1016 Cyg, MWC 17.
4686	He II (1)	V 1016 Cyg, HM Sge, HBV 475, AG Peg, Z And, AX Per, CI Cyg stronger in July, AG Dra.
4701	[Fe III] (3F)	V 1016 Cyg, HM Sge.

Table I (cont.)

4713	[Ne IV]+[A IV] (1F)	HM Sge, V 1016 Cyg.
4713	He I (12)	HBV 475, Z And (Oct.), AG Peg, AX Per, CI Cyg stronger in July.
4725	[Ne IV] (1F)	HM Sge, V 1016 Cyg, AX Per.
4740	[A IV](1F)	HM Sge, V 1016 Cyg.
4815	[Fe II] (20F)	V 1016 Cyg.
4861	H_β	in each star including EG And.
4893	[Fe VII] (2F)	V 1016 Cyg.
4906	[Fe IV]+[Fe II](20F)	V 1016 Cyg, HM Sge.
4922	He I (48)	HBV 475, V 1016 Cyg, HM Sge, CI Cyg (July) Z And, AG Peg, AX Per, very weak in AG Dra.
4922	Fe II (42)	MWC 17.
4942	[Fe VII] (2F)	V 1016 Cyg, HBV 475.
4959	[O III] (1F)	HM Sge, V 1016 Cyg, HBV 475, CI Cyg in July and October.
4969	[Fe VI] (2F)	HM Sge, V 1016 Cyg.
4989	[Fe VII] (2F)	V 1016 Cyg.
5007	[O III] (1F)	HM Sge, V 1016 Cyg, HBV 475, CI Cyg, AG Peg, MWC 17, AX Per.
5015	He I (4)	HBV 475, CI Cyg (July), Z And, AG Peg, AG Dra.
	He I (4)+Fe II (42)	MWC 17.
5146	[Fe VI] (2F)	HM Sge, V 1016 Cyg.
5158	[Fe VII](2F)	V 1016 Cyg.
5177	[Fe VI] (2F)	HM Sge, V 1016 Cyg.

Table II

Absorption lines and bands in 1982 for 10 symbiotic stars

λ(Å)	Elements	Identification of lines and bands in these stars
4227	Ca I (2)	EG And, AX Per, Z And (July), CI Cyg, stronger in October but wider in July.
3933	Ca II (1)	HM Sge (Oct.), V 1016 Cyg (Oct.), AG Dra, MWC 17.
5166	Ti O (0-0)	EG And, Z And stronger in July, HBV 475.
4955	Ti O (1-0)	EG And, Z And stronger in July, AX Per, HBV 475.
4762	Ti O (2-0)	EG And, AX Per, Z And stronger in July CI Cyg, discernible in AG Peg.
4588	Ti O (3-0)	EG And, Z And stronger in July scarcely discernible in October, CI Cyg, HBV 475 discernible.
4462	Ti O (4-0)	EG And, AX Per, perhaps in Z And (July).
4808	Ti O (3-1)	EG And, AX Per, CI Cyg, Z And, stronger in July, discernible in AG Peg.
4300	CH (0-0)	EG And, MWC 17, AG Dra, AG Peg.

MWC 17 : Many FeII and [FeII] lines were seen from this star, HeII was absent.

AG Dra : Few lines were seen, except for HI, HeI and HeII.

EG And : The extremely weak emission spectrum is characterised only by Hβ. In contrast, the absorption spectrum is very rich.

CI Cyg : There were notable differences between the spectra obtained in July and October. The spectrum taken on 26^{th} October 82 coincides with the eclipse of the hot star in the system, (Gunther and Schweitzer, 1983). The HeII line was much less intense in October than in July despite the fact that the October exposure was three times longer. In October, the nebular CIII line did not appear in the spectrum, nor did the singlet lines of HeI at 5015, 4922 and 4388 Å.

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THE DETECTION OF RAPID VARIABILITY IN HR 5156

The F3Vp star HR 5156 (HD 119288, SAO 120075; V=5.88) was monitored photometrically for a total of 6.2 hours during four nights between 11/12 and 15/16 February 1985, as part of a search for rapid oscillations among peculiar stars with spectral types from late A to early F. Low-amplitude light variations with periods near 17 and 24 minutes were detected in this star.

The rapid photometry - a series of continuous 20-second integrations through a Johnson B filter - was performed by one of the authors (JMM) using the 0.9 m telescope and photometer of the Cerro Tololo Inter-American Observatory. Because the programme star was being monitored for periods as short as one minute, a comparison star could not be used for these observations. Although this means that there is no compensation for random changes in sky transparency in the data, such changes should be slow and random enough on nights of good quality that they will not interfere with the identification of rapid periodic variations in the star. This technique of rapid photometry has already been successful in the discovery and study of the rapidly oscillating Ap stars (e.g. Kurtz 1982, Weiss 1983).

On the first night that HR 5156 was observed, there were indications in the raw photometry of regular variations with a period near 16-18 minutes and an amplitude just above the noise level of the measurements. As a result, the star was reobserved on three more nights. A sample light curve, for the night of 14/15 February (JD 2446111), is shown in Figure 1. (The crosses represent three-point averages of the original data. The measurements have been corrected for mean extinction. Also, some power with periods greater than three hours - attributed to sky variations - has been removed.)

The photometric data were searched for periodicities by Fourier analysis, using an algorithm similar to the modified version of Deeming's (1975) code described by Kurtz (1985). Figure 2 is a periodogram (a representation of the amplitude spectrum) of the data presented in Figure 1. Peaks are observed to rise above the noise at frequencies of 0.710, 0.975, and 3.269 (±0.005)mHz; corresponding to periods of 23.5 ±0.2, 17.1 ±0.1, and 5.10 ±0.01 minutes, respectively. This last peak was not seen on any of the other three nights.

If this peak does arise from variations in HR 5156, it would have to be either transient or modulated in amplitude.

A periodogram of the entire data set is displayed in Figure 3. Here, peaks occur at frequencies of 0.708 and 0.981 (±0.002)mHz. These values coincide with two of the peak frequencies in Figure 2, to within the uncertainties.

The 1.2 mmag peak near 0.22 mHz (period = 75 min) may be due entirely to sky transparency variations. However, we note that the beat frequency of 0.71 and 0.98 mHz (the two frequencies prominent in both Figures 2 and 3) is 0.27 mHz. It is possible that some of the power in this lower-frequency peak may result from such a beat. (Since each segment of data is only about 1 1/2 hours long, reliable frequency identification near this timescale using Fourier techniques are impractical.)

Based upon the periodogram of Figure 3, a sum of two sinusoids, with periods (amplitudes) of 17.1 min (0.8 mmag) and 23.5 min (0.7 mmag), has been superimposed upon the light curve of Figure 1. It is shown in that figure as the solid curve. The correspondence between the measurements and the fitted curve is reasonably good.

HR 5156 has been classified as a weak-lined F3Vp star by Cowley and Bidelman (1979). They point out that both the Balmer and CaI lines imply a late F type, whereas the metal lines are consistent with an F3 star. No G band is observed in the spectrum. Bidelman (private communication) describes the Balmer and CaII H and K lines as strong and sharp, and CaI 4226 as moderately strong.

The Strömgren indices from the Strömgren-Perry catalogue (1962) - (b-y)= 0.278, $[\Delta m_1]$ = 0.025, $[\Delta c_1]$ = 0.044 - are those of a normal (or only slightly metal-deficient) F dwarf. The star has a measured parallax, yielding a distance of 28 pc (Eggen 1972), and hence a reliable absolute magnitude (M_V=3.35). This value agrees with that derived from the Strömgren colours for a normal F dwarf.

To date, the only stars in this region of the HR diagram for which rapid oscillations (i.e. periods less than about 30 minutes) have been reported are Ap stars. The chemical peculiarities of HR 5156 as indicated by its spectrum - enhanced Ca and possibly slightly underabundant metallicity - are completely inconsistent with those expected for a magnetic Ap star. Polarization measurements of HR 5156 by Mathewson and Ford (1970) give a value of only 0.02 ±0.05 percent; the presence of a strong magnetic field in this star seems unlikely.

All discussions of the variability mechanism(s) in the rapidly oscillating Ap stars have invoked either the strong magnetic fields present in those stars (e.g. Cox 1984) or δ Scuti-type pulsation in which only high overtones

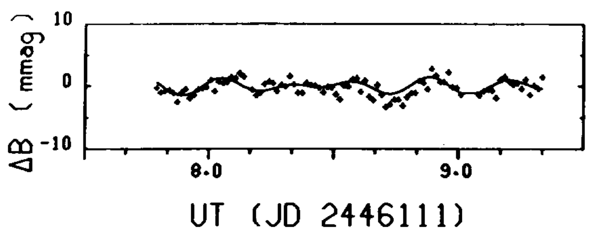
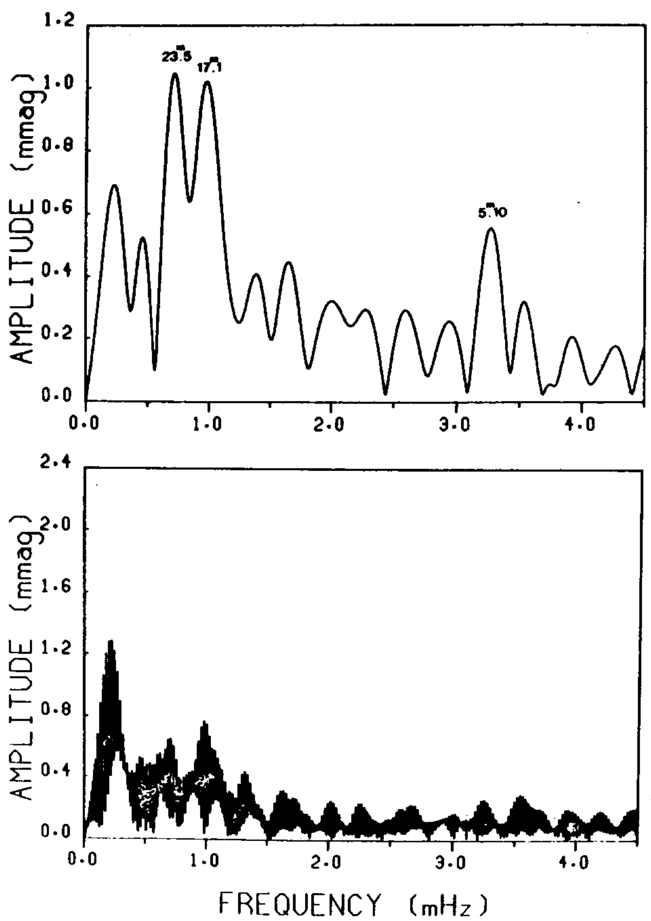


Figure 1



Figures 2 - 3

are allowed to persist by the magnetic field (e.g. Kurtz 1982). In the case of HR 5156, neither agency would appear to apply. This star is presumably non-magnetic, and its colour and absolute magnitude place it well outside the known δ Scuti instability strip.

Given the limited set of observations of HR 5156 and the small sample (10) of known rapidly oscillating Ap stars, it is premature to speculate on any link (or lack thereof) between their variations. Additional rapid photometry of HR 5156, to confirm the variability we have reported, is called for.

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HD 167 971 - AN Of-TYPE ECLIPSING BINARY*

HD 167 971 (spectral type O8 Ibf) has been reported by Leitherer et al. (1984) and Forbes (1984) to show photometric variations of ~0.3 magnitudes. In this note we present additional photometry enabling us to determine the period of variations.

We obtained 42 photometric measurements of HD 167 971 during several observing periods between 1984 August and 1985 March. These observations were part of C. Sterken's "Long-Term Photometry of Variables" which is under way at ESO, La Silla. HD 167 971 was observed in the Strömgren-uvby system at the ESO 50-cm telescope and the Bochum 61-cm telescope, respectively. The results are listed in Table I. The photometric uncertainties are less than $0\overset{m}{.}03$. As already noted previously, HD 167 971 shows variations in all observed passbands with the colours remaining constant. Notice that the Strömgren-y magnitude is nearly identical with Johnson-V for this spectral type. Throughout this note we assume y = V .

Table I. Photometry of HD 167 971

JD	y	b-y	m_1	c_1
2445902.637	7.39	0.64	-0.19	-0.07
5902.648	7.39	0.62	-0.15	-0.09
5905.627	7.52	0.62	-0.16	-0.08
5909.646	7.37	0.62	-0.18	-0.06
5911.610	7.39	0.62	-0.17	-0.08
5914.754	7.36	0.63	-0.21	-0.05
5918.673	7.60	0.63	-0.19	-0.08
5924.698	7.37	0.63	-0.19	-0.07
5927.676	7.37	0.63	-0.18	-0.08

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

Table I (cont.)

JD	y	b-y	m_1	c_1
5930.665	7.45	0.63	-0.18	-0.09
5933.641	7.63	0.64	-0.20	-0.07
5936.611	7.44	0.63	-0.19	-0.07
5939.665	7.36	0.63	-0.19	-0.08
5943.655	7.64	0.63	-0.19	-0.06
5950.578	7.48	0.63	-0.22	-0.08
5950.588	7.49	0.63	-0.22	-0.06
5950.596	7.47	0.62	-0.19	-0.10
5955.554	7.46	0.64	-0.22	-0.09
5966.523	7.43	0.63	-0.21	-0.09
5966.531	7.46	0.62	-0.21	-0.07
5971.554	7.43	0.63	-0.21	-0.08
5974.505	7.36	0.63	-0.22	-0.09
6135.882	7.44	0.62	-0.14	-0.06
6136.856	7.38	0.62	-0.15	-0.05
6137.863	7.58	0.63	-0.15	-0.05
6138.880	7.35	0.63	-0.16	-0.04
6139.871	7.47	0.63	-0.15	-0.04
6140.878	7.41	0.63	-0.16	-0.04
6141.870	7.35	0.63	-0.17	-0.03
6142.870	7.62	0.63	-0.15	-0.04
6144.886	7.45	0.63	-0.15	-0.04
6145.875	7.43	0.63	-0.17	-0.04
6146.863	7.37	0.63	-0.16	-0.06
6149.817	7.49	0.63	-0.13	-0.06
6149.904	7.46	0.63	-0.15	-0.05
6151.809	7.37	0.64	-0.16	-0.05
6152.831	7.63	0.63	-0.15	-0.05
6152.890	7.65	0.63	-0.15	-0.05
6152.894	7.65	0.63	-0.14	-0.05
6152.899	7.65	0.63	-0.14	-0.05
6152.904	7.65	0.63	-0.15	-0.05
6153.818	7.35	0.62	-0.15	-0.04

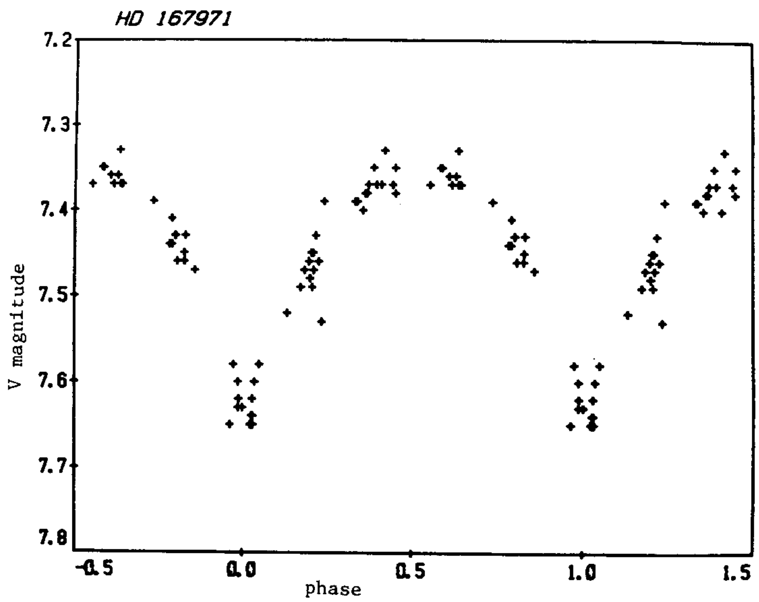

Figure 1. Light curve of HD 167 971

Combining the photometry of Table I and the values published by Leitherer et al. (1984) and Forbes (1984) leads to a total of 62 photometric data points of HD 167 971 over a period of nearly two years. We used these 62 measurements to investigate a possible periodicity of the variations following the method outlined by Stellingwerf (1978). The best-fit solution for the light curve of HD 167 971 is illustrated in Figure 1. HD 167 971 proves to be a short-period eclipsing binary. We derive:

$$\text{Min.} = 2445\,555^{d}.0 + 1^{d}.6607 \cdot E$$

A less significant solution for the light curve of HD 167 971 would be twice the above period, namely 3.3212 days. In this case the light curve shows a secondary minimum about $0^{m}.05$ brighter than the primary minimum. We are not able to distinguish between the two periods with the existing photometry. Further photometry is needed to clarify this question.

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HD 217188 : A LONG-PERIOD CHROMOSPHERICALLY ACTIVE VARIABLE

We began photometry of HD 217188 after noting that Bidelman (1981) had seen moderately strong Ca II H & K emission in its spectrum. The spectral type is K0 according to the HD Catalogue and gK0 according to Bidelman (1981). We found nothing in the literature to indicate it is a binary system.

Henry observed differentially with the 48-inch telescope at Cloudcroft Observatory on 11 nights in 1982, in B and V of the UBV system. Boyd's automatic 10-inch telescope at Fairborn Observatory observed on 47 nights of September through December 1984, in UBV. Henry used BD $-1^{\circ}4373$ as a comparison star. Boyd used 3 Psc = HR 8750 as a comparison star and 2 Psc = HR 8742 as a check star. The nightly means of Henry's BV photometry are listed in Table I. Part of Boyd's photometry has been discussed already (Boyd et al. 1985) and the rest will be published later.

It was immediately obvious from both the 1982 and 1984 photometry that HD 217188 was variable with a period of 80 or 90 days. The 844-day interval between the well-defined minima in 1982 and 1984 indicated therefore that the period was either $76^{d}.7$, $84^{d}.4$, or $93^{d}.8$ depending on whether the number of cycles between was 11, 10, or 9. Two lines of reasoning made us prefer $\Delta n = 10$. (1) Least squares sinusoidal fits of the 1982 data, with a range of periods assumed, indicated $P = 86 \pm 6$ days. (2) The uppermost part of the falling branch was covered twice in 1984, with the interval between being approximately 84 days.

The above-mentioned sinusoidal fit yielded JD 2445165.0 $\pm$ $1^{d}.0$ as a time of minimum brightness in 1982. Application of the Pogson method yielded JD 2446008.5 $\pm$ $0^{d}.5$ as a time of minimum in 1984. Assuming $\Delta n = 10$, we get an ephemeris of

$$\begin{array}{ll} \text{JD } 2446008.5 + 84^{d}.35\, n \\ \quad\quad\quad \pm .5 \quad\; \pm .11 \end{array} \qquad (1)$$

for times of minimum.

Boyd's 1984 photometry is plotted in Figure 1, where each point is a mean of three separate ΔV measures. Similar means of Henry's 1982 photometry are plotted in the same figure, with each value of ΔV made fainter by $3^{m}.26$ (because a different comparison star had been used) and moved forward ex-

Table I

Differential Photometry of HD 217188 at Cloudcroft Observatory

JD(hel.)	ΔV	ΔB	JD(hel.)	ΔV	ΔB
2445120.9211	$-2^{m}.153$	--	2445168.9172	$-2^{m}.008$	$-2^{m}.198$
121.9460	-2.160	--	187.7425	-2.063	--
146.9585	-2.053	--	188.9249	-2.107	--
160.9294	-1.998	-2.195	191.9434	-2.092	--
167.9085	-1.997	-2.196	196.8462	-2.104	--
			213.7824	-2.115	--

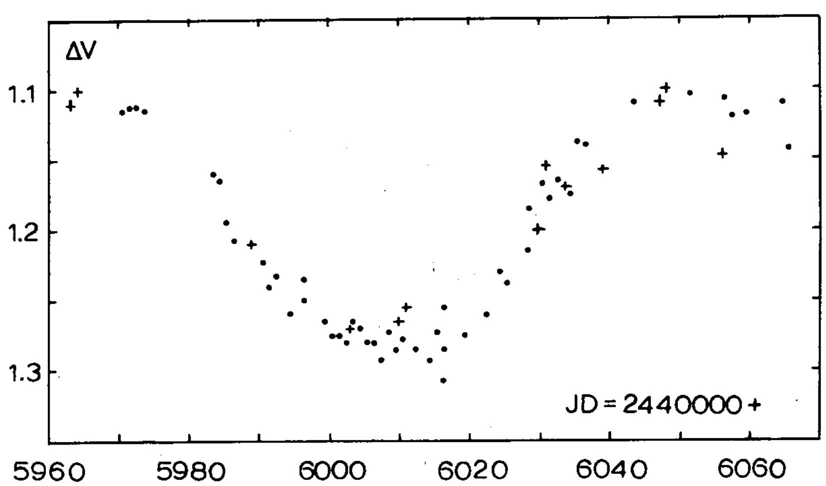

Figure 1

Light curve of HD 217188, where ΔV is in the sense variable minus 3 Psc. Points are from Fairborn Observatory in 1984. Plusses are from Cloudcroft Observatory in 1982, made fainter by $3^{m}.26$ (because a different comparison star had been used) and advanced exactly 10 cycles of the 84.35-day period. Notice the amplitude was larger in 1984 than in 1982.

actly $843^{d}_{\cdot}5$ = 10 cycles. Actually, Henry's earliest two points are plotted twice, advanced 10 cycles and 11 cycles. The light variation in 1984 showed a full range of $\Delta V = 0^{m}_{\cdot}18$, $\Delta B = 0^{m}_{\cdot}22$, and $\Delta U = 0^{m}_{\cdot}25$. In 1982 the full range in ΔV apparently was $0^{m}_{\cdot}03$ or $0^{m}_{\cdot}04$ less.

The 1982 edition of the Bright Star Catalogue remarks that Boyd's comparison star 3 Psc is a suspected pulsating variable with an amplitude of $0^{m}_{\cdot}018$ in V. There is no doubt, however, that HD 217188 is the variable, because its relatively large variation showed up when two different comparison stars were used. Moreover, a small variability in 3 Psc (if it proves to exist) can affect our light curve of HD 217188 only insignificantly. Our differential measures between 3 Psc and the check star 2 Psc confirm this: 51 means obtained on the same 47 nights in 1984 show an rms deviation of only $\pm\ 0^{m}_{\cdot}004$ in V.

The catalogue of Nicolet (1978) gives the following magnitudes for 3 Psc: $V = 6^{m}_{\cdot}21$, $B-V = 0^{m}_{\cdot}89$, and $U-B = 0^{m}_{\cdot}60$. Inspection of Figure 1 shows, therefore, that HD 217188 ranges in brightness between $V = 7^{m}_{\cdot}32$ and $V = 7^{m}_{\cdot}50$.

It will be interesting to see if better spectrograms prove the spectrum composite or reveal radial velocity variations which indicate that HD 217188 is binary, because chromospherically active binaries with very long periods are somewhat unusual.

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HD 115781: A LARGE-AMPLITUDE ELLIPSOIDAL VARIABLE

We began photometry of HD 115781 (= BD +34°2411) after it appeared on a list of bright suspected variables (Hall 1983). The HD spectral type is G5 and the magnitudes (Haggkvist and Oja 1973) are V = $8^{m}.13$, B-V = $1^{m}.14$, U-B = $0^{m}.94$. According to Griffin and Fekel (1985) it is a spectroscopic binary with an orbital ephemeris of

$$JD(hel.) = \underset{\pm .03}{2445280.30} + \underset{\pm .0012}{18^{d}.6917}\, n , \qquad (1)$$

where the initial epoch is a time of maximum positive radial velocity.

As shown in Table I, differential photometry was obtained on a total of 40 nights in 1984 at three different observatories. The comparison star was HD 115707 = BD +33°2324, which is only 40 arc minutes away. Nightly means, of the three individual measures obtained on each night, are given in Table II. The first 31 are Lines, the next 5 Barksdale, the last 4 Stelzer. Each value of ΔV, in the sense variable minus comparison, has been corrected for differential atmospheric extinction and transformed differentially to V of the UBV system.

It was immediately obvious that the brightness was varying nearly sinusoidally with a period of 9 or 10 days. By linear least squares we fit 14 times of maximum and minimum brightness, obtained from the light curve graphically, with the ephemeris

$$JD(hel.) = \underset{\pm .3}{2445803.8} + \underset{\pm .06}{9^{d}.31}\, n , \qquad (2)$$

where the initial epoch is a time of maximum brightness. Twice our value of the period is $18^{d}.62 \pm 0^{d}.12$, consistent with the value in equation (1) found by Griffin and Fekel. This made us suspect that HD 115781 is varying as a result of the ellipticity effect. The suspicion is confirmed by the following reasoning. Times of maximum positive radial velocity should (in a circular orbit) correspond to times of quadrature, which should be times when an ellipsoidal variable reaches maximum brightness. The initial epoch in equation (1), brought forward by exactly 28 cycles, is JD(hel.) 2445803.668 ± $0^{d}.045$. This differs from the epoch in equation (2) by only $0^{d}.1$, entirely consistent with the relevant uncertainties.

Table I

Tally of Observations

Observer	Location	Telescope	Nights	λ
Barksdale	Florida	14-inch	5	V
Lines	Arizona	20-inch	31	VB
Stelzer	Illinois	14-inch	4	V

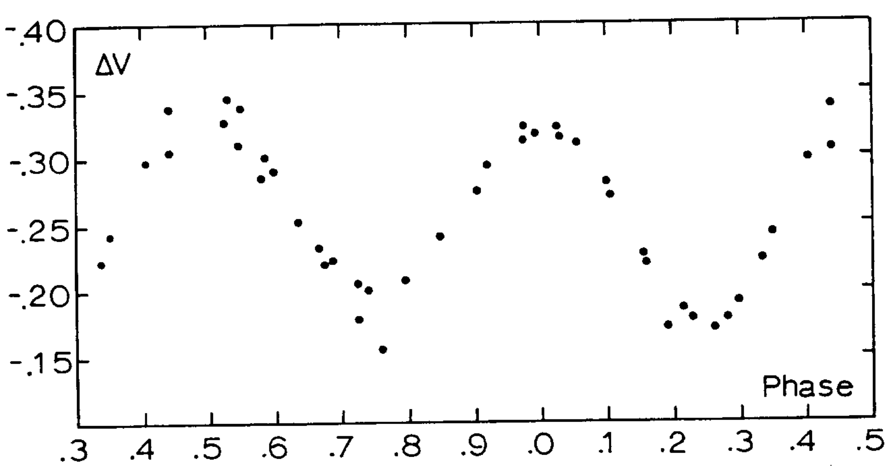

Figure 1

Light curve of HD 115781 in V, where Δ is in the sense variable minus HD 115707 and phase is computed with the ephemeris in equation (3) in which zero phase is at maximum brightness. The $0\overset{m}{.}16$ variation probably results from the ellipticity effect and there is no evidence of eclipses, the reflection effect, or an RS CVn-type asymmetry.

Figure 1 is a plot of the ΔV values in Table II, where phase is computed with the ephemeris

$$JD(hel.) = 2445803.8 + 18\overset{d}{.}69\ n\ . \qquad (3)$$

The light curve shape is characteristic of the ellipticity effect, although we note the $0\overset{m}{.}16$ amplitude is relatively large. Unequal depths of the two minima would indicate the differential reflection effect, but there is no clear indication of this. Unequal heights of the two maxima might

Table II

Nightly Mean Differential V Magnitudes of HD 115781

JD(hel.) 2445000+	ΔV	JD(hel.) 2445000+	ΔV	JD(hel.) 2445000+	ΔV
804.7847	$-0^m.310$	844.7055	$-0^m.171$	874.6761	$-0^m.208$
805.7056	- .270	846.7116	- .191	875.6865	- .241
806.7222	- .220	847.6935	- .242	889.6958	- .289
807.7332	- .185	848.6983	- .298		
813.6990	- .345	854.7096	- .205	797.6914	- .219
814.6885	- .301	859.7009	- .318	839.6753	- .294
820.6834	- .274	861.7098	- .281	840.6733	- .313
826.7171	- .178	862.7076	- .228	853.6440	- .232
827.6865	- .177	864.7179	- .170	854.6914	- .177
828.7211	- .223	869.6772	- .328		
830.6884	- .338	870.6757	- .284	830.6704	- .304
832.7035	- .337	871.6833	- .252	832.6528	- .310
840.7068	- .322	872.6839	- .222	836.6543	- .156
841.7245	-0.315	873.6762	-0.200	841.6504	-0.323

indicate the "wave" seen in RS CVn-type variables, but there is only a slight suggestion of this and, moreover, we could not find in the literature any report of the Ca II H and K emission which would indicate that HD 115781 is an RS CVn system. Eclipses would show up as anomalous faint points around $0^p.25$ and/or $0^p.75$, but we see no evidence of this.

The ΔB measures made by Lines are not reported here, but analysis did show that there is no significant change in B-V index as this variable goes through its $18^d.69$ cycle.

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A CEPHEID-LIKE VARIABLE IN THE ANDROMEDA GALAXY WITH AN EXTREMELY LONG PERIOD

Hubble (1929) indicated H19 as the brightest variable in M31 with a period of 5 years and an unstable light curve varying from cycle to cycle.

The magnitudes of H19 were measured on 16 B plates taken with the 2m RCC telescope of Rozhen Observatory. Our observations are given in Table I. Hubble's magnitude scale m_{pg} was transformed into the B system using the formula $m_{pg} + 1.3 = B$. (It is supposed that H19 does not change its mean magnitude). By a computer period-finding programme we obtained a period P = 1846 d. This value confirms Hubble's period. Figure 1 shows the light curve of H19. Our observations are drawn by circles and those by Hubble by dots. The large dispersion of the light curve can be explained in terms of variations of the light curve from epoch to epoch as one can see in Hubble's Figure 4 (1929). The absolute magnitude of H19 is $M_B \leq -7\overset{m}{.}7$.

Table I. Photometry of H 19

JD 244 0000+	B	JD 244 0000+	B
4528.43	16.73	5557.6	17.7:
4530.42	16.82	5622.33	17.65
4883.42	16.86	5622.34	17.4
5283.4	17.45	5622.36	17.4
5287.31	17.5	5623.33	17.4
5288.33	17.5	5624.33	17.4
5296.39	17.5	5702.21	17.3
5297.31	17.45	5998.42	17.35
5348.31	17.5		

A similar variable in M31 is H42 with $P = 176\overset{d}{.}7$. Ivanov and Kourtev (1985) obtained the period of H42 to be constant but the light curve was unstable.

The flat-topped light curves of H19 and H42 remind of the variable S Vul. The luminosity of this variable coincides with the value predicted by the period – luminosity relation. However, there are variations in the light curve of S Vul (Beyer, 1930) similar to those in H19 and H42.

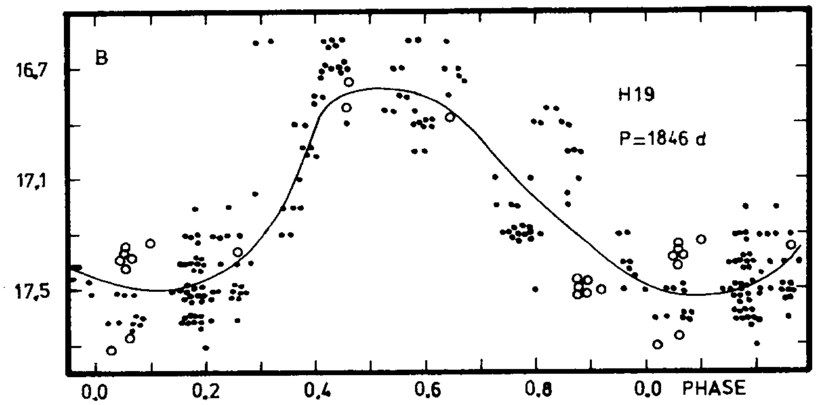

Figure 1

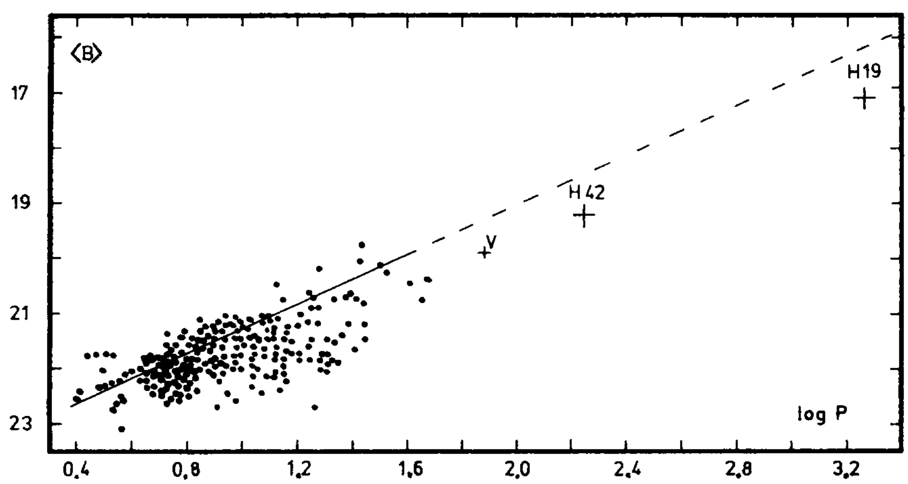

Figure 2

H19 is located in a group of stars which is not indicated as an OB association by Van den Bergh (1964). The location of H42 is at the outer edge of the arm which consists of older stars (Ivanov, 1985). Neither H19, nor H42 belong to young star complexes with active process of star formation.

Both H19 and H42 lie $0^{m}.5$ below the straight line of the period – luminosity relation (Figure 2). This fact can be explained by the absorption in the M31 galaxy. A possible cepheid with a period of 75 days and an amplitude $A_B \sim 0^{m}.5$ is marked by V in Figure 2.

We suppose that both H19 and H42 are cepheid-like variables. These stars are similar to the classical cepheids by their luminosity but they differ from them, as regards the shape and instability of their light curves and probably their age.

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FLARE STARS IN THE PLEIADES

According to the programme of regular search for flare stars in the Pleiades region at the National Astronomical Observatory Rozhen of the Bulgarian Academy of Sciences, patrol photographic plates have been taken with the 20"/28" Schmidt telescope in U-light (ZU21 with a UG2 filter) and in pg-light (ZU21 without filter) during the period September 1983 - October 1984.

Table I gives some details about the observational material obtained.

Table I

Telescope	Light	Time of exposure	Number of plates	Number of exposures	$t_{eff.}$
20"/28"	U	5 min.	24	140	11^h40^m
		10 min.	18	101	16^h50^m
	pg	5 min.	12	72	6^h

A new flare star and 6 flare events of known flare stars have been discovered. Table II summarizes our results. The successive columns give the following data:

1. Rozhen designation of the Pleiades flare stars according to Tsvetkov et al. (IBVS, No.2338, 1983) have been continued;
2. Hertzsprung number;
3.-4. Coordinates for 1900.0;
5.-6. Photographic magnitude at minimum and amplitude of the observed flare events in U-light;
7. Date of the flare event (U.T.);
8. Identification of the flare stars by the Catalog and Identification Charts of the Pleiades Flare Stars (Haro et al., Bol. Inst. Tonantzintla, 3, No. 1, 1982).

The identification charts of those new flare stars (R18, R20, R21, R22, R24 - Tsvetkov et al., IBVS, No.2224, 1982; IBVS, No.2338, 1983, and the present paper) which are not included in the Tonantzintla Catalog (Haro et al.,

Table II

Rozhen No.	HII	R.A.$_{1900}$	D.$_{1900}$	$m_{U\,min}$	Δm_U	Date	Identification
R24		$3^h39^m.4$	$22^o22'$	20.2	5.3	30.09.1984	
R25	1061	3 40.6	23 48	16.6	2.7	7.09.1984	TC224
R26	1355	3 41.4	23 43	17.3	2.2	7.09.1984	TC262
R9	2411	3 43.7	24 01	16.9	0.7	6.10.1983	TC377
R9	2411	3 43.7	24 01	16.9	2.4	30.09.1984	TC377
R9	2411	3 43.7	24 01	16.9	0.6	1.10.1984	TC377
R27	2602	3 44.3	23 41	18.7	3.2	7.09.1984	TC391

1982) are shown in Figure 1. The scale of the charts corresponds to the scale of the identification charts of Haro et al. (1982). North is at the top, east is to the left.

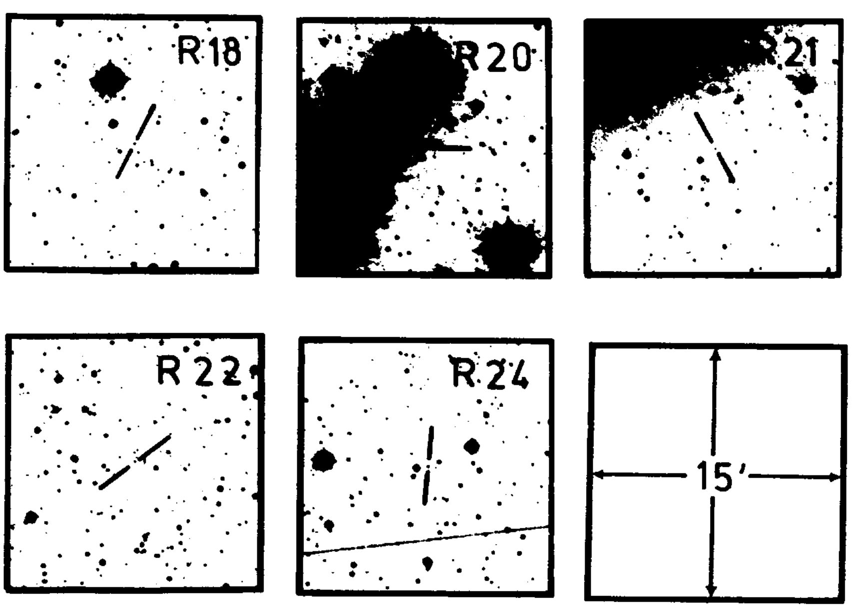

Figure 1

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PHOTOMETRIC BEHAVIOUR OF DR TAURI IN THE SEASON 1984/85

Using the previously given sequence of comparison stars (Götz, 1982) the star was measured on 40 blue-sensitive plates (ORWO-ZU21+GG13+BG12) from 25 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 23 August 1984 and 23 March 1985. The measurements are used to complete and to supplement the already known behaviour (Götz, 1980 , 1982, 1983, 1984) of this star. The light curve given in Figure 1 essentially shows a slow decrease of the brightness. The scattering of the individual observations in the light curve is relatively small.

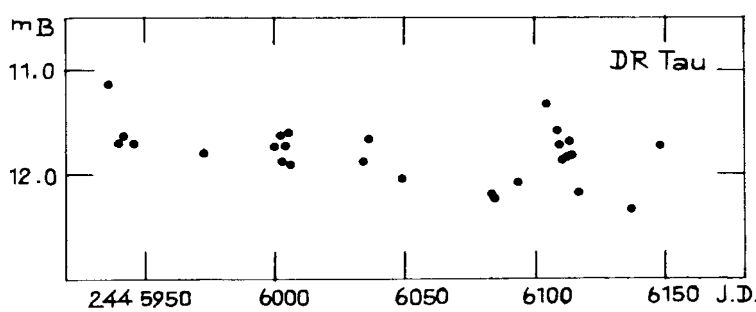

Figure 1

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References:
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BEHAVIOUR OF THE X-RAY BINARY V1727 CYGNI = 4U 2129 +47 IN 1984

On the basis of the sequence of comparison stars given by Wenzel (1983) the star was inspected on 35 blue-sensitive plates (ORWO-ZU21+GG13+BG12) from 31 nights taken with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 1 May 1984 and 13 December 1984. The individual estimates are given in Table I. On most of the plates the star is below the limiting magnitude. V1727 Cygni is only visible on some individual plates. There, its brightness varies between $m_B = 17^m.9$ and

Table I

J.D.hel 244....	m_B	Rem.	J.D.hel 244....	m_B	Rem.
5822.543	$> 18^m.0$		5945.502	$> 17^m.9$	iv
5843.438	> 17.9	iv	5946.454	≫ 17.9	iv
5855.494	17.9::		5946.513	18.2	
5871.494	> 17.9	iv	5962.362	≫ 17.5	iv
5905.437	18.0		5973.372	> 17.9	iv
5905.473	18.05		5991.341	> 17.9	iv
5907.435	≫ 17.9	iv	6000.377	18.3	
5911.444	> 17.5	iv	6001.336	> 17.9	iv
5912.415	> 17.9	iv	6002.337	> 17.9	iv
5913.401	> 17.9	iv	6003.350	> 17.9	iv
5916.401	> 17.9	iv	6004.359	≫ 17.9	iv
5916.426	> 17.9	iv	6005.393	18.0	iv
5930.367	> 18.05		6018.283	> 17.9	iv
5934.463	≫ 17.5	iv	6019.280	18.1	
5935.484	18.1		6019.303	18.2	
5936.475	17.9		6047.221	> 17.9	iv
5940.463	> 17.9	iv	6048.229	> 17.9	iv
5942.470	> 17.9	iv			

iv = invisible

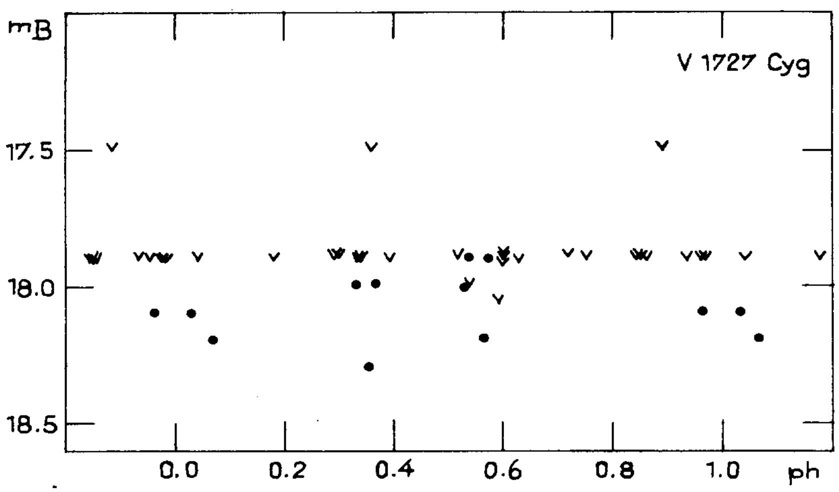

Figure 1

$m_B = 18\overset{m}{.}3$. The behaviour given here characterizes the inactive state of the star which probably started near 7 September 1983 (Wenzel, 1983).

Figure 1 shows the observations listed in Table I , reduced to one common epoch by means of the elements:

$$\text{Min (hel.)} = 244\,4403.743 + 0\overset{d}{.}218\,2579 \cdot E$$

given by McClintock et al. (1982). The arrows indicate "fainter than " observations.

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BEHAVIOUR OF KR AURIGAE IN THE SEASON 1984/85

The star was measured on 28 blue-sensitive plates (ORWO-ZU21+GG13+BG12) from 20 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory, covering the time interval between 2 September 1984 and 12 March 1985, using the comparison star sequence given by Popova (1965). The observations are given in Table I.

Table I

J.D. 244....	m_B	J.D. 244....	m_B
5946.572	$13^m.10$	6036.542	$13^m.34$
6002.529	13.22	6059.471	13.22
6003.542	13.42:	6059.490	13.20
6003.567	13.43	6083.422	13.16
6004.478	13.34	6084.325	13.37:
6004.497	13.32	6084.535	13.26
6005.585	13.12	6093.479	13.22
6005.608	13.14	6104.276	13.36
6006.546	13.42	6108.318	13.12
6006.570	13.27	6109.306	13.20
6031.656	13.38	6110.301	13.15
6034.418	13.32	6113.304	13.30
6034.437	13.50	6116.298	13.68
6036.524	13.52	6137.303	14.08

It can be seen from Figure 1 that most of the time KR Aur is in its maximum light between $m_B = 13^m.1$ and $m_B = 13^m.5$; and slow temporal light fluctuations are superimposed. At the end of the series a decrease in the brightness from $m_B = 13^m.3$ to $m_B = 14^m.08$ is indicated.

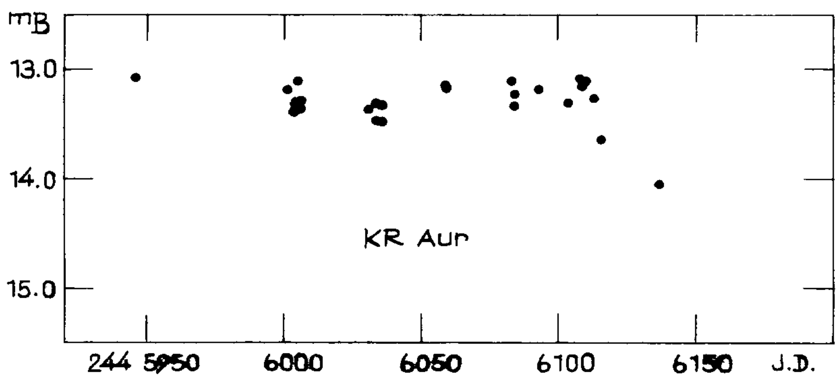

Figure 1

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Reference:

Popova, M., 1965, Peremennye Zvezdy, 15, 534.

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OBSERVATIONS OF AT CANCRI IN THE SEASON 1984/85

The star AT Cnc, which is probably of cataclysmic type, was measured on 66 blue-sensitive plates (ORWO-ZU21+GG13+BG12) from 14 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 29 November 1984 and 22 March 1985, using the sequence of

Table I

J.D.hel 244....	m_B	J.D.hel 244....	m_B	J.D.hel 244....	m_B
6034.595	$15^m.80$	6108.411	$15^m.45$	6113.390	$16^m.20$
6034.616	16.00	6108.431	15.40	6113.411	15.60
6034.635	15.65	6108.454	15.40	6113.431	15.80
6034.656	15.95	6108.474	15.40	6113.474	15.50
6034.677	15.55	6109.372	15.40	6113.495	15.55
6036.693	14.75	6109.390	15.45	6116.333	13.70
6036.711	14.85	6109.408	15.40	6116.354	13.70
6083.573	15.05	6109.429	15.20	6116.372	13.45
6083.639	15.40	6109.449	15.30	6116.392	13.80
6083.662	15.40	6109.469	15.65	6116.411	13.85
6083.683	15.35	6110.351	15.20	6116.430	14.00
6084.419	15.85	6110.373	15.10	6116.451	13.75
6084.436	15.90	6110.393	15.20	6121.397	13.30
6093.507	13.15	6110.431	15.60	6121.417	13.35
6093.527	13.10	6110.449	15.75	6121.437	13.25
6093.547	12.95	6110.471	16.00	6121.457	13.45
6093.567	12.80	6110.493	16.05	6121.479	12.90
6093.586	12.90	6110.603	15.70	6137.347	13.10
6093.630	13.10	6111.449	16.00	6137.368	13.20
6108.347	15.80	6111.470	15.50	6147.322	14.45
6108.366	15.95	6113.351	16.15	6147.342	14.25
6108.386	15.75	6113.370	16.05	6147.362	14.10

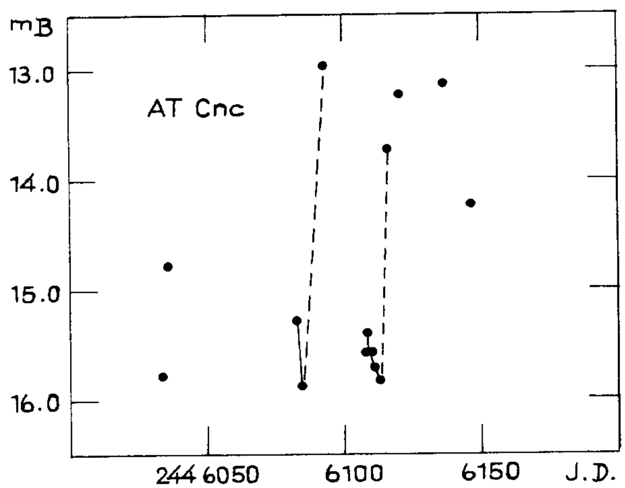

Figure 1

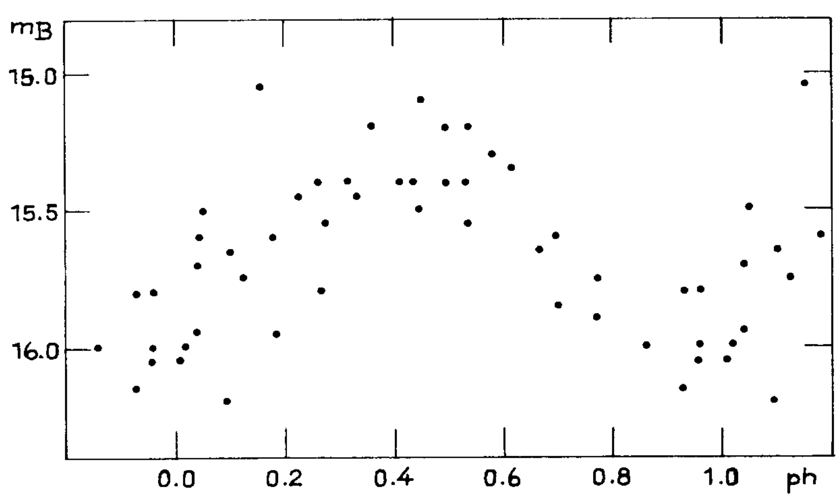

Figure 2

comparison stars given in the IBVS No. 2363 . The observations are listed in Table I. In order to study the short-term behaviour of the star, more than one plate were obtained in all nights. The exposure time of the plates amounts to 20 minutes.

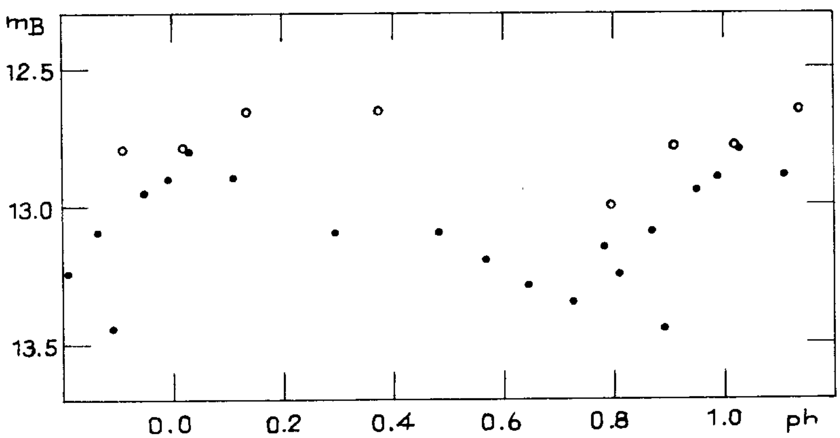

Figure 3

The long-term light curve of AT Cnc which results from the mean magnitudes of the nights listed in Table I, given in Figure 1, shows variations between $m_B = 15\overset{m}{.}90$ and $m_B = 13\overset{m}{.}00$. A remarkable increase in brightness with $\Delta m_B = -2\overset{m}{.}09$ within $2\overset{d}{.}97$ was observed between 16 February and 19 February 1985. Small short time-scale variations of the star can be observed in all series. They seem to be regular and refer to occultation light changes. In order to study the influence of these variations all observations were reduced to one common epoch by means of the preliminary orbital elements:

$$\text{Min. Hel.} = 244\,6110.504 + 0\overset{d}{.}238\,6556 \cdot E$$

The results are given in Figures 2 and 3 where the magnitudes m_B from observations of the low $(15\overset{m}{.}0 < m_B < 16\overset{m}{.}2)$ and the high $(12\overset{m}{.}6 < m_B < 13\overset{m}{.}5)$ state of brightness are plotted against the phases. In Figure 3 the series of observations from the night J.D. 244 5672 given in the IBVS No. 2526 (1984) and marked by circles are also drawn. Comparing Figures 2 and 3 it can be seen that in the high state the minimum phase is displaced to phase ≈ 0.75 . More observations are still needed to make further and detailed statements about the behaviour of AT Cnc.

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

ST LMi belongs to the group of AM Her type stars (Liebert and Stockman, 1984) and is a cataclysmic variable binary system containing a strongly magnetic white dwarf primary. Its finding chart is given by Shore et al. (1982).

The star was measured and inspected on 69 blue-sensitive plates (ORWO - ZU21+GG13+BG12) from 43 nights taken with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 30 May 1983 and 24 April 1985. On 16 nights more than one plate per night were obtained. The exposure time of the plates amounts to 20 minutes.

The identification chart is shown in Figure 1 and the sequence of the comparison stars in B is listed in Table I. The magnitudes of these stars were obtained on two plates by linking them to the UBV sequence of the Coma region given by Argue (1963).

Table I

Comparison star	m_B	Comparison star	m_B
a	$14^m.61$	e	$16^m.57$
b	15.07	f	16.88
c	15.49	g	17.10
d	16.22		

The long time-scale light curves in B from the seasons 1983/84 and 1984/85 are shown in Figures 2 and 3. Similarly to other AM Her objects, two different states of the brightness behaviour of ST LMi can be seen there. Concerning the active state, which is characterized by increased brightness caused by X-ray heating, it is remarkable that the mean brightness amounts to $\bar{m}_B \approx 15^m.75$. On the contrary, the mean brightness of the low and inactive state of the star, which was observed in the time interval between 3 December 1983 and 15 December 1983, amounted to $\bar{m}_B \approx 16^m.65$.

Both the light curve in the low state and that of the high state are influenced by occultation light changes. In order to study these influences,

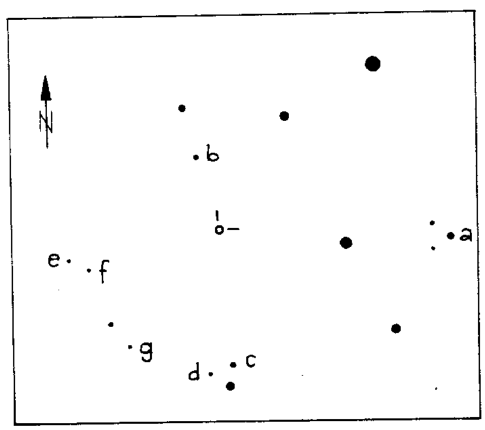

Figure 1

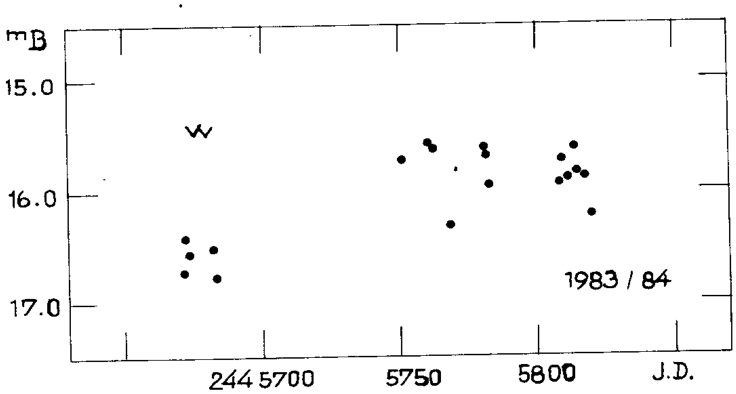

Figure 2

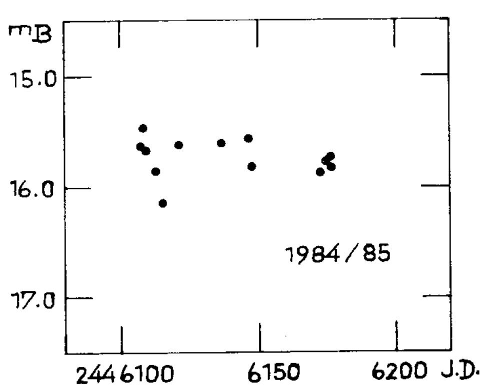

Figure 3

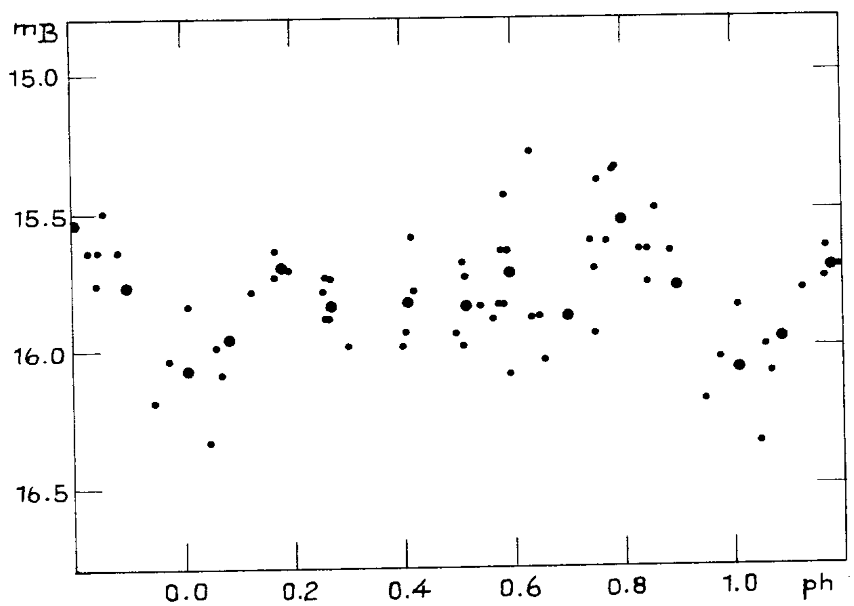

Figure 4

all observations of the high state were reduced to one common epoch by means of the preliminary orbital elements:

$$\text{Min. Hel.} = 244\,5769.531 + 0\overset{d}{.}079\,090 \cdot E$$

The result is given in Figure 4, where the individual observations (small dots) and the mean magnitudes (large dots) are plotted against the phase. More observations are needed to make statements about the behaviour of the occultation light changes in the low state. Besides, it is noticeable that the period of the occultation light changes corresponds to that given by Liebert and Stockman (1984).

The individual observations will be published in MVS.

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GAMMA Cae: A BINARY WITH A SUSPECTED VARIABLE SECONDARY

Gam Cae [$5^h 00^m 48^s.5, -35^\circ 37' 11''$; 1900] is on the University of Virginia parallax program at Mt. Stromlo as part of an effort to measure parallax for a sample of southern giants (Ianna and Culver 1985).

While inspecting a number of our plates, it was noted that the secondary was not always apparent. Close examination of all the accumulated plates shows that this cannot be accounted for purely as a result of variable seeing conditions at the time of exposure.

Gam Cae (=HR 1652 = HD32831) is a K3 III for which Eggen (1973) gives V = 4.55, B-V = +1.20, (R-I) = 0.46. The secondary is located at a distance of 3" in a position angle of about 310 degrees. In the Innes catalogue (Cape Annals) the magnitude of the primary and secondary are given as 4.7 and 9.6; Eggen and Stokes (1970) not a companion to HR 1652 of magnitude 8; the Index Catalog of Double starts lists m(A) = 4.7, m(B) = 8.2. Thus the published magnitude differences range between about 3.5 and 5.

We have scanned several of our plates having the best images of the secondary with the PDS microdensitometer at Mt. Stromlo. The secondary is still weak and not cleanly separated from the primary. These are IIa-0 plates explosed unfiltered with the 66 cm Yale-Columbia refractor having a plate scale of 18.85 arcsec/mm and approximate a B magnitude. Double peak Gaussian functions are fit to marginal distributions derived from the scan map topography. From these fits magnitude and position data can be extracted. The following results were found:

Plate #	# images	sep	P.A.	Δm	date
4391	3	3.15	324	1.4	16 Feb 1983
4856	3	3.11	327	1.7:	3 Jan 1984

The fitting routines failed to converge for 6 other plates where the secondary image is weaker. In these cases we estimate a Δm of about 2.0 or more. The programs have been checked using pairs of simulated stars and seem to work well in the range of separation and magnitude difference found in the present case. On several plates the companion is not visible at all, and, although the seeing is not very good on these plates, it does not appear to be poor enough to account for the non-appearance of the secondary.

There seems a fair probability that the secondary in the Gam Cae system is variable. A hotter companion could account for a somewhat reduced magnitude difference in the blue, however there seems no very likely object that could be two magnitudes brighter in the blue and two to four magnitudes fainter than the primary simultaneously. Of course the observed visual magnitude differences also may not completely characterize any variations. The evidence suggests additional observations of the secondary would be useful to clarify the nature of this object.

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THREE MODES OF VARIABILITY IN THE BRIGHT STAR HR 7428

We began photometry of HR 7428 = HD 184398/9 after it appeared on listings of bright suspected variable stars (Hall 1983ab). The literature contains rather many references to this bright spectroscopic binary, of which we mention about half. Radial velocity measures by Sanford (1925) showed the orbital period to be $108^{d}.5707 \pm 0^{d}.05$. Lucy and Sweeney (1971) later recomputed a circular orbit after concluding it was not significantly eccentric. The spectral type of the primary component has appeared in the literature as K2, cG6, K2 III, K2 (II-III), K2 II-III, and K2 II-III e; the secondary component has been designated variously as A3, A, A?, A0, and A0 V. Ca II H and K emission was first noted by Bidelman (Gratton 1950), the strength being 3 on Wilson's 0-to-5 scale (Glebocki and Stawikowski 1979), whereas H alpha appears in absorption (Bopp and Talcott 1978). Soft x-ray emission has been detected by Walter and Bowyer (1981). Argue (1966) gives the magnitudes as $V = 6^{m}.36$, $B-V = 1^{m}.16$, $U-B = 0^{m}.91$.

As shown in Table I, we obtained differential photometry at eight different observatories in one or all three bandpasses of the UBV system. From the middle of 1982 through the end of 1984, we obtained 179 means of 2-to-5 individual differential measures between HR 7428 and the comparison star HD 184170.

Inspection of our 2.5 years of photometry showed that HR 7428 was varying by about $0^{m}.05$ with a period around 55 days. Since this was so nearly half the known orbital period, we did Fourier analysis with the familiar truncated series which allows for terms in $A_1 \cos \theta$ and $A_2 \cos 2\theta$. Repeated fits with different values assumed for the period, along with chi-squared analysis, indicated $P = 108^{d}.85 \pm 1^{d}.15$. Application of the period-finding technique of Lafler and Kinman (1965) found values which were consistent. Thus both estimates (Fourier and Lafler-Kinman) are in agreement with Sanford's spectroscopically determined orbital period.

Table I

Tally of Observations

Observer	Location	Telescope	Means	λ
Barksdale	Florida	14-inch	2	V
Boyd	Arizona	10-inch	117	VBU
Fried	Arizona	16-inch	11	VBU
Hoff	Iowa	16-inch	3	V
Ingvarsson	Sweden	14-inch	21	V
Nielsen	Delaware	4-inch	5	V
Stelzer	Illinois	14-inch	14	V
Wasson	California	8-inch	6	V

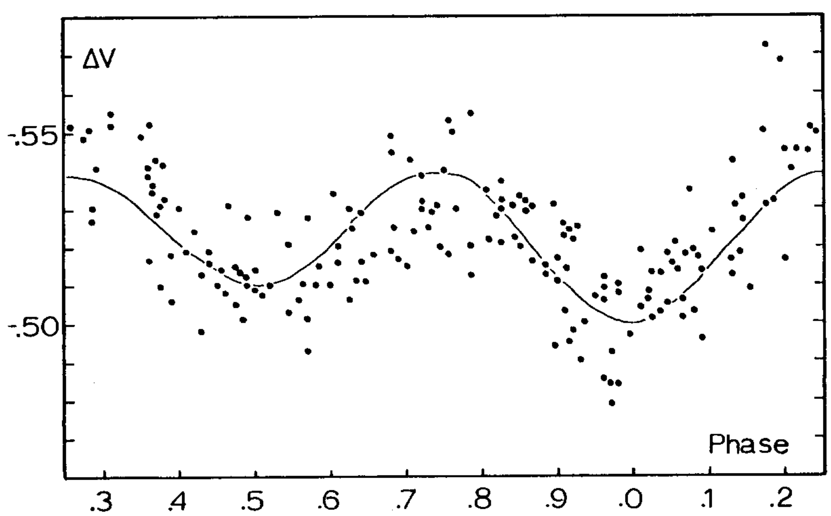

Figure 1

Light curve of the K2 II-III + A spectroscopic binary HR 7428, where ΔV is in the sense variable minus comparison and phase is based on the $108\overset{d}{.}6$ orbital period of Sanford. Each point is a mean of 2-to-5 individual intercomparisons. The solid curve is a Fourier fit allowing for terms in cos θ and cos 2θ. Two points ($0\overset{p}{.}38$,$-0\overset{m}{.}43$ and $0\overset{p}{.}98$,$-0\overset{m}{.}45$) were off scale and are not plotted but were included in the Fourier analysis. We see evidence of an ellipticity effect and a smaller reflection effect. The $0\overset{m}{.}015$ difference between the two maxima, at $0\overset{p}{.}25$ and $0\overset{p}{.}75$, indicates a possible RS CVn-type wave. The total range from minimum at $0\overset{p}{.}00$ to the higher maximum at $0\overset{p}{.}25$ is $0\overset{m}{.}045$ in V.

Redoing the Fourier analysis with the $108^{\mathrm{d}}.5707$ period exactly, we found $A_2 = -0^{\mathrm{m}}.017$, $A_1 = -0^{\mathrm{m}}.005$, a mean light level of $\Delta V = -0^{\mathrm{m}}.522$, and JD 2445062.88 ± $0^{\mathrm{d}}.05$ for a time of the deeper minimum. The 179 mean values of ΔV are plotted in Figure 1, where the curve represents the above Fourier coefficients and zero phase is at the deeper minimum.

A reasonable interpretation of the light curve would be that the A_2 coefficient indicates the ellipticity effect, not surprising in a binary with one very luminous (hence, large) star, and that the A_2 coefficient indicates the differential reflection effect, not surprising in a binary composed of a large cool star and a smaller hot star. A residual asymmetry, not allowed for in our Fourier analysis which contained no sin θ terms, appears in Figure 1 as a $0^{\mathrm{m}}.015$ difference in height between the maxima at $0^{\mathrm{P}}.25$ and $0^{\mathrm{P}}.75$. This might be a manifestation of the "wave" seen in other chromospherically active stars, even ones with quite long rotational periods, the longest known being HR 1362 with P = 154 days (Boyd et al. 1985). We see that HR 7428 reaches maximum brightness around $0^{\mathrm{P}}.25$ (because of this asymmetry) and minimum brightness around $0^{\mathrm{P}}.00$ (because of the reflection effect), the full range being approximately $0^{\mathrm{m}}.045$ in V.

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IS HD 23878 A MILD CP STAR?

In a systematic study of rotation and metallicism among early A stars, Conti (1965) suggested that HD 23878 (= HR 1181 = τ^7 Eri, A2V) might be an Am star or a mild CP star, according to its anomalous (low) ratio Sc II λ 4246/ Sr II λ 4215. To our knowledge, there have been no other spectroscopic studies of this star since then, so that its classification could not be secured. However, Heck (1977) observed the star photometrically and pointed out that, in his sample, it showed the largest discrepancy in the Strömgren index c_1 (0.058) with respect to the value given by Hauck and Mermilliod (1975). Heck and Manfroid (1980) were subsequently unable to definitely decide about the suspected photometric variability.

Yet HD 23878 had been used as a comparison star for the study of photometric variations in the Strömgren *uvby* system of the CP star HD 25267 (= τ^9 Eri). The data, which had been obtained during two runs at the ESO Danish 50 cm telescope in December 1975 (35 points) and November 1977 (44 points), were recently reanalysed (Manfroid et al., 1985). New careful reductions of the observations, using the PHOT2 algorithm (Manfroid and Heck, 1983) allowed to confirm the variability of HD 23878. Nevertheless, in view of its low amplitude (about 0.012 mag peak-to-peak in u, 0.008 in the three other colours) it was kept as a comparison by Manfroid et al., since the second comparison of HD 25267, HD 24587, was also variable.

We analysed the data with our programme of period determination based on least-squares fitting (Manfroid and Mathys, 1985). First, we traced the periodogram for each run separately and then for both together. A periodicity is obviously present and the most likely frequencies that we derive are:

$$f = 0.13945 \pm 0.00015 + n\,0.00144\,\mathrm{d}^{-1}.$$

The alias frequencies $(1+f)$ cannot be definitely ruled out but seem much less probable; furthermore, the low projected rotational velocity ($v \sin i = 30\,\mathrm{km.s}^{-1}$, Uesugi and Fukuda, 1981) also favours the longer period. In spite of the very low amplitude, we believe that the variations that we observe are real, because the same frequency appears in all three periodograms. Another argument is that HD 24587 (for which HD 23878 was used as a comparison) is the only CP-like variable in Mathys et al.'s recent study (1985) for which the standard deviation of the least-squares fit is significantly larger than the estimated accuracy of the measurements.

In conclusion, HD 23878 appears to be a low amplitude variable with a period of about 7.17 d. As far as one can judge for such small variations, these seem to be similar to those of CP stars. A new spectroscopic study of this star would thus be very desirable in order to confirm Conti's suggestion that it is a mild CP star.

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THE DISCOVERY OF RAPID OSCILLATIONS IN THE Ap STAR HD 134214

HD 134214 has been discovered to be a rapidly oscillating Ap star with a period of approx. 5.65 min. It is a cool member of the class of CP2 stars and has a spectral type of FO SrEu. Photoelectric photometry in Johnson B and V was obtained with Lowell Observatory's 1.1 m telescope and a dual-channel photometer. Four nights of data reveal so far only a single period with a variable amplitude of about 3 mmag in B and a much smaller amplitude in V. Continuous integrations of 20 sec were utilized, with breaks only for sky measurements.

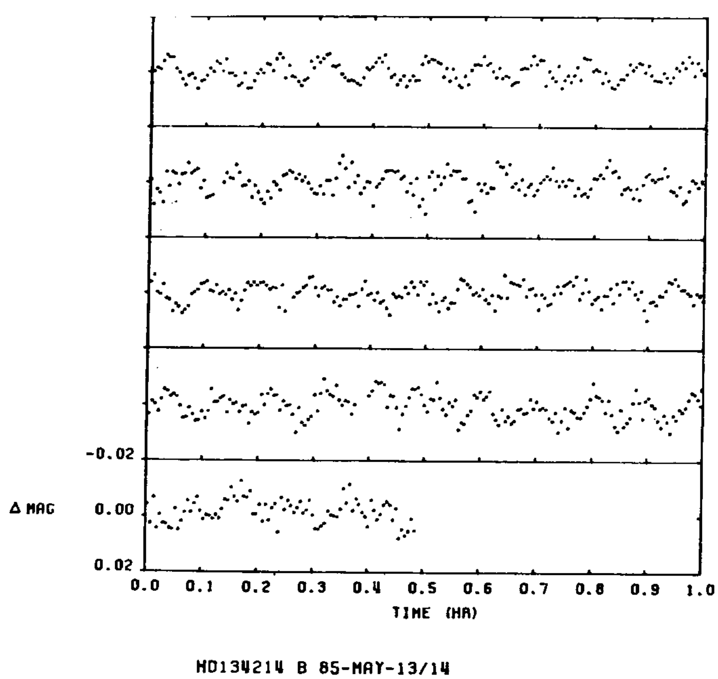

Figure 1: B photometry of HD 134214 on the night of 1985-May-13/14. The time series progresses left-to-right and top-down.

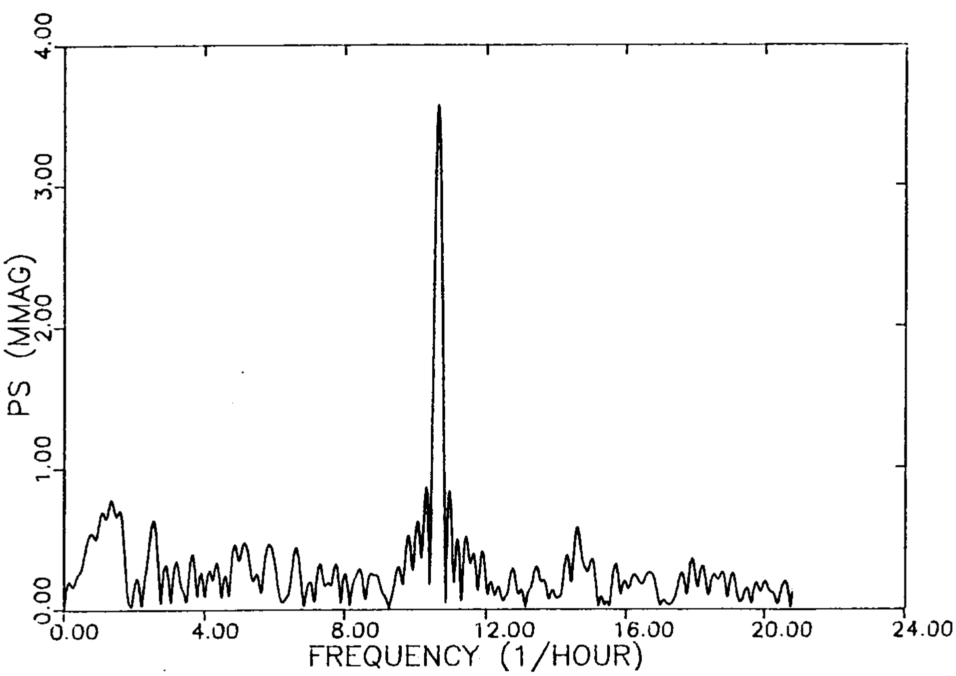

Figure 2 : The power spectrum of the data appearing in Figure 1. The semi-amplitude of the 5.65 min period is about 3.6 mmag.

HD 134214 is the eleventh known member of the class of rapidly oscillating Ap stars. All previous members of this class have been discovered by Kurtz. The characteristics of the first nine members are tabulated in Kurtz (1984), while those of the tenth member are given in Kurtz and Kreidl (1985).

The B observations for the night of 1985 May 13/14 are shown in Figure 1. The power spectrum of these data is presented in Figure 2. A detailed analysis will be presented elsewhere.

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NEW FLARE STAR SVS 2559 PERSEI

The variability of SVS 2559 was discovered by Kurochkin (Astron.Tsirk. No. 1325, p. 5; 1984), who already suspected that the object might be a flare star. His plate material, however, accidentally did not allow to trace completely one of the eruptions.

On 343 suitable Sonneberg 40 cm astrograph exposures of the years 1964 to 1983 one conspicuous flare could be detected confirming the UV Ceti type. It is recorded by two of five plates of a night series of 1971 Oct. 19 as follows:

J.D.$_{\odot}$	244 1244.283	$16^{m}.7$ pg
	.346	16.7
	.401	15.1
	.457	16.4
	.557	16.7

As the exposure times of the plates amount to 80 minutes each, the observed range of the eruption is flattened, by an unknown amount.

The distribution of brightness data of our material very nearly resembles that given by Kurochkin (l.c.). We should note that the star is never invisible on good plates. Therefore the "faint tail" of the distribution is supposed not to be caused by observational bias. The comparison stars used are those of Kurochkin.

This variable is (besides QZ Persei, of similar brightness) one of the two UV Ceti stars to lie in the Sonneberg 100 square degrees field centred at ρ Persei.

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PERIOD CHANGE IN THE ECLIPSING BINARY GK CEPHEI

The Cracow yearbook for 1985 (Rudnicki, 1984) remarks that observations of GK Cephei are needed to determine the current elements. The following photoelectric timings have been made by members of the BAA Variable Star Section. The column $O-C_1$ gives residuals against the previous elements (Dworak, 1975)

$$\text{Min I} = 2438694.7063 + 0^{d}.936157\ E$$

and the column $O-C_2$ is against the revised elements

$$\text{Min I} = 2441946.9191 + 0^{d}.936170\ E.$$

Hel. J.D.	Min.	$O-C_1$	$O-C_2$	Observer
2441946.9191	I	+0.0034	0.0000	T. T. Gough
4937.516	II	+0.047	+0.002	M. Peel
5671.4680	II	+0.0517	-0.0034	M. Peel
6162.4943	I	+0.0636	+0.0017	J. Ells

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THE PERIOD BEHAVIOUR OF AU SERPENTIS

The variability of AU Serpentis is one of the many discoveries made by Hoffmeister (1935). The system was observed visually by Soloviev (1936, 1951). Photographic observations were made by Huth (1964). The first photoelectric observations were published by Binnendijk (1972) who produced the first light curves and classified AU Ser as a W-UMa class system.

Our observations were made during four nights in the time interval between 20 and 27 June 1982, using photoelectric equipment attached to the 38-cm reflector at Midway Observatory. The equipment and observational procedures have been described previously (Kennedy & Wisniewski, 1980; Kennedy, 1982). The observations yielded one primary and two secondary eclipses. Enough data were obtained to present an almost complete light curve (ΔV); Figure 1. Maximum light has been normalised to zero. Paucity of data near the maxima, especially the one following secondary minimum, prevents confirmation (or otherwise) of the shifts of the extreme values of light from phases 0.25 and 0.75, as recorded by Binnendijk. The observation of one of the secondary minima was interrupted by cloud, thus not permitting a reliable determination of time of minimum light. Recorded times of minima are listed in Table I.

Table I

J.D. Hel. 2,440,000 +	Min.	Epoch	Phase	(O-C)
5142.9884	I	11369.0	.9911	$-\,^{d}.0034$
5142.0227	II	11366.5	.4928	$-\,^{d}.0028$

Phases and residuals were computed from the light ephemeris:

J.D. Hel. Min. I = 2,440,748.8592 + 0.38650124 E and are plotted versus heliocentric Julian date in Fig. 3 together with all previous recorded minima (I and II) as tabulated by Binnendijk (1972). No period diagram has been published previously.

Our observations indicate that the period of AU Ser has remained constant since J.D. Hel. 2,436,673.5930 when the system was observed by Huth (1964).

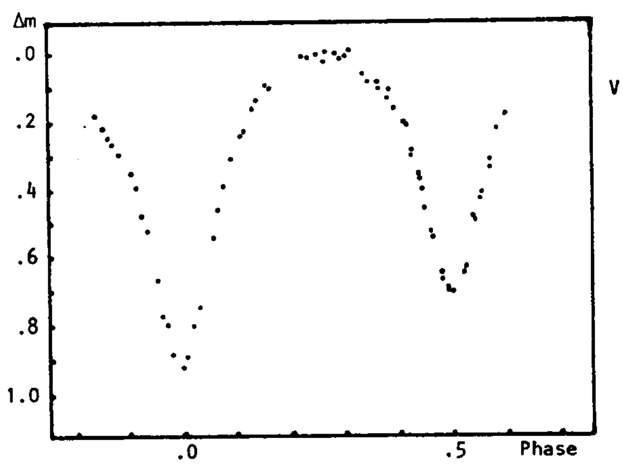

Fig. 1: The Lightcurve of AU Serpentis

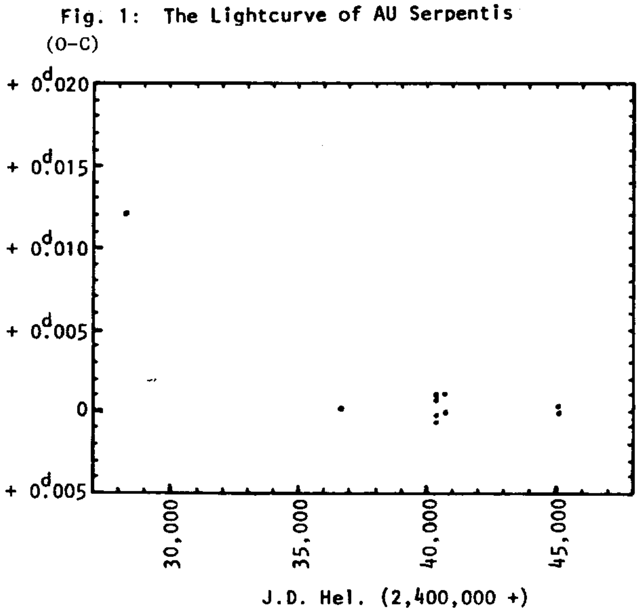

Fig. 2: Rectified Period Behaviour of AU Ser

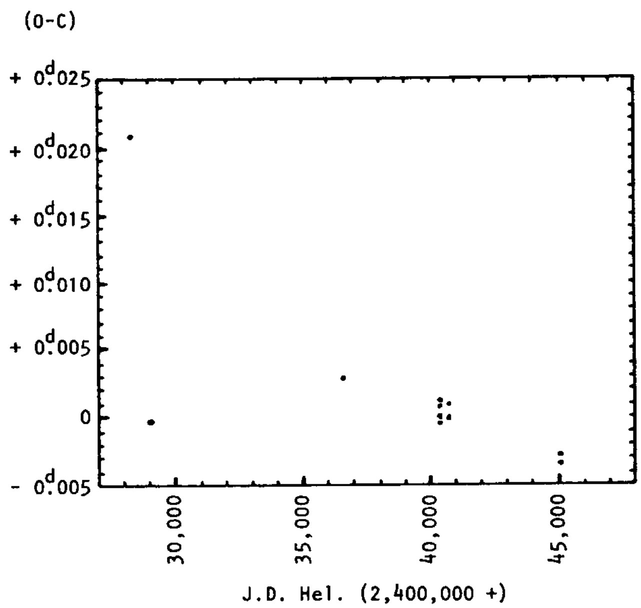

Fig. 3: Period Behaviour of AU Ser

The period diagram was rectified by plotting the steadily decreasing residuals horizontally. The rectified period diagram is shown in Figure 2 and is based on the ephemeris: J.D. Hel. Min. I = 2,436,673.5929 + $0^d.38650096$ E. The largest residual for the horizontal branch is $0^d.0009$. Residuals for primary and secondary minima, based on the above ephemeris are listed in Table II.

Table II

YEAR	$(O-C)_1$	$(O-C)_2$	Δ	REF.
1959	+ .0001	-	-	Huth
1969	{- .0003, - .0007}	{+ .0006, + .0009}	.0012	Binnendijk
1970	.0000	+ .0010	.0010	Binnendijk
1982	- .0002	+ .0003	.0005	This paper

The different heights of the maxima (occurring at phase angles 100^{o} and 260^{o}) and the rapid variations in the shape of the light curve (Binnendijk, 1972) together with the decreasing value of $\Delta = (O-C)_2 - (O-C)_1$ appear to indicate periastron revolution. For this system, its major cause is likely to be the distortion of the close components.

The observations by Soloviev indicate that a period change may have taken place prior to J.D. Hel. 2,436,673. Unfortunately, Soloviev's observations appear to be contradictive in this respect.

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BV PHOTOMETRY AND PERIOD VARIATION OF GO CYGNI

The variability of GO Cyg (=HD 196628 = BD + 34^{o}4095) was discovered photographically by Schneller (1928). The star was classified as a short-period eclipsing binary by Kukarkin (1929). The first light elements were given by Szczyrbak (1932) considering the system to be of Algol type as follows:

$$\text{Min.I} = \text{JD Hel. } 2426509.467 + 0\overset{d}{.}717767.E. \qquad (1)$$

The visual observations made by Kukarkin (1932) from 1929 to 1931 showed a β Lyrae type variation. From the visual and photographic observations, several authors have found contradictory results about the shape of the light curve and the eccentricity of the orbit (see Ovenden, 1954). The only published spectrographic observation of the system was made by Pearce (1933). The complete two-colour photoelectric photometry of the star was made by Ovenden (1954), and Mannino (1963) who also analyzed their light curves. The period variation of the system was discussed by Purgathofer and Prochazka (1967) collecting all of the published minima in the literature. Using the recent photoelectric times of primary minima, they gave the following linear light elements:

$$\text{Min.I} = \text{JD Hel. } 2433930.40561 + 0\overset{d}{.}71776382.E. \qquad (2)$$

Assuming a parabolic O-C variation for all minima they also suggested the following quadratic light elements:

$$\text{Min.I} = \text{JD Hel. } 2433930.40614 + 0\overset{d}{.}71776314.E + 0\overset{d}{.}108.10^{-9}.E^{2}. \quad (3)$$

The system was observed photoelectrically at the Ege University Observatory on eight nights during the summer of 1984. The observations were made in yellow and blue colours using a 48 cm Cassegrain telescope and a photoelectric photometer equipped with an unrefrigerated photomultiplier tube EMI 9781A and Johnson's standard B, V filters. A total of 398 individual points were obtained in each colour. BD + 35^{o}4180 was used as the comparison and BD + 34^{o}4098 as the check star. No evidence for the variability of the comparison star was found. The extinction coefficients determined night by night were applied in the correction for differential extinction. During the observations three primary and two secondary minimum times were obtained. These minima are given in Table I together with all of the other published ones.

Table I. Times of minima of GO Cygni.

JD Hel.	Min	Method	E	$(O-C)_1$	$(O-C)_2$	Ref.
2425556.99	I	pg	-11666	0.02	0.00	1
864.905	I	vis	-11237	0.011	-0.009	2
26112.539	I	vis	-10892	0.017	-0.002	3
120.424	I	pg	-10881	0.007	-0.013	4
509.467	I	vis	-10339	0.022	0.004	5
540.327	I	vis	-10296	0.018	0.000	2
711.145	I	vis	-10058	0.008	-0.009	6
957.355	I	vis	-9715	0.025	0.009	7
27058.553	I	vis	-9574	0.018	0.003	8
140.3745	I	pg	-9460	0.0146	-0.0007	8
325.561	I	vis	-9202	0.018	0.003	8
330.589	I	pg	-9195	0.022	0.007	9
417.433	I	vis	-9074	0.016	0.002	8
28035.431	I	vis	-8213	0.020	0.007	10
398.612	I	vis	-7707	0.012	0.001	11
418.708	I	vis	-7679	0.011	0.000	11
797.688	I	vis	-7151	0.011	0.002	11
807.744	I	vis	-7137	0.019	0.009	11
823.529	I	vis	-7115	0.013	0.003	11
838.604	I	vis	-7094	0.015	0.005	11
33111.4392	I	pe	-1141	0.0021	0.0010	12
483.9573	I	pe	-622	0.0008	0.0000	13
496.8783	I	pe	-604	0.0020	0.0013	14
539.944	I	pg	-544	0.002	0.001	15
861.499	I	pe	-96	-0.001	-0.002	16
930.40600	I	pe	0	0.00039	0.00000	17
34309.38563	I	pe	528	0.00072	0.00057	17
516.818	I	pe	817	-0.001	-0.001	18
606.53982	I	pe	942	0.00069	0.00068	17
923.786	I	pg	1384	-0.005	-0.005	19
36782.442	II	pe	3973.5	0.002	0.002	20
37106.5092	I	pe(V)	4425	-0.0013	-0.0017	20
106.5116	I	pe(B)	4425	0.0011	0.0007	20
147.42258	I	pe	4482	-0.00047	-0.00085	21
189.41700	II	pe	4540.5	0.00477	0.00436	21
882.4140	I	pe	5506	0.0008	-0.0002	20
887.4377	I	pe	5513	0.0002	-0.0009	20
888.516	II	pe	5514.5	0.002	0.001	20
910.4056	I	pe	5545	-0.0004	-0.0014	20
45866.4836	II	pe(B,V)	16629.5	0.0245	0.0014	22
874.376	II	pe(B,V)	16640.5	0.022	-0.002	22
954.4082	I	pe(B,V)	16752	0.0231	-0.0005	22
972.3535	I	pe(V)	16777	0.0243	0.0006	22
972.3528	I	pe(B)	16777	0.0236	-0.0001	22
982.4010	I	pe(B,V)	16791	0.0231	-0.0006	22

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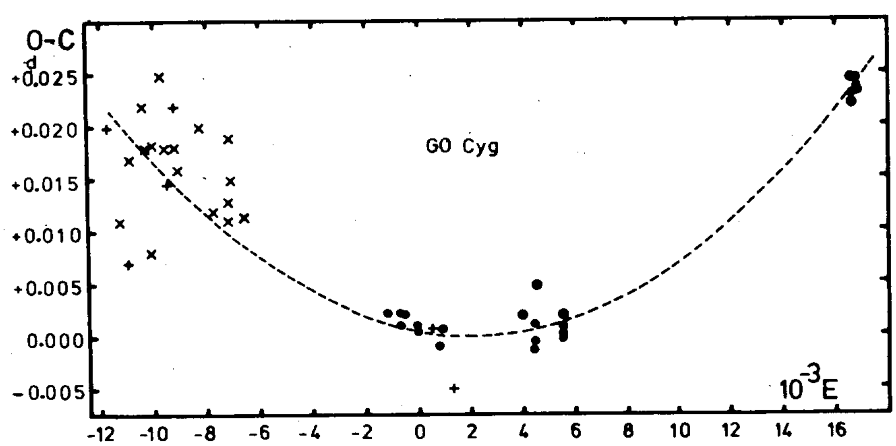

Figure 1 : 0-C diagram of GO Cygni. The dots, circles, plusses and crosses denote photoelectric MinI, photoelectric MinII, photographic and visual MinI, respectively. The dashed line represents the computed parabola.

The $(O-C)_1$ residuals in the table were computed using Equation (2) and plotted in Figure 1 versus E. As it is seen from the figure, the distribution of the $(O-C)_1$ residuals seemsto be a parabola. Using the two photographic and 23 photoelectric times of minima obtained after JD 2433000, the new quadratic light elements,

$$\text{Min.I} = \text{JD Hel. } 2433930.4060 + 0^{d}.71776331.E + 0^{d}.113.10^{-9}E^{2} \quad (4)$$
$$\pm 5 \qquad\qquad \pm 22 \qquad\qquad \pm 12$$

have been derived by the least squares method. The $(O-C)_2$ values in the table are the differences between observations and calculations with these new light elements. Although the old visual and photographic observations are not taken into account in the computations because of their large scattering, they fit well to the parabolic curve. The parabolic curve has a minimum at about JD 2435600 (E ≈ 2300) and after this epoch the period is increasing. The increase in the period of the system is found to be about 0.99±0.11 second per century.

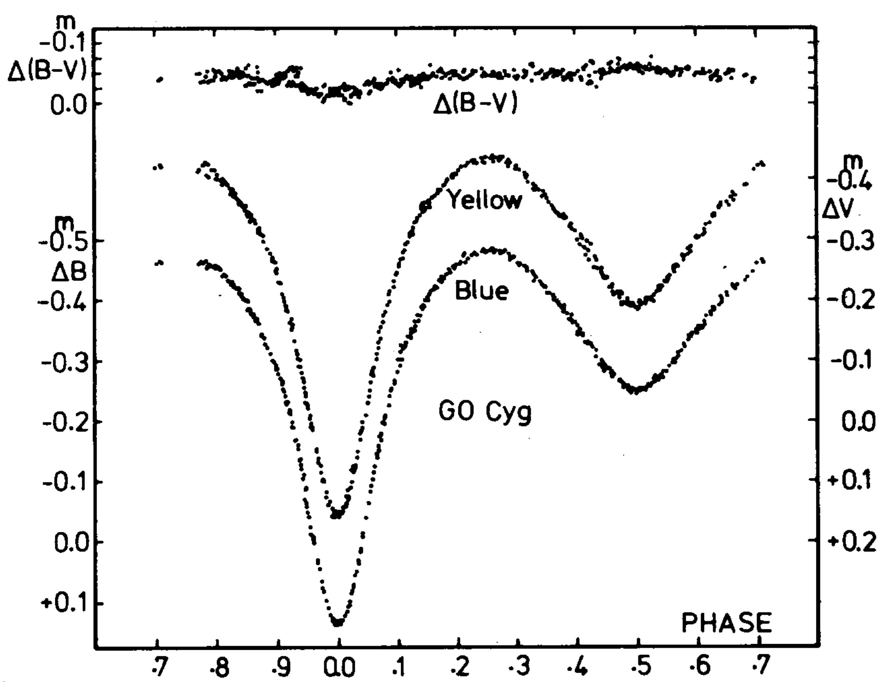

Figure 2 : The light and colour curves of GO Cygni.

The light and colour curves of GO Cygni are shown in Figure 2 where the phases have been calculated with the following linear light elements:

$$\text{Min. I} = \text{JD Hel. } 2445865.4056 + 0^{d}.71776707.E. \qquad (5)$$

These light elements have been obtained from the Equation (4) reducing the epoch and the period to June 13, 1984 and may be used in the near future. The shape of the light curve is typical of β Lyrae type. There is no asymmetry in the minima and no displacement in the secondary minimum, and the maxima are equal. The amplitudes are about $0^{m}.600$ and $0^{m}.580$ at the primary, $0^{m}.230$ and $0^{m}.240$ at the secondary minimum in the blue and yellow light, respectively. The system is slightly redder at the primary and bluer at the secondary minimum which is consistent with the spectral types of the components given by Pearce (1933).

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PHOTOELECTRIC PHOTOMETRY OF DI CEPHEI DURING 1981-1984

The T Tauri type variable star DI Cephei (Kholopov, 1952) was observed at the mountain station of the Konkoly Observatory. The measurements were carried out with an unrefrigerated photoelectric photometer, attached to the 102 cm Ritchey-Cretien telescope of the observatory. The identification chart is shown in Figure 1.

On several nights DI Cephei was monitored in order to record flare-like activity in the U band. As Figures 2-5 show, there are irregularities on the light curve, especially in the U band. The most convincing flare-like events occurred on the night 10/11 September 1983 (J.D.2445588.5702).

In that case the amplitude of the brightening reached about 3 magnitudes in U band, about 0.8 magnitude in B band and about 0.4 magnitude in V band.

Table I shows the observed average brightnesses during the monitoring intervals, where the first column gives the calendar date, column 2 the J.D. of the beginning and the end of measurements. One moment represents the middle of the monitored time interval. Columns 3-5 give the average UBV magnitudes.

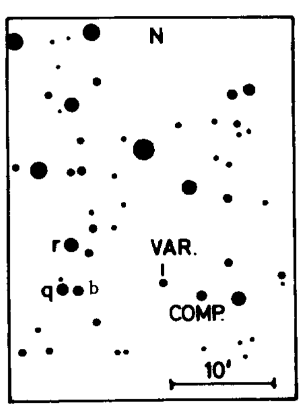


Figure 1 : Identification chart for the variable and the comparison stars.

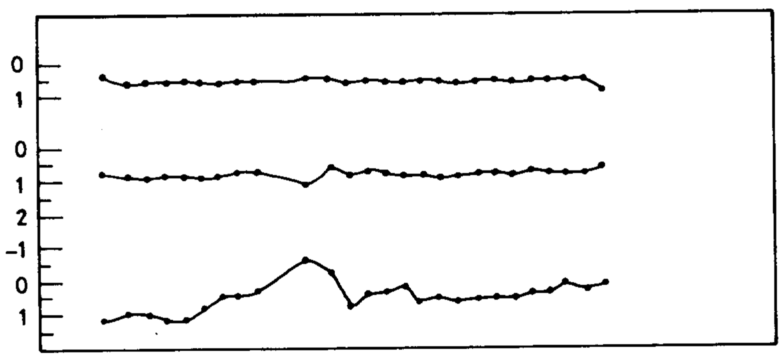


Figure 2 : Light curve based on the 08/09 Sep. 1983 (J.D.2445586.3098-.6255 observations.

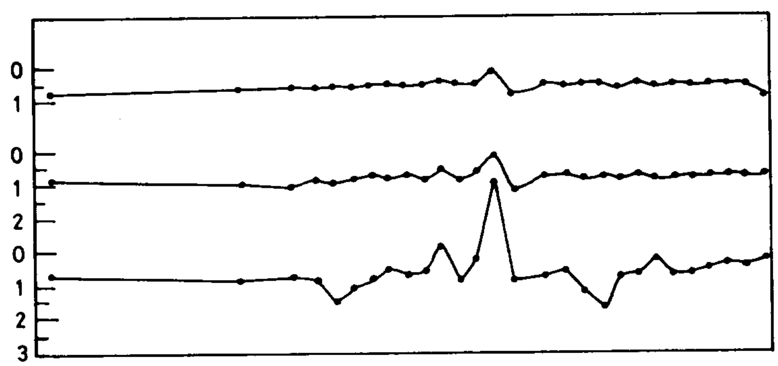


Figure 3 : Light curve based on the 10/11 Sep. 1983 (J.D.2445588.3361-.6292) observations.

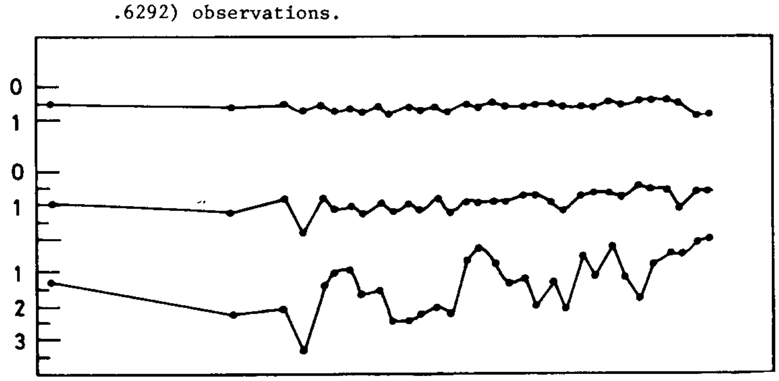


Figure 4 : Light curve based on the 04/05 Oct. 1983 (J.D.2445612.3350-.6076) observations.

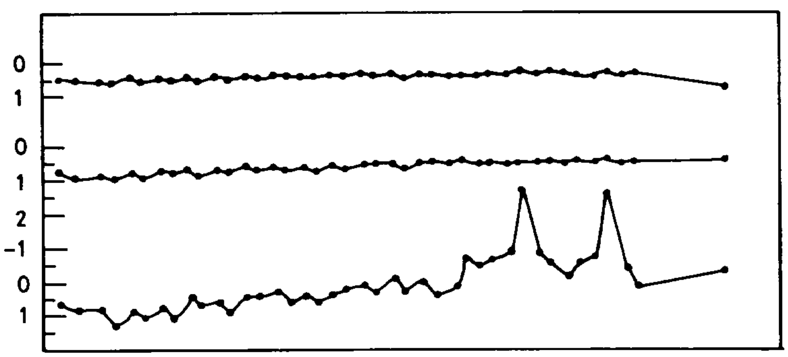
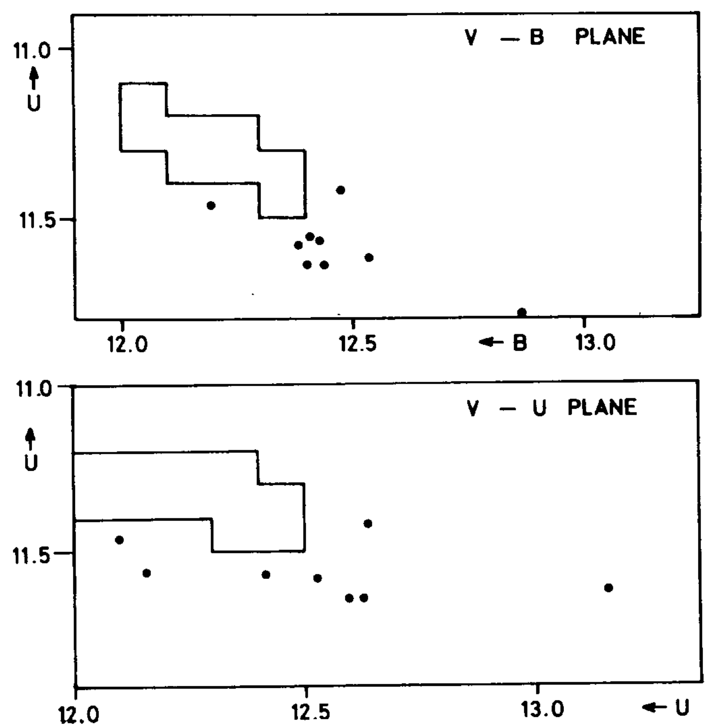


Figure 5 : Light curve based on the 05/06 Oct. 1983 (J.D.2445613.2545-.5855) observations.



Figures 6-7 : The observed average values on the V-B and V-U plane. The area encircled with solid lines means the observed boundaries of previous measurements. (Drawing after the graphs published by Gahm and Petrov, 1983).

Table I

Date	J.D.(244...)	V	B	U
16/17.07.1981	4802.5044	11.36	12.58	12.64
27/28.03.1982	5056.6444	11.73	12.97	13.5
08/09.09.1983	5586.3098-.6255	11.51	12.53	12.42
10/11.09.1983	5588.3361-.6292	11.52	12.49	12.53
04/05.10.1983	5612.3350-.6076	11.56	12.64	13.16
05/06.10.1983	5613.2545-.5855	11.4	12.3	12.1
01/02.09.1984	5945.5597	11.58	12.51	12.63
04/05.09.1984	5948.6220	11.5	12.51	12.16
05/06.09.1984	5949.5976	11.58	12.54	12.6

Figures 2-5 show the ΔV ΔB and ΔU light curves in the monitored interval.

DI Cephei shows remarkable variability pattern on the V - B and V - U plane (Gahm and Petrov, 1983). The new observations are in good agreement with that pattern but the measured magnitudes are greater than the previous ones.

Figures 6-7 show the new data plotted on the graph from the publication of Gahm and Petrov.

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PHOTOELECTRIC $H_\beta W$ AND $H_\beta N$ OBSERVATIONS OF W UMa (BD+56°1400)

The photoelectric observations of W UMa were carried out on 7 nights of April 3, 5, 6, 13, 15, 16 and 19, 1983. The observations were obtained using the 51 cm, f/13.5 cassegrain reflector at Biruni Observatory of Shiraz University. The photoelectric photometer is equipped with an unrefrigerated RCA 4509 multiplier tube and a Leeds and Northrup Speedomax was used to record the amplified signals from the photomultiplier. The observations were made using Strömgren $H_\beta N$ and $H_\beta W$ filters, the characteristics of them are given in Table I. The sequence of observations was the usual pattern of sky-comparison-variable-comparison-sky, with each reading lasting about 50 seconds.

Table I: Filter characteristics

Filter	Halfwidth (Å)	Max transmission	λ(max)(Å)
$H_\beta W$	155	86.5%	4859
$H_\beta N$	31	47.5%	4858

The comparison star was SAO 27274 and SAO 27268 served as a check star. No significant variations were detected in the magnitude differences between the comparison and check stars. The moments of minima were obtained using Russell method according to the ephemeris (Hamzaoglu et al., 1982).

JD Hel MinI=2444986.3624 + $0^d_.33363808$ E

The observed minimum times and (O-C) values are given in Table II.

Table II

JD Hel 2440000+	Type of Min	Filter	E	(O-C) days
5444.4468	Min I	$H_\beta N$	1373	-0.0007
5444.4456	Min I	$H_\beta W$	1373	-0.0019
5444.2802	Min II	$H_\beta N$	1372.5	-0.0005
5444.2789	Min II	$H_\beta W$	1372.5	-0.0018

One can see that the (O-C) values of the primary minimum are slightly greater than those for the secondary. The light curves are presented in Figure 1. Both light curves are asymmetrical where the maximum near 0.25 phase is brighter than the corresponding maximum at 0.75 phase. The differences in the mean heights of the maximum at 0.25 phase relative to the maximum at

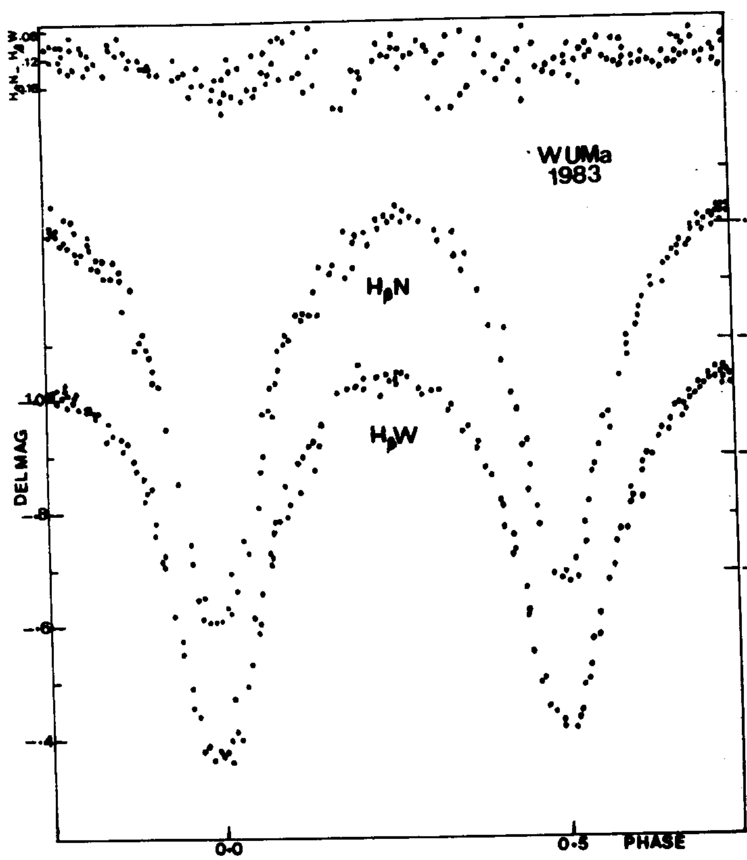

Figure 1 : The $H_\beta N$ and $H_\beta W$ light curves ot W UMa.

0.75 phase are 0.013 mag and 0.010 for $H_\beta W$ and $H_\beta N$ observations respectively. The loss of light at primary eclipse relative to the brighter maximum at 0.25 phase is 0.670 mag and 0.712 mag in $H_\beta W$ and $H_\beta N$ respectively. Consequently the primary minimum depth is deeper than the secondary minimum.

I would like to express my gratitude to Mr. Y. Sobuti, Mr. D. Dorren, Mr. H. Hadipour and Mr. N. Riazi for their help.

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A FUOR-LIKE NEW VARIABLE STAR IN ORION

R.Sh. Natsvlishvili from the Abastumani Observatory, Georgia, U.S.S.R., published in July, 1984, in the IBVS No. 2565 an interesting note dealing with non-stable stars in the Orion Nebula Region. His new variable star No. 24 is "characterized by Fuor-like variability in smaller scale and at maximum it has a very strong Hα emission".

We were very much interested in this particular star and reviewed the large Tonantzintla Schmidt camera plate collection obtained in different colors - with and without the objective prism - which covers the Orion Nebula Region starting in 1944 and ending in 1984. Unfortunately, we did not observe the Orion region during the 1982 winter months nor during the 1983 Orion seasons. Apart from the Tonantzintla Observatory photographic material we have at our disposal some of the Mt. Palomar 48" Schmidt camera photographs (blue and red) taken on March 20/21, 1950, and the corresponding ones to the already well known National Geographic Society - Palomar Observatory Sky Survey collection taken in November, 1955. Besides it is important to add single image plates in the B, R, I colors and 3 multiple image plates (U-B-V) secured by one of us (G.H.) at Mt. Palomar during the October and November months in 1958 plus 1 U-B-V plate in February, 1963. Finally in March 20 and 21 of this year M. Peimbert, using the 2.1 m telescope at KPNO and the intensified dissector scanner IIDS and two gratings covering the wavelength ranges λλ3400-5200, λλ5600-7400, secured good spectrophotometric information on the Abastumani variable star No. 24.

In this preliminary note and based on the observations briefly mentioned before we can present the following general conclusions:

1. The Abastumani star No. 24 was a variable star of small amplitude (no more than 1 magnitude) in the UBVRI colors, at least during the lapse comprised between 1944 up to the beginning of 1982.
2. During the prolonged minima the smoothed average magnitudes were:
   $U \simeq 18.5$; $B \simeq 18.6$; $V \simeq 17.5$;
   $R \simeq 16.4$; $I \simeq 15.2$.

3. The small dispersion objective prism spectra (Tonantzintla Schmidt camera) did show with certainty that during minima a very weak Hα emission line (W λ $\lesssim$ 10 Å) appeared. At the same time the red and near infrared spectra were difficult to classify although it can be guessed a late K or early M type. Of course this particular star could not be classified during minimum light as an advanced T Tauri object.
4. It seems that during and after the outburst a rather strong Hα emission line appears, according to Natsvlishvili's information.
5. The spectra obtained at the Kitt Peak Observatory by one of us (M.P.) in March 20 and 21, 1985, corresponds to a rather advanced T Tauri type star with very strong H and CaII emission lines and the metallic emission features are very conspicuous. Of course, the flourescent FeI emission lines λλ4063-4132 are easily detected. No [S II] or [O I] emission lines were detected, but the HeI and [CaII] emission lines seem to be present.
6. Although in the visual, blue and ultraviolet part of the spectrum (1985) the absorption lines seem to be masked, in the red TiO absorption broad bands are detectable and provide a base to classify the star No. 24 as of early M type.
7. The magnitudes of the star in March 20/21, 1985, derived from the spectrophotometric observations are as follows: $U = 17.4 \pm 0.2$; $B = 17.5 \pm 0.2$; $V = 16.4 \pm 0.2$; $R = 14.8 \pm 0.3$.
   From an extrapolation of the observations it is predicted that $I \sim 13.6 \pm 0.3$.
8. In a multiple exposure ultraviolet color plate obtained at Tonantzintla on the 27/28 of January, 1982 (limiting magnitude $U = \sim 17.5$) the Abastumani variable star No. 24 is not visible at all but in another multiple exposure ultraviolet photograph secured on the night of 23/24 January, 1984, $U \leq 15.5$.

More detailed information and some provisional remarks will be given elsewhere in the near future. We hope that at the Abastumani and the Byurakan Observatory, as well as at other observatories, there are available photometric and spectroscopic observations obtained during the 1982-1985 period and previous to the 1982 outburst of the variable star No. 24.

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THE ELLIPTICITY EFFECT AND A MIGRATING WAVE
IN THE CHROMOSPHERICALLY ACTIVE TRIPLE SYSTEM V772 Her

V772 Herculis = HD 165590 = ADS 11060 is a triple system very interesting in many respects. Important references are Morbey et al. (1977), Scarfe (1977), Batten et al. (1979), Fekel (1981), Bakos and Tremko (1982), and Stern and Skumanich (1983). From these we get the following picture. A G0V star (the spectroscopic primary) and an M1V star (spectroscopically unseen) orbit each other with a period of $0\overset{d}{.}8795$ at an inclination of $77^{\circ} \pm 7^{\circ}$. That close pair orbits a G5V star (the spectroscopic secondary) with a period of $20\overset{y}{.}25$ at an inclination of $82\overset{\circ}{.}7 \pm 2\overset{\circ}{.}0$. The system is very young, similar in age to the Pleiades, and emits soft x-ray radiation, with $L_x = 4 \times 10^{30}$ ergs/sec. Both the G0V and the G5V stars show Ca II H and K emission in their spectra. The G5V star rotates unusually rapidly (Vsini = 18 ± 2 km/sec) and the G0V star rotates exceedingly rapidly (Vsini = 75 ± 5 km/sec), apparently in synchronism with the short orbital period. The long-period orbit is highly eccentric, with e = 0.958, and last underwent periastron passage in 1978. The short-period orbit undergoes shallow ($\Delta V = 0\overset{m}{.}05$) eclipses and also additional variations outside eclipse which until now have not been understood.

With the 10-inch Newtonian at Fairborn Observatory (Boyd et al. 1984) V772 Her was observed differentially on 21 nights in 1984 in the UBV system, the comparison star being HR 6763 = HD 165524. The data are given in Table I. A preliminary plot, with respect to the ephemeris

$$JD(hel.) = 2443656.6635 + 0\overset{d}{.}8794998\ n \qquad (1)$$

given by Bakos and Tremko for times of primary eclipse, indicated that V772 Her was in eclipse on two of our 21 nights, marked with a (p) in Table I. They are useful as recent timings of mid eclipse, uncertain by approximately $\pm\ 0\overset{d}{.}01$. O-C residuals with respect to equation (1) are $+0\overset{d}{.}017$ and $+0\overset{d}{.}003$.

Next we used least squares to fit a sinusoidal light curve to the 19 differential magnitudes outside eclipse, with a range of different periods assumed. The results are shown in Table II, where the second column is the period which gives the smallest variance, the third column is the full amplitude of the wave, and the last column is the Julian date of the minimum of

Table I

Differential Photometry of V772 Her = HD 165590

JD(hel.)	ΔV	ΔB	ΔU	note
2445970.6444	$0^{m}.903$	$0^{m}.293$	$-0^{m}.743$	(p)
2445972.6468	0.812	0.247	-1.054	(f)
2445973.6602	0.843	0.250	-0.920	(f)
2445984.6088	0.860	0.245	-0.793	
2445986.6221	0.854	0.217	-0.857	
2445987.6157	0.824	0.203	-0.847	
2445990.6117	0.870	0.257	-0.779	
2445993.5999	0.842	0.215	-0.841	
2445996.5891	0.886	0.292	-0.720	
2445999.5812	0.837	0.227	-0.810	
2446000.5977	0.832	0.216	-0.831	
2446001.5774	0.812	0.186	-0.875	
2446002.5815	0.877	0.262	-0.790	
2446005.5663	0.838	0.235	-0.811	
2446006.5701	0.857	0.229	-0.819	
2446007.5695	0.909	0.272	-0.799	(p)
2446008.5688	0.836	0.221	-0.839	
2446009.5720	0.867	0.261	-0.768	
2446010.5621	0.883	0.271	-0.773	
2446012.5612	0.849	0.239	-0.825	
2446013.5601	0.853	0.231	-0.849	

Table II

Fourier Analysis of the Migrating Wave

λ	P	Δm	JD(min.)
V	$0^{d}.8726$	$0^{m}.0489$	2445970.428
	±.0020	±.0038	±.009
B	0.8755	0.0598	2445970.416
	±.0020	±.0044	±.008
U	0.8710	0.0965	2445970.420
	±.0025	±.0064	±.007

Table III

Fourier Analysis of the Ellipticity Effect

λ	Δm	JD(min.)	O–C
V	$0^{m}.0136$	2445970.604	$-0^{d}.023$
	±.0035	±.010	
B	0.0197	2445970.593	-0.034
	±.0033	±.005	
U	0.0469	2445970.617	-0.017
	±.0052	±.005	

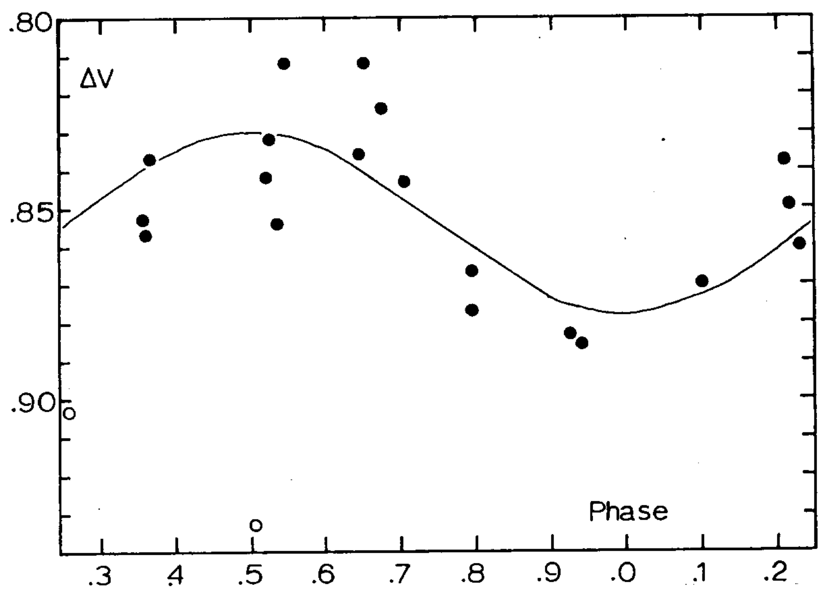

Figure 1

Light curve of V772 Her in V with phase computed from equation (2). The solid curve is a sinusoidal fit of the migrating wave, with zero phase at light minimum. The two eclipse points, open circles, do not coincide here because 0.873 days is not the 0.8795-day orbital period.

the wave. All 21 ΔV values are plotted in Figure 1, where phase is computed with the ephemeris

$$JD(hel.) = 2445970.421 + 0^{d}.873\ n, \qquad (2)$$

which is an average of our results in the three bandpasses. The solid curve is a sine wave with a full amplitude of $\Delta V = 0^{m}.049$ and with its minimum at zero phase. Note that the two eclipse points do not coincide, because $0^{d}.873$ is not the $0^{d}.8795$ orbital period.

Our Fourier analysis in the U bandpass omitted values from two consecutive nights, marked (f) in Table I, which gave extremely large residuals, both overluminous. We recall that Bakos and Tremko saw a flare on June 16, 1979 which made the system brighten by $0^{m}.125$ in U.

In short-period (therefore, presumably, close) eclipsing systems one anticipates a detectable ellipticity effect. Therefore we removed the wave from our observations, using its $0^{d}.873$ period and the appropriate amplitude for each bandpass, and did another Fourier analysis which allowed for a cos 2θ variation, this time computing phase with the $0^{d}.8795$ orbital period. Results are shown in Table III, where Δm is the full amplitude of

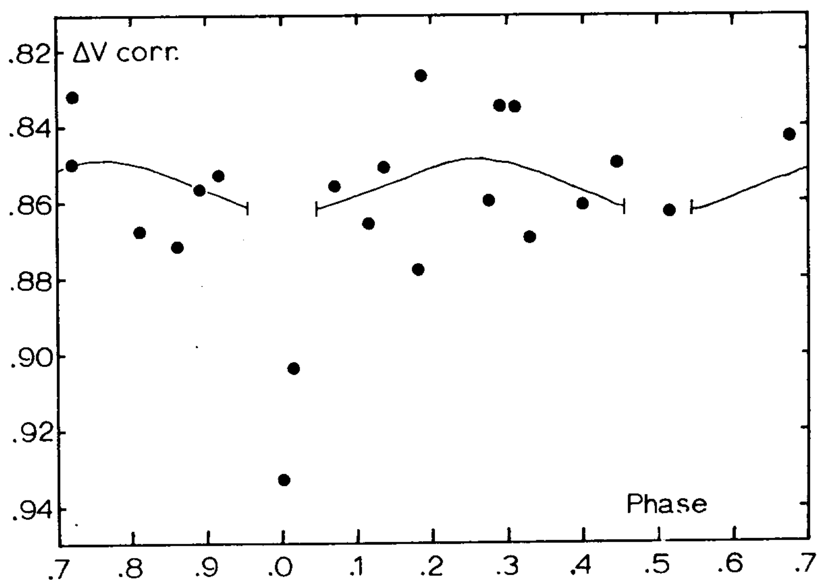

Figure 2

The ordinate is ΔV corrected by removing the migrating wave; phase is computed with equation (1). The solid curve is a cos 2θ Fourier fit showing presumably the ellipticity effect, with zero phase at the conjunction corresponding to primary eclipse. In this figure the two eclipse points do coincide because here 0.8795 days is the orbital period. We see no trace of a secondary minimum.

the variation, JD(min.) is the Julian date of the minimum which corresponds to conjunction with the GOV star behind, and O-C is the residual with respect to the ephemeris in equation (1). Because these times of conjunction should be logically equivalent to times of mid primary eclipse, it is not surprising that the O-C residuals are close to zero vis a vis their uncertainties.

All 21 ΔV values, with the wave removed as we discussed, are plotted in Figure 2, where phase is computed with the ephemeris in equation (1). The solid curve is the cos 2θ wave with a full amplitude of $0^{m}.0136$. The interrupted portions allow for eclipses, which Bakos and Tremko say are approximately 2 hours in duration. Note that, because we are using the orbital period here, our two eclipse points do coincide very near zero phase. Although our phase coverage is not dense, we note no trace of a secondary eclipse around phase $0^{p}.50$.

The 1978 periastron passage should have produced an interesting glitch in the O–C curve similar to that seen in QS Aquilae, another eclipsing binary in a highly eccentric long-period orbit around a third star, by Knipe (1971). From parameters in table II of Batten et al. we can estimate that the amplitude of such a glitch should have been only about $0^d.001$ or $0^d.002$. The only times available to establish the course of the O–C curve before the JD 2443669.24 periastron were the two of Scarfe, closely spaced in time (Δn = 24 cycles) and both relatively uncertain (± $0^d.007$). Our recent times add little statistical weight in defining the course of the O–C curve after periastron. Therefore, unfortunately, the available data are incapable of revealing this small effect. The amplitude of the glitch Knipe saw in QS Aql, $0^d.07$, was considerably larger.

Our finding of a migrating wave in the light curve of V772 Her explains the curious photometric behavior outside eclipse which Scarfe noticed but did not explain. The 0.75% difference between $0^d.8795$ and $0^d.873$ would explain why Scarfe found the variation correlated approximately but not exactly with orbital phase. Bakos and Tremko noticed similar behavior but explained certain aspects of it by imagining the M-type component a T Tauri star filling its Roche lobe, transferring matter onto the GOV star, and producing a hot spot at the point of impact. We, however, believe the $0^d.873$ variability arises from a not-quite-synchronously rotating star whose surface is darkened unevenly by regions of starspot activity, as is virtually always the case in chromospherically active stars which show strong Ca II H and K emission in their spectra. The star responsible is surely the GOV component, because the G5V component (although it shows H and K emission also) has Doppler broadened lines which imply a rotation period of 2 or 3 days, very different from $0^d.873$. Note that the wavelength dependence of the Δm values in both Table II and Table III is such as to have arisen from the GOV star, i.e., the hottest of the three in the triple system.

This extremely interesting triple system would profit from more thorough photometric coverage which could yield a solution of the light curve for the geometrical parameters of the GOV + M1V system. Such photometry should cover the phases of both primary and secondary eclipse, although the latter may prove undetectable. It should cover the phases outside eclipse simultaneously, so that the photometric complication of the migrating wave can be removed before solution. And the photometry should be multicolor, to help in removing the third light contributed by the G5V star.

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CONTACT TIMES FOR THE 1982-4 ECLIPSE OF EPSILON AURIGAE

Photoelectric UBV measurements of Epsilon Aurigae have been obtained during the past three observing seasons with the Hopkins Phoenix Observatory 20-cm telescope and during the 1982-3 and 1983-4 seasons with the Tjornisland Astronomical Observatory 36-cm telescope. Using the extensive V-filter dataset shown in Figure 1, contact times are derived for the system's recent eclipse.

The times are calculated by extrapolating a linear fit of ingress and egress data to the mean in- and out-of-eclipse light levels (for details, see Schmidtke 1985). The derived contact times are labeled on Figure 1 and summarized in Table I. Included in the table are the predicted times given by Gyldenkerne (1970), based primarily on photometry of the 1955-7 eclipse. Third contact during the recent eclipse is considerably delayed with respect to the other contact times as noted by Oki (1984) and Boyd (1984), yielding a longer totality and more rapid egress than observed during past eclipses. Whether these phenomena are due to real changes in the system's geometry or just represent the superposition of the primary's intrinsic light variations on a normal egress is unclear.

Subject to these uncertainties, the contact times given here must be regarded as provisional estimates. A more extensive treatment of this dataset as well as other photometry contributed to the Epsilon Aurigae 1982-4 Observing Campaign is in preparation. Investigators are encouraged to continue their monitoring of this system during the next observing season to document the post-eclipse variations. UBV data summaries can be sent to Hopkins Phoenix Observatory.

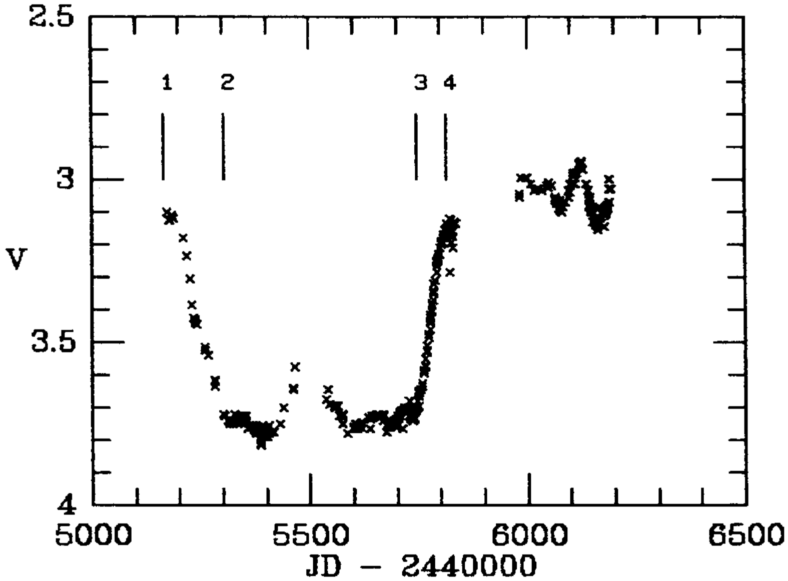

Fig. 1. V-filter light curve of Epsilon Aurigae.

Table I

contact	Observed Time Date	Observed Time JD	Predicted Time Date	Predicted Time JD
1st	82 Jul 14	2445165	82 Jul 29	2445180
2nd	82 Nov 28	2445302	82 Dec 11	2445315
3rd	84 Feb 17	2445748	82 Jan 09	2445709
4th	84 Apr 21	2445812	82 May 29	2445850

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NEW VARIABLE STARS FOUND IN SOUTHERN OPEN CLUSTERS

In this note we report the variability detected photoelectrically in sixteen stars located in the vicinity of the southern open clusters NGC 2323, NGC 2567, IC 2395, NGC 5460, and NGC 5662. We are studying all these clusters using new photometric and spectroscopic material obtained at Cerro Tololo (CTIO) and Las Campanas (LCO) observatories. The project, initiated a couple of years ago, consists in obtaining UBV photometry and classification of spectra as basic data to investigate the fundamental properties of the selected clusters. A total of 1040 stars in the cluster fields have been measured photoelectrically during various observing runs in 1984-1985, using the 60 cm telescope of the David Dunlap Observatory at LCO, and the CTIO 91 cm and 1 m telescopes. Several red stars in the cluster fields have also been observed in the DDO intermediate-band system (McClure and van den Bergh 1968; McClure 1976) and the CMT_1T_2 broad-band system (Canterna 1976). A large number of standard stars, taken from the lists of Cousins (1973, 1974), McClure (1976), and Canterna (1976), were observed each night for conversion to the standard UBV, DDO, and Washington systems, respectively. Pulse-counting electronics was used for all measurements. Photometric errors are similar to those quoted in previous papers (e.g., Clariá and Rosenzweig 1978; Clariá and Lapasset 1983). The mean internal error is about $0^m.02$, a value which is practically independent of the V-magnitude and the telescope used.

We have considered a star to be photometric variable when its individual V measures during different nights displayed variations greater than five times the mean internal error, i.e., $\Delta V \geq 0^m.1$. Among the new photometric variables detected there are nine which are members or probable members of the clusters (Clariá and Lapasset 1985), while the other seven are almost certainly non-member field stars. Four of the new variables exhibit ΔV variations greater than $0^m.20$, while the other twelve stars have ΔV variations in the interval $0^m.10 \leq V \leq 0^m.20$.

The individual UBV observations of the new variables are listed in Table I. The references for star identifications are given at the head of each section of the table. Column (2) of Table I lists the heliocentric Julian Date. The magnitude and colours in the UBV system are given in columns (3)-(5), while column (6) gives the spectral type as estimated from the UBV colours. The last column of Table I indicates if the star is considered to be cluster member (m), a probable member (pm), or a non-member (nm) field star. Finding charts for the variable stars are shown in Figures 1 to 4. The new variables found in NGC 2567 are shown in the finding chart published by Lindoff (1968).

Table I: Individual UBV observations of new variable stars found in southern open clusters.

STAR	HJD 2440000 +	V	B-V	U-B	Sp. Type	Membership
		NGC 2323 (Clariá and Lapasset 1985)				
58	6111.6149	12.541	0.279	0.281	A1	m
	61112.5583	12.432	0.379	0.279		
	6167.5106	12.475	0.349	0.302		
	6168.4912	12.480	0.333	0.276		
100	6111.6499	12.826	0.674	0.179	F8	pm
	6112.5121	12.926	0.603	0.139		
	6167.5167	12.891	0.610	0.178		
	6168.4937	12.868	0.640	0.150		
160	6111.6880	12.561	0.616	0.124	F8	nm
	6112.6138	12.557	0.522	0.187		
	6167.5614	12.453	0.594	0.052		
	6168.5420	12.524	0.577	0.121		
		NGC 2567 (Lindoff 1968)				
19	6112.6995	13.111	0.396	0.091	A7	pm
	6113.6127	13.310	0.275	0.173		
	6115.5762	13.240	0.365	0.122		
	6168.5774	13.305	0.316	0.124		
35	6112.7591	12.947	0.468	0.091	F6	nm
	6113.6760	12.900	0.525	-0.033		
	6115.7382	13.030	0.451	0.000		
40	6112.7669	13.841	0.264	0.176	A7	m
	6113.6760	13.730	0.336	0.195		
	6114.6406	13.782	0.304	0.147		
58	6112.6825	13.057	0.257	0.085	A5	m
	6113.6026	12.912	0.352	0.100		
	6115.5584	12.930	0.266	0.123		
	6168.5295	13.016	0.251	0.132		

Table I (continued)

STAR	HJD 2440000 +	V	B-V	U-B	Sp. Type	Membership
	IC 2395 (Clariá and Lapasset 1985)					
169	5762.7436	11.811	0.568	0.088	F8	nm
	5763.6896	11.919	0.449	0.058		
	5764.7196	11.759	0.558	0.051		
215	5762.6901	13.575	0.698	0.129	G0	pm
	5766.5873	13.688	0.665	0.124		
	5767.6165	13.632	0.682	0.127		
220	5781.6215	13.014	0.853	0.628	K1	nm
	5782.6795	13.331	0.580	0.583		
	NGC 5460 (Clariá and Lapasset 1985)					
330	5760.8987	13.056	0.625	0.079	G0	pm
	5765.8063	13.175	0.599	0.041		
	5768.7884	13.178	0.570	0.075		
337	5764.7675	12.935	0.384	0.038	F6	pm
	5767.7932	12.787	0.452	-0.002		
	5768.8055	12.785	0.494	0.002		
366	5761.8073	12.449	1.200	0.975	K3?	nm
	5762.8267	12.048	0.782	0.289		
	5767.8523	12.537	1.131	1.079		
375	5764.8179	13.006	0.426	0.063	F7	pm
	5765.8722	12.846	0.549	0.099		
	5767.7982	12.912	0.527	0.018		
	NGC 5662 (Clariá and Lapasset 1985)					
17	6112.8627	11.476	0.362	0.088	F2	nm
	6113.7821	11.364	0.415	0.214		
	6118.7769	11.465	0.378	0.160		
166	6111.8559	12.775	0.582	0.360	F8?	nm
	6113.8883	12.713	0.606	0.440		
	6118.8843	12.664	0.686	0.348		
	6167.8197	12.703	0.601	0.403		

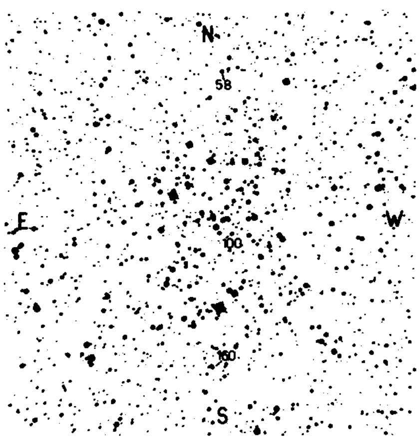

Figure 1: Finding chart for the variables found in NGC 2323.

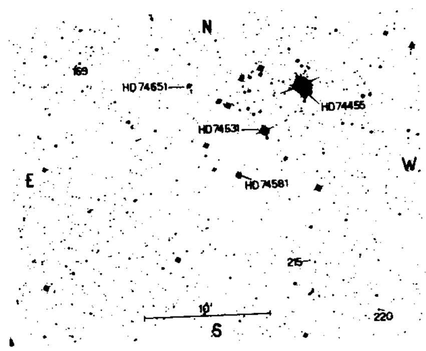

Figure 2: Finding chart for the variables found in IC 2395.

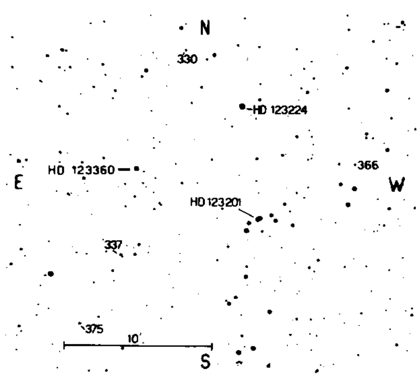

Figure 3: Finding chart for the variables found in NGC 5460.

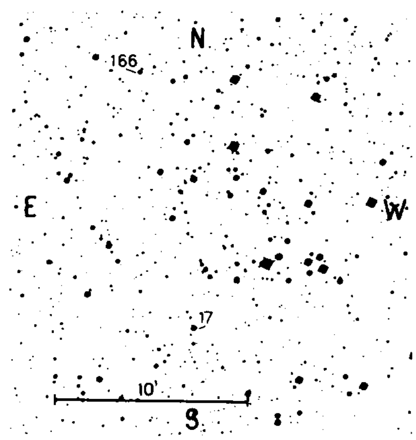

Figure 4: Finding chart for the variables found in NGC 5662.

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Number 2750

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UBV OBSERVATIONS OF SYMBIOTIC STARS IN JULY AND OCTOBER 1982

The observations were made using the Polarimeter II Martel (Chevreton et al. 1977) mounted at the Cassegrain focus of the 80 cm telescope at the Haute-Provence Observatory. Polarization measurements for the observed symbiotic stars did not yield significant results.

Each measurement relating to a variable star is given within the limits taken from similar measurements made for one or more comparison stars as indicated below:

Variable Stars	Comparison Stars
AG Dra	BD +67°925
CH Cyg	BD +49°2994
HM Sge	BD +28°3438
CI Cyg	BD + 35°3964, BD +35°3825, BD +35°3821
V 1016 Cyg	HD 194 279
HBV 475	No.1 NGC 6910
AG Peg	BD +11°4681
Z And	BD +48°4066, BD +47°4192
EG And	HD 3765
AX Per	No.2 NGC 581, BD +53°340
MWC 17	No.2 NGC 581
RW Aur	BD +30°748

The results of UBV measurements of the variable stars are given in Table I, together with the date and time in hundredths of the Julian day of the observation.

Our values of UBV for Z And, AG Peg and CI Cyg are in good agreement with results obtained by Belyakina (1984 and 1985) except that the values of U-B for CI Cyg are much lower than the minimum read from the curve given by Belyakina for CI Cyg in 1982.

If all the measured stars, with the exception of EG And, have U-B values between -0.30 and -1.10, the B-V values can be used to divide the stars into two classes :

1) those of type Z And with B-V>1 magnitude
2) [BQ] stars and protoplanetary nebulae with 0.10<B-V<0.70 magnitude.

Table I

UBV magnitudes of symbiotic stars observed in July and October 1982

Stars	JD 2 445 000+	V	B−V	U−B
AG Dra	174.46	9.53±0.02	+ 1.04±0.03	− 0.89±0.07
CH Cyg	174.50	5.75±0.006	+ 0.45±0.01	− 0.77±0.01
HM Sge	177.50	11.47±0.015	+ 0.14±0.03	− 0.41±0.05
CI Cyg	173.48	10.50±0.03	+ 1.16±0.05	− 0.23±0.05
	258.39	11.28±0.02	+ 1.65±0.04	− 0.37±0.10
	263.43	11.24±0.02	+ 1.53±0.04	− 0.25±0.10
V 1016 Cyg	178.49	11.23±0.01	+ 0.10±0.03	− 0.98±0.03
HBV 475	264.42	12.88±0.02	+ 0.68±0.04	− 1.08±0.08
AG Peg	173.54	8.31±0.01	+ 0.99±0.02	
Z And	174.55	10.53±0.01	+ 1.35±0.02	− 0.49±0.04
	262.45	10.74±0.005	+ 1.10±0.03	− 1.02±0.05
EG And	263.53	7.22±0.01	+ 1.71±0.02	+ 1.61±0.05
AX Per	262.51	11.48±0.01	+ 1.38±0.04	− 0.63±0.05
MWC 17	262.56	11.66±0.02	+ 0.42±0.03	− 0.20±0.04
RW Aur	263.56	10.66±0.01	+ 0.52±0.03	− 0.30±0.04

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THE OLD-NOVA GK PER (1901) : EVIDENCE FOR A TIME-DELAY BETWEEN ITS X-RAY AND OPTICAL OUTBURSTS.

One of the most intriguing peculiarities of the old-nova GK Per is its "dwarf nova-like" behaviour (Sabbadin and Bianchini, 1983, Astron. Astrophys. Suppl. Series 54, 393).

A comparative analysis of X-ray, UV, and optical data from the nova during the outburst phenomena revealed the existence of a time-delay between the X-ray and the optical light curves. This is shown in Fig.1 which refers to the 1978 outburst, the only one for which an extended X-ray monitoring of the old-nova is available (King et al.,1979, Monthly Notices Roy. Astron. Soc. 187, 77P). In this figure the X-ray data are as in King et al.(1979) whereas the optical ones have been kindly communicated to us by Janet Mattei, director of the AAVSO.

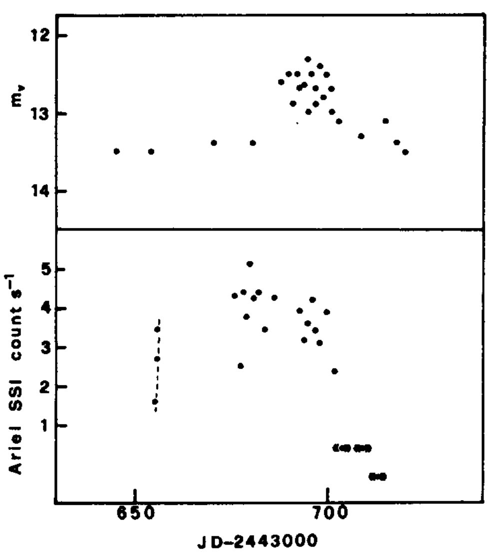

Fig.1. The optical (top panel) and the X-ray (bottom panel) light curves of GK Per during the 1978 outburst. Comments on the X-ray data points are given by King et al.(1979). The dashed line refers to what seems to be a steep rise.

Fig.1 clearly shows that the X-ray phenomenon started about 30 days before the optical one, which means that the former is not simply a consequence of an enhanced Roche-Lobe overflow from the secondary. This might also explain the presence of high excitation lines of OV λ1371, [ArIII] λ3110, [ArIV] λλ2854,2869 and [NeIV] λ2423 in the IUE spectra of the nova taken during the early rise to the 1981 maximum and their absence (or weakness) at light maximum and during the decline (Bianchini *et al*., 1985, submitted to Astron. Astrophys.).

We wish to note here that the time-delay between the X-ray and the optical outburst is quite a common phenomenon in X-ray novae (Ciatti *et al*.,1977,Astron. Astrophys., 56, 311).

It seems to us that a more systematic X-ray survey of the nova will be of paramount importance for underestanding its outburst activity. Actually, only a continuous X-ray monitoring will allow the study of the very beginning of the phenomenon.

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PHOTOELECTRIC OBSERVATIONS OF THE FLARE STAR AD Leo

The monitoring of AD Leo was carried out on March 27/28 1984 from 00^h51^m to 03^h29^m UT at La Palma Observatory (I.A.C.) on the Swedish 60 cm Cassegrain telescope with a single-channel photon counting photoelectric uvbyβ photometer. This was done within the framework of the Coordinated Program on Ultraviolet, Optical and Radio Observations of RS CVn and Flare Stars in March 1984 (Rodono 1983).

A complete set of measurements in u,$H_{\beta n}$,$H_{\beta w}$ filters were obtained with 15 sec resolution time.

During the monitoring time (Table I) a flare has been recorded. Its characteristics (Andrews et al. 1969) are given in Table II.

a.- UT at flare maximum.

b.- Flare duration t_a, t_b.

c.- Flow of the outbursts I_f/I_0, where I_f is the total intensity of the star plus flare minus sky background and I_0 is the quiet state intensity of the star minus sky background.

d.- Amplitude of the flare in instrumental magnitude Δm.

e.- Standard deviation of random noise fluctuations in magnitude $\sigma=2.5\log(I_0+\sigma)/I_0$, during the quiet state phase immediately preceding the beginning of the flare.

f.- Air mass at the flare maximum.

The flare is one of the best ever recorded, with a complete coverage from Radio to Ultraviolet wavelengths (Rodono et al. 1984).

Table I

Date	Monitoring Interval UT		Total Monitoring Time
March	$00^h51^m31^s$		$01^h42^m36^s$
27/28	01 47 53	02 08 49	
	02 29 00	03 02 35	
	03 12 36	03 29 59	

Table II

Filter	UT_{max}	t_a	t_b	Δt	I_f/I_0	Δm	$\sigma(m)$	Air mass
u	03^h23^m	6^m	30^s	7^m	9.8	2.6	0.47	1.44
$H_{\beta n}$	"	-	"	-	0.9	0.7	0.23	"
$H_{\beta w}$	"	-	"	-	0.6	0.5	0.14	"

From Figure 1 (lower panel), we can see a typical light curve with type I flare characteristic of UV Cet stars, with Δu of 2-3 magnitude. Following the distribution function of amplitudes (Gurzadyan 1980) it corresponds to the highest amplitude recorded for AD Leo, with a frequency of 10%.

The relative flux measurements through $H_{\beta n}$ and $H_{\beta w}$ filters show peak fluxes of 0.9 and 0.6 in good agreement with the H_γ and continuum (4400 A) behaviour during flare maximum reported by Rodono et al. (1984).

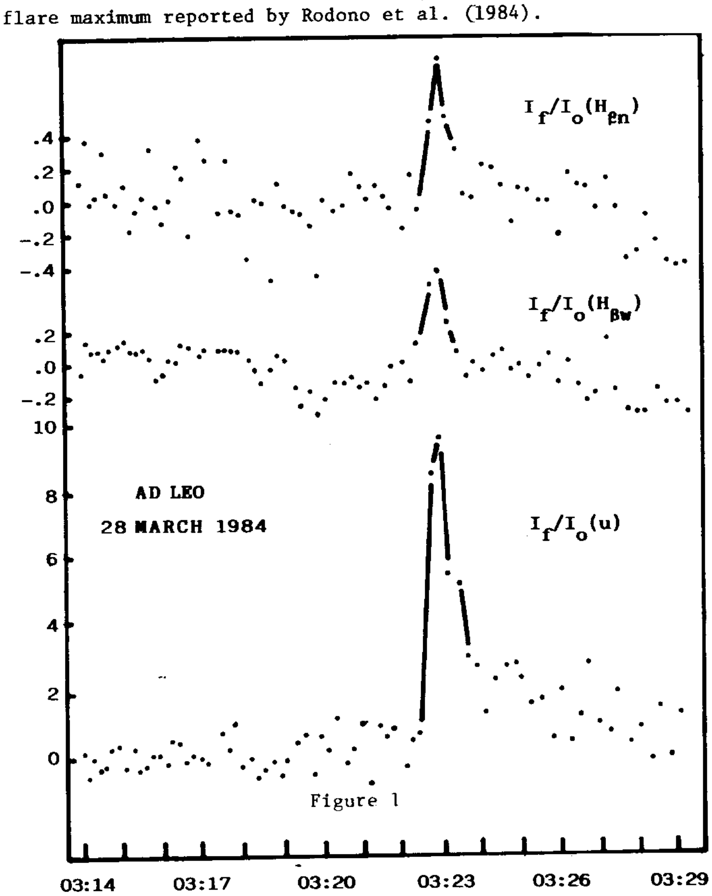

Figure 1

A noticeable increase of the scatter in the u filter in coincidence with a $H_{\beta w}$ deep a few minutes before the maximum could be inferred from the data shown in Figure 1. A faster flux decrease below the normalization value in H_{β} filters after the peak should be explained.

The emission line index H_{β} is formed by taking the ratio fluxes recorded in the narrow and wide filters. This quantity shows an amplitude of 0.03 at maximum. Due to the random fluctuations, no significant conclusions could be deduced from the H_{β} index.

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AN INTERESTING EPISODE IN THE HISTORY OF CH CYGNI

Periods of activity of CH Cyg observed so far lasted from September 1963 till August 1965, then from June 1967 till the end of 1970, and the latest outburst began in May 1977 and has not ended yet, In the quiet state CH Cyg has a usual spectrum of the M6III type. During outbursts this late type spectrum is veiled by a blue continuum extending far into ultraviolet, and numerous emission lines of hydrogen and ionized metals appear. In all the three observed outbursts forbidden lines were seen belonging to FeII, OI (λ6300), SII (λ4069), and only once, in 1968, the line λ5007 [OIII] appeared (Hack, Selvelli). When the star returned to its normal phase in December 1970 it showed a normal M6III spectrum with weak emissions in Hα and Hβ (Faraggiana and Hack). We began our observations of CH Cyg in 1974, more than 3 years after the end of the previous active period. That year 4 spectrograms were obtained on August 15 and 17 with a grating spectrograph attached to the 70 cm reflector of the Main Astronomical Observatory of the Ukrainian Academy of Sciences. The spectrograms have dispersion $1.68 \cdot 10^5$ and cover the wavelength range 6800 - 3800 Å. They revealed the presence of several emissions in the otherwise quite normal M6III spectrum without any trace of the blue continuum. Table I gives laboratory wavelengths of the emission lines, their identification and intensities relative to the intensity of the underlying continuum. Such a spectrum has not been observed in CH Cyg, the more so in quiet periods. The line λ3869 of double ionized neon has never been observed in this star either. Apart from λ5007 no other lines of the multiplet OIII 1F are seen on our spectrograms, though it would be very difficult to notice the line λ4959 in a very sharp intensity leap in TiO α(1.0) band

Table I

Emission lines in the spectrum of CH Cyg in 1974

λ lab Å	Identification	Intensity
6562.82	Hα	1.74
6300.23	OI 1F	1.18
5006.84	OIII 1F	1.45:*
4861.33	Hβ	2.18:*
4340.47	Hγ	1.19
4068.62	SII 1F	1.33
3868.74	NeIII 1F	1.62:

* lines $\lambda 5007$ and $\lambda 4861$ are situated in strong absorption bands of TiO, and the local continuum for them is traced with great uncertainty because of low photographic density in those bands.

head at λ=4957Å. Thus, taking into account the photographic plate noise the ratio of intensities of OIII auroral and nebular lines can be evaluated: $I_{4363}/(I_{5007}+I_{4959})<0.06$. This ratio is ~ 0.3 for symbiotic stars (Boyarchuk) while it is of the order of 0.01 for planetary nebulae (Aller and Liller).

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UBV PHOTOMETRY OF THE 1985 ECLIPSE OF 22 VULPECULAE

The newly-discovered ζ Aurigae system 22 Vul was the target of several photometric observers at its eclipse in August 1984, including the present authors (IBVS 2668, 1985) and Fernie and Lyons (IBVS 2658, 1985). The observations have been collected and analysed by Parsons, Ake, and Hopkins (preprint, 1985). They determined that the time of mid-eclipse was JD 2445942.3 ± 0.2, and this, combined with the spectroscopic period of 249.1 days found by Parsons (Ap. J. Suppl. 83, 553, 1983), permitted prediction that the next eclipse would be centred at JD 2446191.4 or 1985 May 5.9 U.T. The times of contacts were less certain, but the duration of total eclipse was predicted to be 9.8 ± 0.2 days.

We have obtained UBV observations of the May 1985 eclipse of 22 Vul, concentrating on nights near the times of contacts in order to try to locate these times more precisely. Our equipment was the same as for the UBVRI observations described previously, but R and I observations were not made since the eclipse is very shallow indeed at these wavelengths.

The observations were again made differentially with respect to HD 192712, but this time 18 Sge was observed as a check star each night. For it, our differential magnitudes and colours, in the sense 18 Sge minus HD 192712 are, with uncertainty ±0.01 in each case,

$$\Delta V = -1.05$$

$$\Delta(B-V) = 0.09$$

$$\Delta(U-B) = 0.23$$

Our new nightly mean differential magnitudes are given in Table I. Each is the average of three to seven individual observations, except for that of JD 2446187.929, when only a single observation was possible before clouds intervened.

On the first, second and last of these nights the system was outside eclipse, and the magnitude differences agree (within 3σ) with those found in 1984. However during totality (the third, fourth and fifth nights), 22 Vul was brighter than in August in all three bands although in B this difference was less than 3σ. Indeed in V the depth of the 1985 eclipse was all but undetectable. These results are summarized in Table II.

Table I. The Observations

HJD 2446000+	ΔU	ΔB	ΔV
183.979	-2.00	-1.94	-2.00
184.954	-1.98	-1.94	-2.03
187.929	-1.72:	-1.81:	-2.01:
188.946	-1.71	-1.82	-2.00
194.952	-1.67	-1.81	-2.00
196.959	-1.86	-1.90	-2.00
200.963	-1.99	-1.93	-2.00

Table II. Mean Magnitude Differences

	Out of Eclipse 1984	Out of Eclipse 1985
ΔV	-2.005 ± 0.003	-2.014 ± 0.005
ΔB	-1.936 ± 0.003	-1.934 ± 0.006
ΔU	-2.011 ± 0.005	-1.992 ± 0.005

	Totality 1984	Totality 1985
ΔV	-1.953 ± 0.003	-1.997 ± 0.009
ΔB	-1.794 ± 0.005	-1.816 ± 0.008
ΔU	-1.644 ± 0.006	-1.689 ± 0.009

The observations of JD 2446196 clearly were obtained during the partial phases of egress, shortly before fourth contact. The phase of these data on the ephemeris of Parsons, Ake and Hopkins is 5.56 days, and this allows us to suggest that the partial phases in optical light do indeed last about one day, in agreement with the estimate made by those authors.

Since the apparent change in the depth of eclipse from 1984 to 1985 is based on several nights' observations and is fairly consistent in all three colours, it is difficult to ascribe it to observational error or to the effect of poor observing conditions, although the hour angle at which the new observations were made was necessarily large. The other possibility, that the G star was slightly brighter in 1985, and the B star correspondingly fainter, is not much more palatable. It is however supported by the out of eclipse observations, which indicate that the system as a whole was slightly redder in 1985, although its B magnitude was unchanged. The U-B colour index of the B star is unaltered at -0.21 ± 0.10; the eclipse depth in V is too shallow to permit its B-V to be found.

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PERIOD AND LIGHT CURVE OF THE W UMa-TYPE STAR NSV 4070

NSV 4070 (= CSV 1297 = SVS 510), a star in the constellation of Cancer with coordinates 1950.0: $\alpha = 8^h23^m24^s$ $\delta = +21^o02'.7$, spectral type F0, is listed as a possible eclipsing binary in the New Catalogue of Suspected Variable Stars (Kukarkin et al., 1982).
It was proved to be a variable star by Kulikovski in 1934. Shakhovski (1955) confirmed the variability (photographic range: 11.5 to 12.4 mag) but not Kulikovki's period of 1.68 day. He suggested a shorter period and a possible W UMa type for the star. From 133 visual estimates made from 1983 February to April, yielding 6 times of minima, Figer (1983) came to the same conclusion.

To ascertain the period and obtain BV light curves we monitored NSV 4070 photoelectrically during 5 nights, from 1983 December 4 to 11, in alternance with FZ Orionis, another under-studied EW star (see Le Borgne et al., 1984). Both stars are part of the visual observing programme of the European group GEOS.

121 BV measurements of NSV 4070 were obtained at the 1 meter telescope of Pic du Midi Observatory using a photoelectric photometer and computerized data acquisition.
The measurements of several standard stars allowed the transformation to the Johnson and Morgan BV system every night; as a rule the achieved accuracy of the whole reduction procedure is about 0.03 mag.

The 0.418 day-period can be derived straightaway from the nightly curves of the variable. The mean V light curve in Figure 1 shows that most of the variation cycle was covered, a cloudy interval beginning at about 3 h U.T. on December 8 having unfortunately prevented us from observing what may have been a primary eclipse : as a consequence there still remains a doubt in the discrimination of both minima.

The magnitude at maximum is 11.73 in V band and 12.26 in B, the range of variation being near 0.7 magnitude in both colours. There seems to be a slight B-V variation throughout the cycle with a somewhat bluer secondary minimum (see Figure 1). If real, this effect could amount to 0.05 mag.

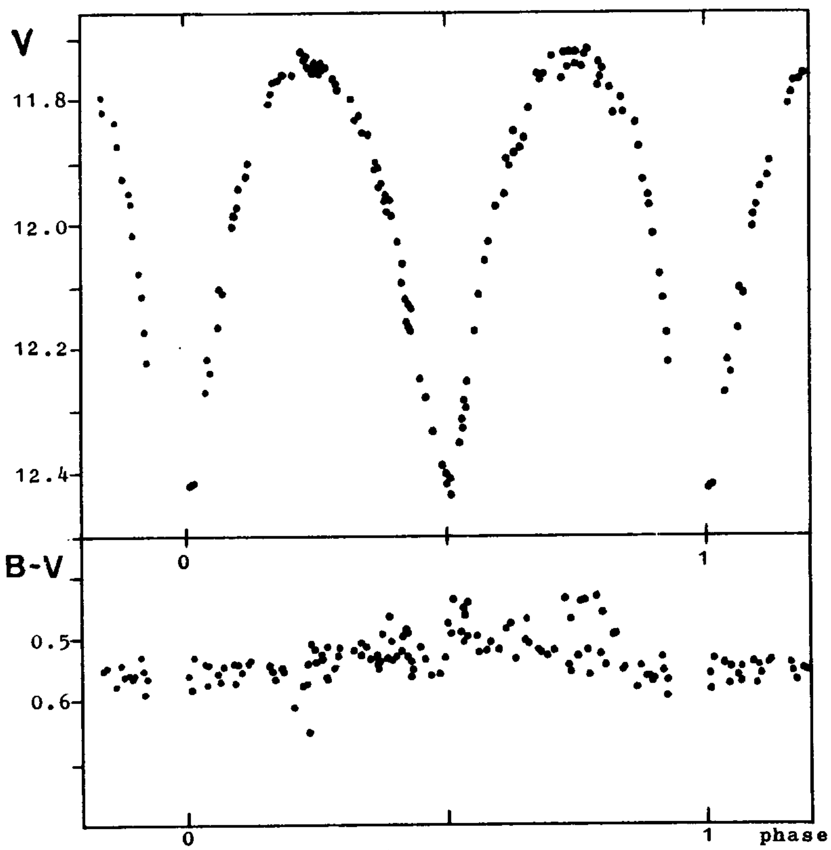

Figure 1: V and B-V light-curve of NSV 4070. Phase according to ephemeris (1).

A first ephemeris has been computed using 35 visual times of minimum obtained by several GEOS observers from 1983 to 1985 (Figer, 1985):

$$(1)\quad \text{Min I?} = \text{Hel.J.D. } 2\,445\,768.624 + 0.^{d}418\,034 \;\; E$$
$$\pm 0.003 \quad \pm 0.\,000\,004$$

Table I shows the photoelectric O-C's referring to this ephemeris. The agreement is fairly good.

Table I

Date	Filter	Hel.J.D.		O-C	Mag.	Type of minimum (tentative)
1983 Dec 4	V	2 445 672.6838		-0.0012	12.40	II
	B	.6827		-0.0023	12.94	II
1983 Dec 7	V	675.6123		+0.0011	12.43	II
	B	.6127		+0.0015	12.92	II
1983 Dec 8	V	676.6545	(*)	-0.0018	12.47??	I
	B	.6538	(*)	-0.0025	13.03??	I

(*) using the partial descending branch observed on 1983 Dec 8 and the ascending one on 1983 Dec 11.

With its typical BV light curves, its 0.418-day period, its spectral type and quasi-constant B-V index, NSV 4070 can be definitely catalogued as a new W UMa-type variable.

The mean B-V index is equal to 0.53 mag. Considering that no correction for interstellar reddening was made, this value remains consistent with Eggen's period-colour relation for contact binaries (1961, 1967).

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COMPARISON STARS WHICH TURN OUT TO BE VARIABLE

As reported in the IBVS N°2255, the Standard Star Newsletter edited by Laura E. Pasinetti for the Working Group on Standard Stars of the IAU Commissions 29, 30, 45, publishes regularly the list of comparison stars which turn out to be variable or suspected variable. Such stars are found in the papers of the main astronomical journals reviewed for the bibliography of the Newsletter.

The following table reports the list of the stars reported in the Newsletters N°1-6 (November 1982-May 1985) and the relative references.

The observers are kindly requested to point out these objects for publication in the Newsletter, writing to the following address:

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All contributors are acknowledged for this invaluable cooperation.

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Table I: List of reference stars which turn out to be variable or suspected variable.

IDENTIFICATION		REFERENCE
HD	5210	Innis, J.L. et al.: 1984, IBVS N°2544
HD	8152	Sarma, M.B.K. et al.: 1982, IBVS N°2073
HD	13831	Garrido, R. et al.: 1982, IBVS N°2080
HD	27563	Manfroid, J., Mathys, G.: 1984, IBVS N°2551
HD	78616	Cousins, A.W.J.: 1982, IBVS N°2158
HD	85037	Renson, P.: 1983, IBVS N°2298
HD	93163	Megessier, C. et al.: 1983, Astron.Astrophys.Suppl. 54, 483
HD	137147	Van Gent, R.H.: 1982, IBVS N°2140
HD	172268	Olah, K., Soliman, M.A.: 1984, IBVS N°2648
HD	174403	Turner, D.G.: 1983, IBVS N°2263
HD	192685	Pavloski, P. et al.: 1983, IBVS N°2431
HD	205328	Lelatko, I.: 1984, IBVS N°2568
HD	219989	Crawford, R.C. et al.: 1984, IBVS N°2624
BD	+ 37° 443	Lolli, M. et al.: 1983, IBVS N°2325
BD	+ 43°1894	Agerer, F. et al.: 1983, IBVS N°2370
BD	+ 60° 562	Bartolini, C. et al.: 1982, IBVS N°2139
BD	+ 75° 325	Bartolini, C. et al.: 1982 Astrophys. Space Sci. 83, 287

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ON THE MEAN CYCLE-LENGTH OF THE U GEMINORUM STAR VW VULPECULAE

VW Vul has been suspected by Shafter (Inf.Bull.Variable Stars No. 2373 and Astron.J. 90, 643) as being a U Geminorum star of SU Ursae Majoris type; he also gave an estimate of the mean cycle-length of "roughly 30 days" (according to Mattei, unpublished).

Since its discovery by Wolf in 1904 (Astron.Nachr. 166, 77) and a few estimates given by him (Astron.Nachr. 221, 261; 1924) no long-term photometric observations have been published. Its probable nature as a cataclysmic variable was not detected before 1978, when Bond (Publ.Astron.Soc.Pac. 90, 526) found spectroscopic features.

I therefore determined the brightness of VW Vul on 132 Sonneberg plates taken with the 140/700 mm Triplet camera between 1930 and 1969 by the late R.Brandt. On this material the star varied from $13^m.1$ to $>14^m.9$ pg., exhibiting the numerous "bright observations" typical for a medium-cycle U Geminorum star: 27 observations show the star in the upper part of the eruptions down to 0.6 mag below maximum light. At this level an average width of $4^d \pm 1^d$ of the outbursts can be deduced from the short series of the AFOEV (observer Verdenet, Bull. 26; 27a-28; 30). With this, our material statistically yields a mean cycle-length of about $19^d \pm 5^d$. That means that the findings of Mattei and the AFOEV, from a comparatively very short time interval, are confirmed by our 40 years' data, thus indicating a stable behaviour of the star.

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THE DOUBLE-MODE CEPHEID BQ Ser

Wenzel (1966) and Szabados (1975) observed the double-mode Cepheid BQ Ser in the UBV system, but did not publish the data. Because only twelve such stars are known to exist, it is important that a reddening be accurately determined so that the star can be placed in the H-R diagram. For this purpose, we observed BQ Ser in the Johnson UBV and Kron-Cousins VRI systems with the 0.5-m reflector of the South African Astronomical Observatory (Table I). As standards we used HD171367 (V = 7.644, B-V = 1.165, U-B = 1.009, V-R = 0.624, V-I = 1.215) and HD172365 (V = 6.373, B-V = 0.794, U-B = 0.502, V-R = 0.442, V-I = 0.856). The magnitudes and colours of these two stars were obtained by observing E-region standards.

Power spectrum analysis confirmed the periods already obtained for this star: we find P_0 = 4.283 and P_1 = 3.012 days. Because the older data are not published. these periods could not be refined. Fourier analysis gives the following amplitudes and phases:

m	m_0	A_0	ϕ_0	A_1	ϕ_1
V	9.499	0.183	-0.249	0.107	0.238
B-V	1.446	0.079	-0.221	0.047	0.267
U-B	1.039	0.075	-0.201	0.047	0.283
V-R	0.876	0.045	-0.198	0.026	0.290
V-I	1.732	0.074	-0.212	0.044	0.267

where $m = m_0 + A_0\cos 2\pi(t/P_0+\phi_0) + A_1\cos 2\pi(t/P_1+\phi_1)$ and the time t is measured from JD2445000.000.

Using the relations given in Dean, Warren and Cousins (1978), we obtain $\langle B-V\rangle_0$ = 0.626, $\langle V-I\rangle_0$ = 0.656. The star is very heavily reddened with E_{B-V} = 0.82. Caldwell's (1983) PLC relationship gives M_V = -2.90. This places BQ Ser very near the red edge of the instability strip and shows that it is considerably cooler than any of the other double-mode Cepheids.

Table I

Observations of BQ Ser.

HJD-2445000	V	B-V	U-B	V-R	V-I
823.660	9.581	1.502		0.887	1.758
825.663	9.183	1.314		0.797	1.598
828.662	9.534	1.447		0.867	1.731
829.669	9.314	1.338		0.834	
859.624	9.265	1.337		0.849	1.659
860.623	9.549	1.481		0.925	1.788
861.617	9.635	1.497		0.922	1.791
862.620	9.516	1.444		0.911	1.755
866.623	9.757	1.528		0.974	1.853
892.425	9.543	1.452		0.882	1.747
893.420	9.470	1.435	1.029	0.843	1.677
897.410	9.506	1.416	0.992	0.860	1.714
922.375	9.557	1.442	1.023	0.875	1.743
923.358	9.407	1.408	1.016	0.840	1.698
924.395	9.451	1.422	0.995	0.859	1.714
925.380	9.497	1.454	1.055	0.889	1.737
926.357	9.649	1.508	1.122	0.902	1.799
927.324	9.557	1.450	1.015		
929.373	9.548	1.485	1.076	0.891	1.773
930.276	9.759	1.575	1.149	0.921	1.829
936.307	9.407			0.848	1.693
939.323	9.776	1.558	1.149	0.903	1.792
940.316	9.233	1.320	0.942	0.770	1.580
957.248	9.576	1.451	1.035	0.885	1.763
958.266	9.223	1.327	0.950	0.805	1.630

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PHOTOMETRY OF THE VARIABLE CENTRAL STAR OF PLANETARY NEBULA NGC 2346 IN FEBRUARY 1984

Further photometry of the variable central star of planetary nebula NGC 2346 was made at the European Southern Observatory, La Silla, Chile (V-photometry; W.E.C.) as well as at the German-Spanish Astronomical Centre, Calar Alto, Spain (UBV-photometry; L.K.) in February 1984. We used the Bochum 61 cm telescope (f/15) equipped with a pulse counting photometer (EMI 9558A) at La Silla, and the 1.23 m telescope (f/8) with Photometer II (RCA 31034A-02) at Calar Alto. As photometric standards we observed α Car, β Cen at La Silla, and stars in the equatorial extinction star network (Barnes III, Moffett, 1979) as well as stars in the SA 102 (Landolt, 1983) at Calar Alto.

Our results are summarized in Table I: V_{obs}, B_{obs}, U_{obs} are observed (stellar + nebular) magnitudes through diaphragms either 18.2 arcsec (La Silla-LS) or 14.7 arcsec (Calar Alto-CA; on JD 5739.470 we observed through dia.21.0 arcsec only; the values given in Table I are those transformed to 14.7 arcsec using the mean brightness of the nebula); V, B, U are stellar magnitudes only, i.e. after subtracting the contribution of the nebular radiation; n - number of measurements. Great attention has been paid to the nebular radiation which reduces the accuracy of the stellar magnitudes very much. The mean nebular magnitudes in the respective diaphragms are given in Table II. It is hardly possible to use them generally, because they strongly depend on the given multiplier - filter combination.

The accuracy of our photometry of the central star can be estimated as follows: through the standard diaphragms 14.7 arcsec and 18.2 arcsec, respectively, the stellar magnitudes were fainter than the nebular ones in all colours. The internal errors of the stellar magnitudes are: $\sigma_{V,B} \simeq \pm 0.1$ to ± 0.2 mag, $\sigma_U \simeq \pm 0.2$ mag.

In February 1984 the light curve showed a flat maximum, $V_{max} \simeq 14.1$ mag, $(B-V)_{max} \simeq +0.6$ mag, at the time of about Feb. 6.0 ($JD_{max} = 2445736.5 \pm 0.4$). The descending branch to the following minimum was observed, the minimum itself not; we can estimate $V_{min} \gtrsim 15.0$ mag, $(B-V)_{min} \gtrsim +0.7$ mag.

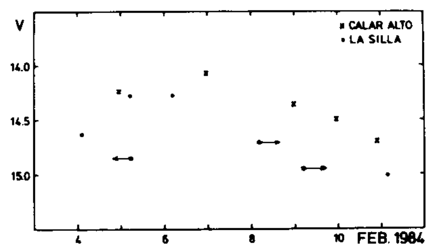

Figure 1: V light curve of the central star of NGC 2346 in February 1984.

Table I

Photoelectric observations of the central star of NGC 2346 in February 1984.

JD_{hel}	Observed brightness			Central star				
2445300+	V_{obs}	B_{obs}	U_{obs}	V	B	U	n	Obs.
5719.784	13.67	–	–	14.85	–	–	2	LS
5734.621	13.53	–	–	14.63	–	–	2	LS
5735.443	13.19	13.93	13.70	14.24	14.82	15.07	2	CA
5735.721	13.41	–	–	14.28	–	–	2	LS
5736.696	13.43	–	–	14.28	–	–	2	LS
5737.442	13.22	13.97	13.74	14.07	14.67	14.93	3	CA
5739.470	13.30	14.07	13.82	14.36	14.97	15.32	3	CA
5740.455	13.37	14.20	13.80	14.50	15.32	15.17	3	CA
5741.410	13.42	14.23	13.85	14.70	15.33	15.43	4	CA
5741.653	13.79	–	–	15.01	–	–	2	LS
5754.643	13.64	–	–	14.71	–	–	2	LS
5755.644	13.71	–	–	14.95	–	–	2	LS

Table II

Mean brightness of the nebula (mag).

La Silla		Calar Alto			
Diaphragm (arc sec)	V_{neb}	Diaphragm (arcsec)	V_{neb}	B_{neb}	U_{neb}
11.3	15.15	10.5	14.54	15.42	14.87
18.2	14.12	14.7	13.81	14.69	14.14
28.9	13.19	21.0	13.01	13.93	13.33
		29.4	12.46	13.42	12.74

The brightness of the central star of NGC 2346 derived from the La Silla observations is systematically fainter than that derived from the Calar Alto measurements. This difference (about 0.2 mag) is probably caused by the radiation of the nebula the subtraction of which is rather uncertain especially in the given range of magnitudes.

The V-values of JD 5719.784 and JD 5754.643, 5755.644 given in Table I correspond to the preceding and the following cycle, respectively. We have shifted them along the time-axis with the photometric period $P=15^{d}.957$ (Kohoutek, 1983) to the main interval of our observations (February 4-11), and we have obtained points significantly below the observed light curve. According to our opinion there are two possible explanations : either the period of the light curve was shorter than $15^{d}.957$, or the shape of the subsequent cycles was not identical with that of the main observations. We prefer the first explanation - the decrease of the binary orbiting period as a result of the motion of the A-component inside the dust cloud (moving from the planetary nucleus - Kohoutek, 1983) will be discussed in a separate paper. This decrease would also explain the "dephasing" light curve observed in Sep. - Oct. 1984 by Acker and Jasniewicz (1985) who used the period 15.991 days. Let us mention that the hypothesis of a clumpy shell ejected by the hot subdwarf in the planetary nucleus has very recently been proposed by Shaefer (1985).

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VBLUW PHOTOMETRY OF THE NEW BRIGHT O TYPE ECLIPSING BINARY HD 167971 IN NGC 6604

During a photometric program of high luminous OB type stars for the investigations of optical micro variations, the star HD 167971 in NGC 6604 of spectral type 07.5 IF (Cruz-Gonzalez et al.1974) attracted attention because of the relative large light amplitude amounting to $\sim 0\overset{m}{.}3$.
The observations were made with the 90-cm Dutch telescope at the ESO, equipped with the WBLUW photometer of Walraven during several occasions in 1981 by M.D.P. van der Bij and in 1984 by E. Damen.

The variability was also noticed by Leitherer et al. (1984) on account of photometric observations made in 1983 and later on Forbes (1984) obtained new observations, but the type of variability was still unknown.
Additional observations by Stahl et al. (1985) proved that the star is a short-period eclipsing binary with two possible periods viz. $1\overset{d}{.}6607$ and $3\overset{d}{.}3212$.

The table lists our observations V_J (the V of the UBV system), which were transformed from the V of the VBLUW system with the aid of a formula given by Pel (1983). Each observation is an average of a series of eight measurements of the variable relative to the nearby comparison star HD 170719 (B9). The mean error of the average of such a series amounts to $\leq \pm 0\overset{m}{.}004$.

Combining our observations with those of Leitherer et al., Forbes and Stahl et al. and by using the second period of Stahl et al., but slightly revised, we obtained the light curve as shown in the figure (upper panel). Phases were derived with the aid of the formula:

$$\phi = \frac{\text{J.D.} - 2445555.0}{3.3215}$$

in which the zero point is taken from Stahl et al.. The estimated error in the period amounts to $\pm 0\overset{d}{.}0005$. The bracketed observation is from Forbes and has a larger uncertainty than his other observations, viz. $\pm 0\overset{m}{.}1$ (Forbes, priv. comm.).

Table I

The visual magnitudes of HD 167971 in the UBV system.

J.D.-	V_J	J.D.-	V_J
4774.875	7.418	5971.524	7.435
4779.847	7.430	5972.538	7.375
4786.785	7.380	5973.528	7.660
4795.792	7.513	5974.556	7.393
5955.615	7.448	5978.559	7.595
5964.566	7.393	5979.542	7.393
5965.542	7.443	5981.566	7.468
5970.514	7.463		

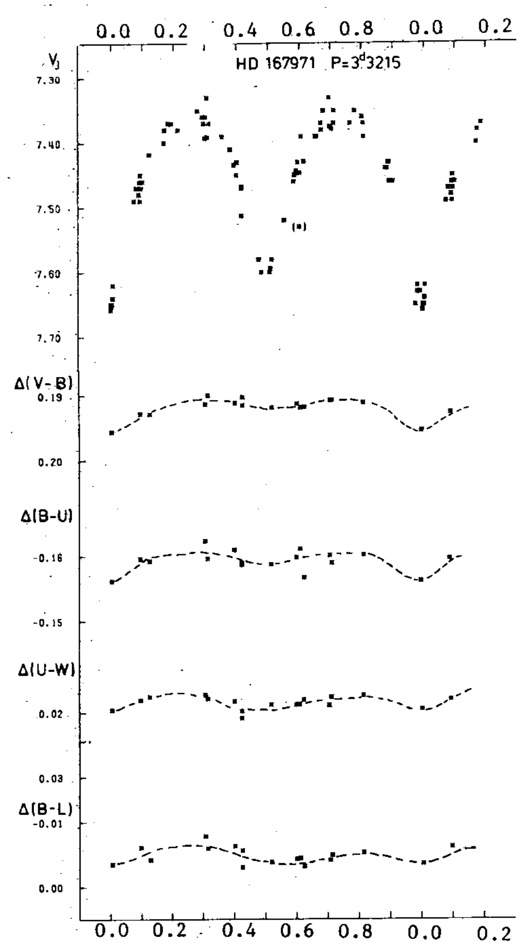

Figure 1

The primary and secondary minima have depths of $\sim 0\overset{m}{.}30$ and $0\overset{m}{.}25$, respectively. The other panels shows in log intensity scale the relative colour variations with respect to the comparison star. The mean errors are usually $\lesssim \pm 0.0005$. The primary minimum is deeper in V-B (equivalent to $(B-V)_J$) and perhaps also in B-U than the secondary one. The depths are roughly $0\overset{m}{.}012$ and $0\overset{m}{.}004$, respectively.

Although the number of observations is actually still too low to draw definite conclusions, the B-U curve appears to show the largest scatter. Other hot luminous stars also show a relative large scatter in the B-U index (the U band contains the Balmer limit) (van Genderen et al. 1985, van Genderen 1985). This fact suggests the presence of short time scale temperature - and/or density variations in the outer parts of these stars. Further observations are planned to enlarge the number of data.

HD 167971 is obviously a member of the small group of early type massive interacting systems to which also HD 57060 = UWCMa in NGC 2362 belongs (cf. Parthasarathy 1978; Herczeg et al. 1981).

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FLARE LIKE ACTIVITY OF AR LACERTAE IN 1982

Investigations of the eclipsing binary system AR Lacertae have been reported earlier by the author (cf. Srivastava, 1981; 1983a; 1983b; 1984; Goraya and Srivastava, 1984). AR Lac is a well known radio flaring source. Some evidence of spot activity, radio flaring in the system has already been described by the author (cf. Srivastava, 1981; 1984; Goraya and Srivastava 1984). Recently Walter et al. (1983) derived coronal structure of the components of the system from X-ray and UV observations.Kiziloğlu et al. (1983) obtained UV observations of AR Lacertae and found both chromospheric and transition region lines. Very recently, Huenemoerder and Ramsey (1984) spectroscopically monitored the system AR Lacertae and found very weak excess in Hα emission on two nights. Doiron and Mutel (1984) obtained dual frequency radio observations of AR Lacertae and found 2% to 8% circular polarization and a helicity reversal between 1485 MHz and 4885 MHz. They inferred the range of magnetic field strength as $5 \leqq B \leqq 80$ G.

There are some indications that the system may have been active in 1982 and therefore, the author analysed Everen et al.'s (1983) B and V observations to find out the flare characteristics of the flares associated with the system.

Smoothened light curves of six nights of observations show some deviations from the average smoothened light curves drawn through all the observations. The B and V magnitudes of deviating and average smoothened light curves have been read out at phase intervals of 0.002 and their differences are plotted in Figure 1 (a, b, c) and 2 (a, b, c). In these figures, the filled circles represent the flare like activity ascending above the quiescent intensity level while open circles are the points by virtue of O-C calculations, which help in gaining an idea about the start and the end times of various flares. The solid curves in the figures represent the quiescent level of intensity. The characteristics of relevant flares are given in Table I.

The flare pattern of JD 2445131 appears as a combination of two flares.

The flare pattern of JD 2445152 appears incomplete.

The flare pattern of JD 2445164 suggests that it is a combination of three flares. The system does not appear significantly active on this night.

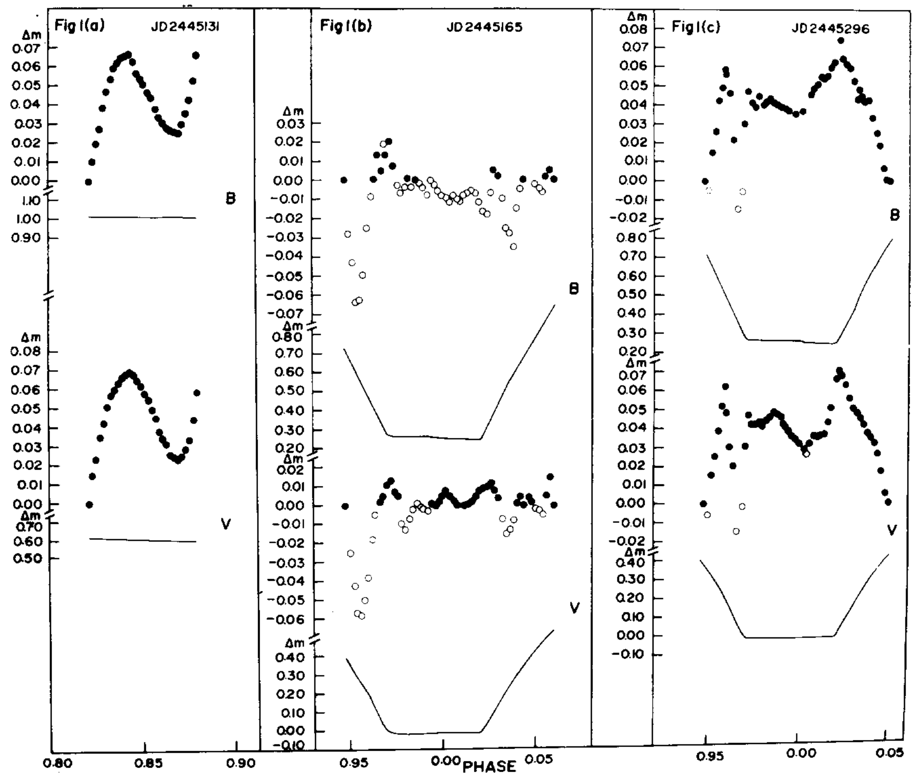

Figure 1(a,b,c): Flares of AR Lacertae around the primary minimum phase.

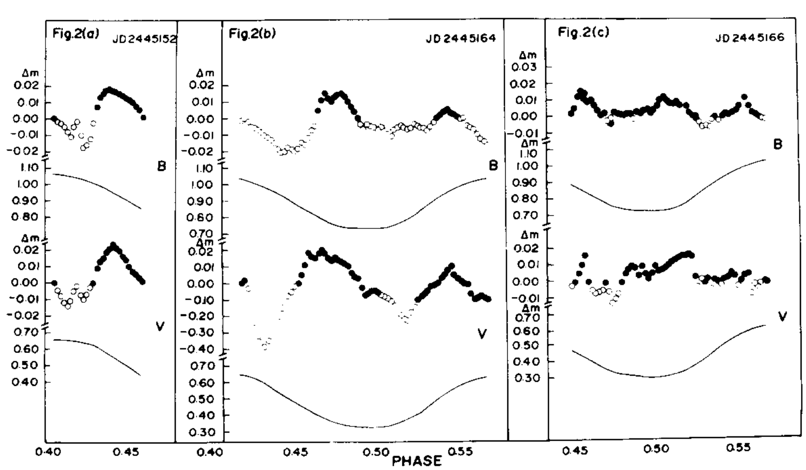

Figure 2(a,b,c): Flares of AR Lacertae around the secondary minimum phase.

Table I

Characteristics of the flares of AR Lacertae

Min.	JD	Filter	Start phase of flare	End phase of flare	Duration of flare in phase	Duration of flare in hours h m	Phase of the flare maximum	Maximum amplitude of flare m
			First flare					
Pr.	2445131	B	0.822	0.870	0.048	02 18	0.844	0.065*
		V	0.822	0.870	0.048	02 18	0.844	0.070*
			Second flare					
		B	0.870	0.880	0.010	00 29	0.880	0.065**
		V	0.870	0.880	0.010	00 29	0.880	0.059**
Sec.	2445152	V	0.406	0.460	0.054	02 35	0.442	0.024***↑
			Second flare					
Sec.	2445164	V	0.436	0.496	0.060	02 53	0.470	0.020*↑
			Second flare					
Pr.	2445165	B	0.955	0.978	0.023	01 06	0.972	0.021*↑
			First flare					
Pr.	2445296	B	0.950	0.965	0.015	00 43	0.959	0.058***
		V	0.950	0.965	0.015	00 43	0.959	0.062***
			Second flare					
		B	0.968	0.000	0.032	01 31	0.980	0.046*
		V	0.968	0.004	0.036	01 42	0.986	0.048*
			Third flare					
		B	0.000	0.050	0.050	02 24	0.022	0.075*
		V	0.004	0.050	0.046	02 13	0.022	0.070*

* The flare has emerged with the other flare and is incomplete.
** Incomplete flare
*** Complete flare ↑Very weak and doubtful flare.

On JD 2445165 at least two flares are visible. Perhaps the first flare was observed in the declining phase (between the phases 0.948 and 0.955).

On JD 2445166, some fluctuations above the quiescent intensity level are seen, however, it is difficult to say whether these represent the real flares or not.

The flare pattern of JD 2445296 shows that there are three distinct peaks which may represent three flares.

The presence of gas streaming, pulsation, existence of the extended atmosphere around the components, and the presence of spot or flare activity can change the depth and/or light levels. The humps and asymmetries in the branches of minima are not seen, hence gas streaming cannot account for these features. The duration of totality is not changing from night to night, as is apparent from the present figures, hence the possibility of pulsation is also ruled out. The dips are not seen before first and after fourth contacts of the eclipses, hence the presence of extended atmosphere around the components of the system is not possible either. Thus, the spot or flare activity remains the only possibility which can account for the changing light patterns of the system. The presence of spot activity in 1982 was established by polarization measurements of Doiron and Mutel (1984).

We may say that the flare like activity is strongly visible on JD 2445131 and JD 2445296, while on the remaining nights, the system was not very active. Since the flares originate both within and outside the totality region of the system, hence both the components of the system are active. The amplitudes of various flares indicate that their activity is varying.

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LIGHT, COLOR, AND H-ALPHA LINE VARIATIONS OF RIGEL

Rigel (Beta Ori, HR 1713, HD 34085) is a luminous, blue supergiant ($M_v \approx -7$; B8 Ia) which is one of the brightest stars visible in the sky. Plaskett (1909) reported that Rigel varied in radial velocity by ≈ 8 km/s with a period of 21.9 days. Subsequent spectroscopic studies (e.g. Sanford 1948 and Crivellari et al. 1979) confirm the variability in velocity but indicate that the velocity variations are not periodic at least in a simple way. Photometry of Rigel carried out by Stebbins (1930) and Brodskaya (1950) show it to vary irregularly in brightness with a mean light range (at blue wavelengths) of ≈ 0.07 mag.

Photoelectric photometry of Rigel was carried out on 18 nights from September-December 1984. The observations were made with the 38 cm reflector of Villanova University which is equipped with a thermoelectrically cooled EMI 9658 photomultiplier. A description of the instrumentation is given elsewhere (e.g. Guinan et al. 1982). A pair of narrow and intermediate - band interference filters, centered near the rest wavelength of the Balmer H-alpha line, and intermediate - band blue (λ 4530) and yellow (λ 5500) filters were used. The H-alpha filter pair permits a measure of the net strength of the H-alpha line feature to be determined in the form of an alpha-index:

$$\text{alpha-index} = -2.5 \log (F_n/F_i) + \text{constant}$$

where F_n and F_i are the fluxes through the narrow and intermediate-band H-alpha filters, respectively. Observation of a number of standard stars permits the instrumental alpha-indices to be transformed to the Villanova alpha-system (Baliunas, Ciccone and Guinan 1975). Because of the extreme apparent brightness of Rigel ($m_v \approx +0.2$ mag.), a neutral density filter was employed, when observing the variable star. The neutral density filter reduces the light by 4.968 mag and 4.916 mag for the blue and yellow filters and by 4.889 for the H-alpha filter pair.

Differential photometry was made with respect to a fainter comparison star (HR 1704;V = +6.37; B5 V) which is within 20' of the variable star. The comparison star and adjacent sky-background measures were obtained without the neutral density filter. Because of the angular proximity of the comparison and variable stars, the differential extinction corrections were insignificant. Typically, the observations were made once a night for about 45-60 minutes when the star was near the meridian. Nightly mean differential magnitudes were formed from the data and differential color and H-alpha indices were calculated. The yellow observations are plotted in Figure 1 along with the differential color index $\Delta(b-r)' = \Delta m(\lambda 4530) - \Delta m(\lambda 6600)$, and the differential alpha-index.

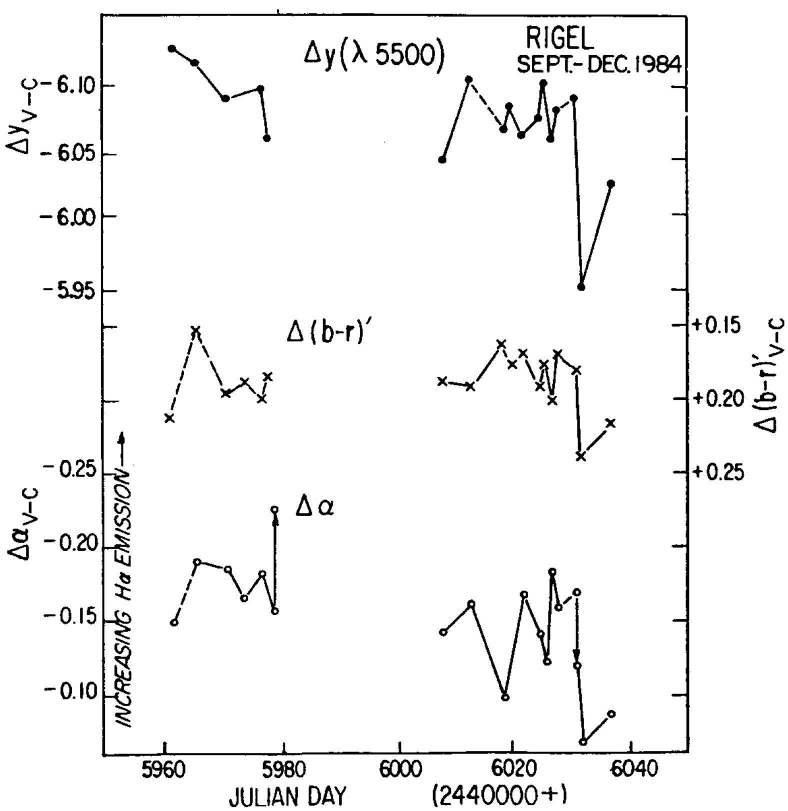

Figure 1: The photoelectric observations of Rigel made with respect to the comparison star, HR 1704, are plotted. The filled circles are the intermediate band yellow observations, the crosses are the differential $\Delta m\lambda 4530 - \Delta m\lambda 6600$ color indices, and the open circles are the differential alpha-indices. More negative values of the differential alpha index indicate increased net emission at H-alpha.

As shown in the figure, the yellow (5500) observations show irregular fluctuations in brightness on time-scales of one day to several days with a maximum range of light of ≈0.16 mag. The behavior of the star at blue and red wavelengths is similar to that at the yellow wavelength. Small variations in the Δ(b-r)' color index also occur with a maximum range of ≈0.05 mag., and having timescales of a few days. Generally the color changes show no definite correlation with the brightness variations. The relatively large negative values observed for the differential alpha index (Δalpha ≈-0.07 to -0.22) indicate that H-alpha emission is always present and that it is highly variable in strength. If the variable star had no H-alpha line emission, we estimate that the differential alpha-index (no H-alpha emiss.)≈ +0.01 mag. Although the timescales of the variations in the alpha-index are similar to those of the brightness and color variations, there appear to be no definite correspondence among these quantities. Moreover, there is evidence that at least on two nights (JD 2445977 and JD 2446030) the level of H-alpha emission changed significantly over an interval of less than one hour. No corresponding variations in light or color were found to occur on these nights.

An abrupt decrease in brightness of about 0.13 mag. was observed over an interval of just one day (i.e. from JD 2446030.67 to JD 2446031.74). This event was accompanied by an increase in the color index of +0.06 mag. and an increase of +0.05 in the alpha index. Thus, during this time the star decreased in brightness while its color reddened and the net H-alpha emission line strength decreased. One possibility that explains these rapid changes is the ejection of gas from the star toward the observer. The cooler expanding gas temporarily obscures a portion of the star's photosphere, causing the net brightness to diminish, the color index to become redder, and the net H-alpha line absorption to become stronger.

In summary, the observed irregular variations in brightness, color and in the H-alpha line strength indicate the complex and unstable nature of Rigel's atmosphere. No periodicities were uncovered from the present data set in accord with the results of the modern radial velocity investigations and previous photometry. Moreover, there is evidence that the H-alpha line emission is variable on relatively short time scales. Further observations are planned and a more detailed discussion of the results will be presented elsewhere.

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ON THE ORBITAL PERIOD OF A PROBABLE POLAR HV ANDROMEDAE

The cataclysmic variable HV Andromedae (= S 10777) was discovered by Meinunger (1975) and classified by him as an irregular variable of Ia type. Meinunger (1980) supposed that the object belongs to AM Her-type stars based on photometric and spectral observations. Unfortunately, until now there are no data on polarisation, spectral changes and rapid variability.

HV Andromedae was investigated using 94 ORWO ZU-21 photographic plates, which were obtained on the AZT-3 telescope of Astronomical observatory of Odessa State University in autumn of 1984. The magnitudes of comparison stars were taken from Meinunger (1975).

Individual light curves of HV Andromedae are shown in Figure 1. The magnitude changes with a 81-minute cycle, but periodic variations are perturbed by strong irregular changes. Because the duration of the exposure is 1/7 of the period, the observed light curves are essentially deformed. The magnitude of brightness variations in some nights may be greater than 1^m. As for AM Herculis (Andronov, et al., 1980), the shape of the light curve varies not only from night to night, but also from cycle to cycle. When luminosity decreases, the amplitude of magnitude variations increases, that is usual for "intermediate state" of polars (Andronov, 1984).

By our observations, there was a tendency of brightness increase from night to night, that corresponds to the upper part of ascending branch of luminosity curve. During 16^d the system brightened by $\sim 0\overset{m}{.}3$, which is in fairly good agreement with Meinunger's (1975) data. By his data the duration of the ascending branch on the luminosity curve is $\sim 200^d$ long, that is greater than $30\text{-}80^d$ for AM Herculis.

On the light curve obtained on J.D. 2446007 one may suppose the beating of two similar in magnitude oscillations with the periods of approximately 0.056^d and 0.062^d. But because of the accuracy of photographic observations it is impossible to draw a certain conclusion.

The periodogram for HV Andromedae is shown in Figure 2. The values of periods of $0\overset{d}{.}055994$, $0\overset{d}{.}055404$, $0\overset{d}{.}056600$, $0\overset{d}{.}055043$, $0\overset{d}{.}057010$,$0\overset{d}{.}055627$,

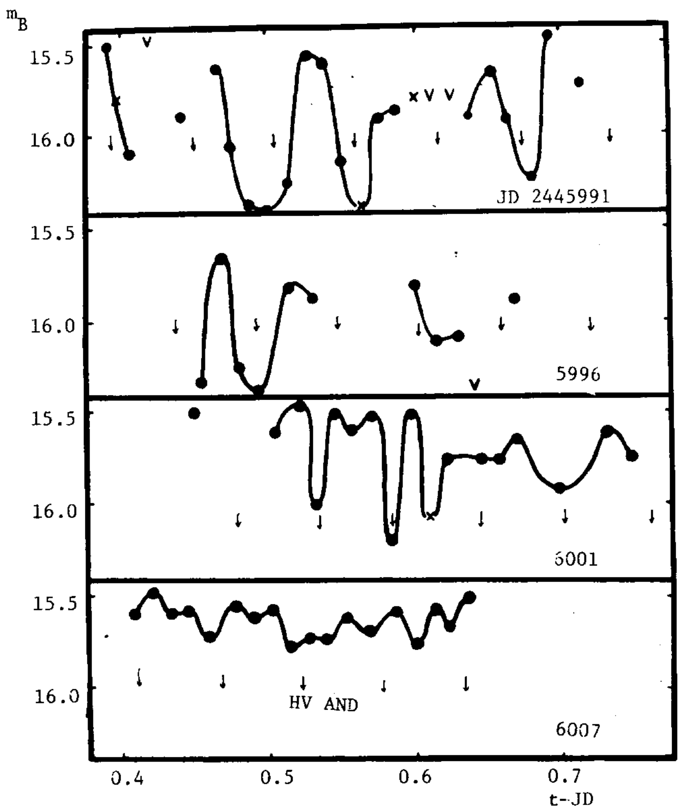

Figure 1: Individual light curves of HV Andromedae. Uncertain observations are marked by crosses, ephemerides for times of minima are marked by arrows.

are possible. As a test parameter we used the dispersion of phases of times of minima which were derived from our observations and are shown in Table I.

Table I

H.J.D.	E	O-C	H.J.D.	E	O-C
2445991.4984	0	$-0^d.0076$	2446001.5319	179	$0^d.0030$
5991.5602	1	-0.0018	6001.5818	180	-0.0031
5991.6220:	2	0.0040	6001.6327	181	-0.0082
5991.6767	3	0.0027	6001.7053:	182	0.0084
5991.7252	4	-0.0048	6007.4057	284	-0.0026
5996.4916	89	0.0021	6007.4605	285	-0.0038
5996.6212	91	0.0198	6007.5256	286	0.0053
			6007.5996:	287	0.0233

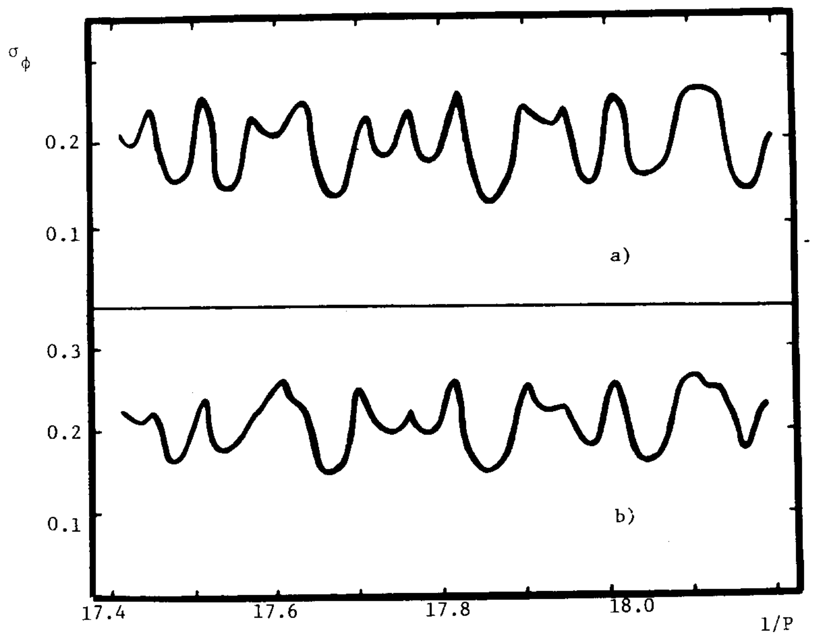

Figure 2: The periodogram for HV Andromedae. The upper curve was obtained for 12 times of minima, the lower one - for 15 (using also observations marked by ":").

Uncertain minima are marked by a symbol ":". From conjugate periods it is not easy to choose the true one, but the most probable elements are as follows:

$$\text{Min.H.J.D.} = \underset{\pm 3}{2445991.506} + \underset{\pm 18}{0^{d}.055994}\ E.$$

For choosing the true period, new observations are needed.

The data indirectly confirms that HV Andromedae belongs to polars, but polarimetric data are needed for the adequate classification . In addition the star is an interesting object for investigations in X-ray and UV regions; for photometric, polarimetric, and spectral studies.

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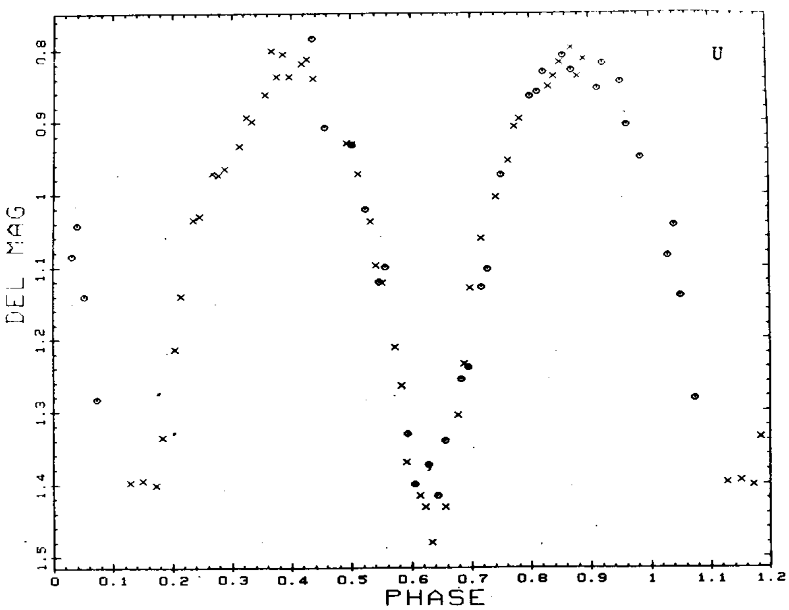
AC Boo CHANGES ITS PERIOD BUT NOT ITS LIGHT CURVE

From season to season significant variations are seen in the light curves of many short period eclipsing binary systems, especially the W-type W Ursae Majoris stars. These stars also experience period changes, which may or may not be associated with the light curve activity. In order not to smear out variations occuring on a time scale of days, it is necessary to obtain complete light curves in the shortest possible time. The W-type W UMa star AC Boo was reported by Schieven et al. (1983) to have experienced a period change at some time between 1982 and 1973. At that time only a lower limit could be found for the new period, so to obtain another time of minimum and also to check on light curve variations, I observed the system in the spring of 1984.

The data were taken with the 50 cm. reflector of the Climenhaga Observatory of the University of Victoria on 1984 April 25/26 and 26/27. A refrigerated EMI 6256SA photomultiplier tube and filters closely matching the Johnson UBV system were used. The sky was observed nearly simultaneously with each star and smoothed with a three point average (Bevington, 1969). The observations of the variable star were bracketed by observations of the comparison star SAO 45287, whose constant brightness was checked twice nightly with observations of SAO 45274. The mean check star minus comparison star magnitude was 0.622±.013 in V, -0.004±.024 in (U-B), and 0.021±.020 in (B-V). The quoted errors are standard deviations about the mean and are consistent with those expected from photon statistics. Mean extinction and transformation coefficients were used to correct the differential magnitudes to the Johnson system. The data have been deposited in the I.A.U. Archives of Unpublished Observations of Variable Stars, File No. 146 (Breger 1985).

The differential UBV magnitudes are plotted in the figures with the heliocentric phase calculated from the ephemeris of Mancuso et al. (1977). The circles identify data observed on Julian date 2445816 and the x's identify Julian Date 2445817. Between the first night and the second the secondary minimum became shallower in V by 0.04 magnitudes and redder in (B-V) by 0.06 and in (U-B) by 0.04. This variation in secondary minimum may represent a substantial change in temperature or obscuration. These new light curves can be compared with light curves from 1962-63 (Binnendijk 1963), 1972-73 (Mancuso et al. 1977), and 1982 (Schieven et al. 1983). Variations are seen in the depth of secondary minimum in both 1982 and 1972-73. The 1962-63 light curve shows similar variations in size and shape in the primary minimum. The distortions previously observed in the ascending branch of the first maximum seem to be stronger now than those seen in 1962-63, 1972-73, or 1982. Differential UBV measures of the comparison stars used by Binnendijk, Schieven and Mancuso could determine if there was a systematic brightening after the period change, as was seen in CG Cyg (Robb 1984). Unfortunately, as noted above, night to night variations are about 0.04 magnitudes in V, 0.02 in B, and 0.06 in U and there is no evidence for yearly variations significantly larger than this.



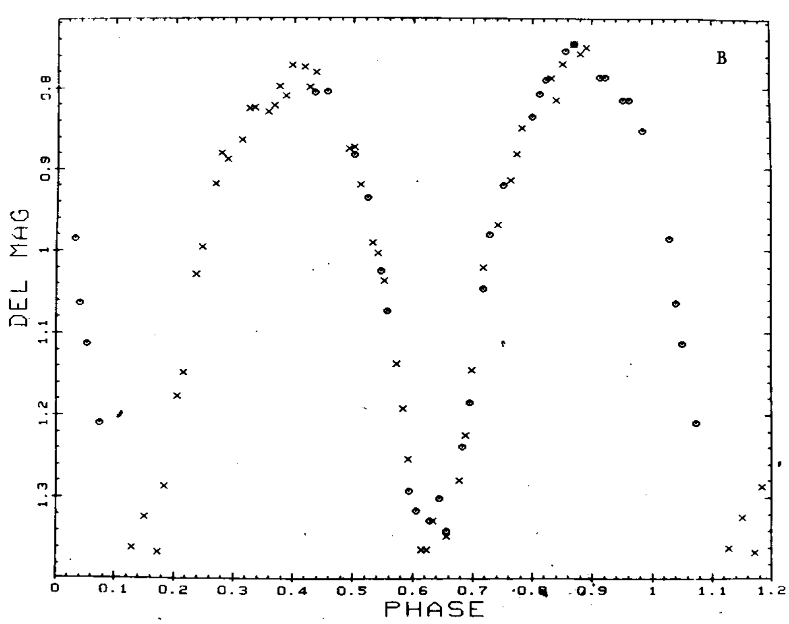


Figure 1a, b.

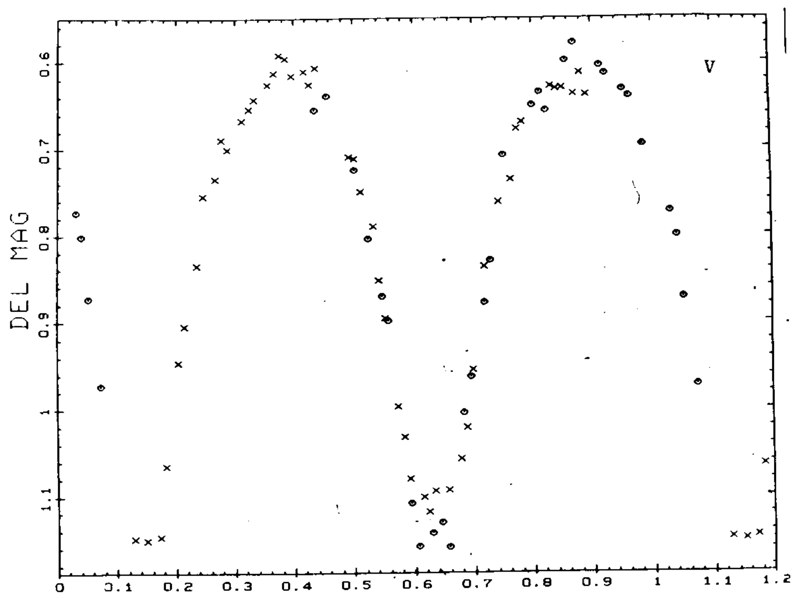


Figure 1c

To find the times of minimum light all data points within one hour of the minimum were used in a computer program based on the method of Kwee and Van Woerden (1956). Observations in each color were treated individually, but since there was no significant difference between the times obtained, they were combined in a mean weighted by the error in each color's determination. The heliocentric times of minimum light were found to be 2445816.8361±.0004 and 2445817.8935±.0003 for the secondary minima. These minima confirm the period change found by Schieven et al. (1983) and a new ephemeris based on their data and my two minima is:

$$\text{J.D. Hel. min. I} = \underset{\pm 22}{2445117.7816} + \underset{\pm 2}{.352435}\ E.$$

Assuming the period change was a discrete event, this new period implies that the change took place in 1978. The period became longer by 0.55 second or 1.8E-5 $\Delta P/P$.

A truncated nine-term Fourier series was fitted to all the intensity data shifted to make primary minimum at 0.0 phase and normalized to maximum light equal to 1.0. The coefficients are given in Table I.

Table I.

	V		B		U	
A0	0.832 ±	.002	0.811 ±	.002	0.811 ±	.003
A1	-.003	.003	-.016	.003	-.012	.004
A2	-.187	.003	-.199	.003	-.201	.004
A3	0.000	.003	0.004	.003	0.012	.004
A4	-.046	.003	-.044	.003	-.049	.004
B1	-.007	.003	-.010	.003	-.006	.004
B2	-.005	.003	-.010	.003	-.005	.004
B3	-.008	.003	0.004	.003	-.002	.004
B4	0.000	.003	0.001	.003	0.005	.004

These coefficients are essentially the same as those found by Rucinski (1973) from Binnendijk's 1962 data. A fit to the out of eclipse variations gave coefficients very similar to the ones from 1972-73. Mancuso et al. (1978) solved the 1962-63 and 1972-73 light curves and significantly different solutions would not be expected to result for the 1984 data. This lack of activity in the general shape of the light curve is quite different from that found for 44 i Boo (Robb 1982, Duerbeck 1978).

From these light curves we can see that AC Boo varies in brightness and color over a timescale of days, but the light curve stays essentially the same over the longer term, in spite of a rather large period change. More observations of this very interesting system will be necessary to refine the determination of the new period and to look for light curve variations.

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ON STAR-LIKE IMAGES NEAR THE GAMMA BURST SOURCE GBS 1901+14

A careful examination of the sky area around the position of the gamma-ray burst source GBS 1901+14 from 1979 March 24/25/27 (Mazets, E.P., et al. 1981, Astrophys.Space Sci. 80, 3-143) has been performed using the collection of archival plates at the Sonneberg Observatory. Three unique star-like objects have been found on three of altogether 1910 plates, taken by H. Huth and predecessors. They were examined for a probable optical counterpart of the above mentioned gamma-ray burst.

The search enclosed 1762 sky patrol plates of the years 1928 to 1984 and 148 plates taken with the 17/120 cm and the 14/70 cm astrographic cameras in the years 1929 to 1961. The exposure times of the plates range from 30 to 60 minutes. The brightness of the three images is considerably greater than the limiting magnitude of the plates of ≈13. The middle of the exposure times of the respective patrol plates and the estimated image positions are given in the following table:

Table I

	Plate	Heliocentric JD (Date UT)	$\alpha_{1950.0}$	$\delta_{1950.0}$
Image 1	Te20 646	2438594.518 (1964 July 18)	$19^h0^m47^s\pm5^s$	$15^\circ5'\pm1'$
Image 2	Te2 1994	2437189.344 (1960 Sep. 11)	$18^h59^m47^s\pm5^s$	$13^\circ48'\pm1'$
Image 3	T 5053	2432803.386 (1948 Sep. 8)	$19^h3^m13^s\pm5^s$	$14^\circ6'\pm1'$

All three images are not distinguishable from normal stars. Image 3 even shows the distortion caused by the objective. The plate 646 is the last of three immediately successive exposures and shows the image to lie on the border of the very narrow error box of GBS 1901+14. In contrast, the other images have probably no connection with the gamma-ray burst source because of their spacing of ≈2 arcmin to the error box. However, there exist other possible explanations for such flash-like objects (for example U Geminorum stars).

Investigations at a photometer are in progress in order to provide further arguments concerning the possible explanation of these images to be plate defects.

We thank all colleagues, especially Drs. G. Richter and W.Wenzel for the helpful support at Sonneberg Observatory where this work was done.

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A NEW ALGOL TYPE VARIABLE IN CYGNUS?

In summer 1984 photoelectric photometry of the WR star HD 186943 was carried out at the Tian-Shan High-Altitude (∿3000m) Observatory of the Sternberg State Astronomical Institute (SSAI). The star HD 186943 was discovered by Massey (1981) as a double-lined spectroscopic binary with the period $9^{d}.55$. During the observations of HD 186943 the star C2=BD+28°3434 was used as a comparison, and the star C4=HD 187462 - as a check star. Data concerning these stars are given in Table I. The observations were made with an unrefrigerated WBVR-photometer using the 0.48 m reflector.

Table I

	Name	Sp	W	B	V	R
"Comparison"star	C2=BD+28°3434	B1 Ibp	$7^{m}.69$	$8^{m}.70$	$8^{m}.51$	$8^{m}.33$
Check star	C4=HD 187462	G05	$7^{m}.46$	$7^{m}.53$	$6^{m}.97$	$6^{m}.72$

W, B, V, R - values were determined by reduction to the photometric standard HD 190603 observed on July 28/29 (JD 2 445 910) and August 1/2 (JD 2 445 914).

After tha data processing it became clear that on the night August 17/18 (JD 2 445 930) the light of the "comparison" star C2 fell by $\sim 0^{m}.22$ in W, $\sim 0^{m}.12$ in B, $\sim 0^{m}.09$ in V, and $\sim 0^{m}.06$ in R as compared with the previous night. On the last 5 nights of our observations the light still diminished somewhat in W, and in other colours it remained about the level of the night JD 2 445 930. The full amplitudes of the light changes are $\Delta W_{max}=0^{m}.28$; $\Delta B_{max}=0^{m}.26$ (or $0^{m}.13$, if we disregard the last, "jumped out", point in B); $\Delta V_{max}=0^{m}.11$; $\Delta R_{max}=0^{m}.07$.

The W-light curve of the star C2 over the observational period (JD 2 445 900 - 2 445 935) is shown in Figure 1. On the former 30 nights, the light of C2 appeared to remain approximately constant (its variations were $\lesssim 0^{m}.015$ as compared to the mean level. The observations of the last successive 5 nights revealed light variations resembling ingress into eclipse for an Algol-type variable.

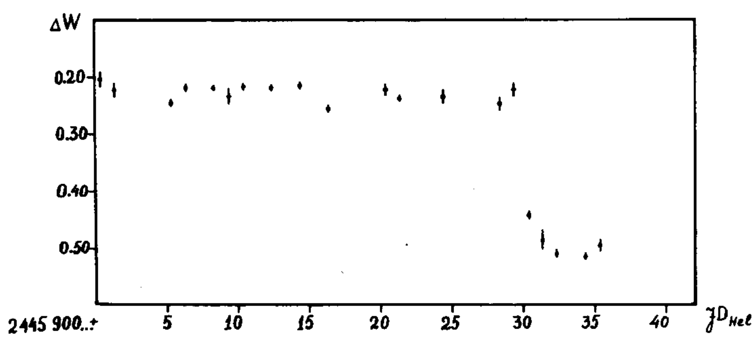

Figure 1: The W light curve for BD+28°3434. The difference between stellar magnitudes of two stars in the sense BD+28°3434 - HD 187462, ΔW, versus Julian Date is shown. Vertical bars indicate nightly scattering between individual observations.

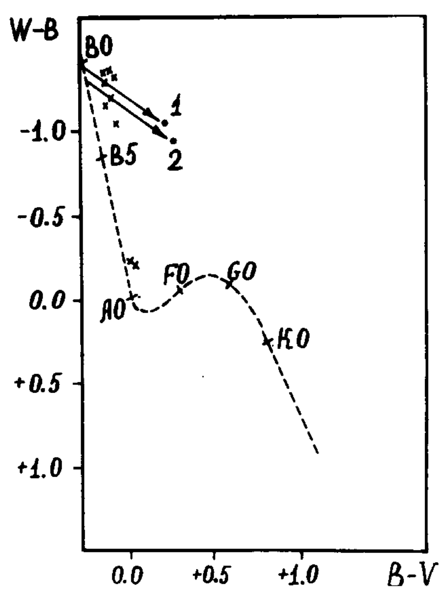

Figure 2: The colour - colour diagram. The dashed curve is the main sequence, crosses mark supergiants. The positions of BD+28°3434 are shown by points 1 and 2 corresponding to its maximum and minimum light. Direction of reddening is indicated by lines with arrows.

Table II

JD Hel 2 445 900+	W	B	V	R
0.298	$7^m.66$	$8^m.72$	$8^m.53$	$8^m.53$
1.355	7.68	8.71	8.52	8.51
5.352	7.70	8.69	8.50	8.51
6.236	7.68	8.69	8.50	8.48
8.263	7.68	8.69	8.50	8.50
9.235	7.69	8.70	8.53	8.51
10.272	7.68	8.69	8.51	8.49
12.251	7.68	8.68	8.50	8.49
14.311	7.67	8.69	8.50	8.50
16.371	7.71	8.71	8.53	8.51
20.348	7.68	8.70	8.51	8.49
21.220	7.70	8.70	8.52	8.52
24.335	7.69	8.70	8.50	8.48
28.275	7.71	8.71	8.52	8.49
29.226	7.68	8.69	8.51	8.50
30.236	7.90	8.81	8.60	8.56
31.224	7.94	8.82	8.60	8.55
32.214	7.97	8.83	8.61	8.56
34.208	7.97	8.83	8.62	8.56
35.211	7.95	8.96	8.60	8.57

Fortunately, the star C2 was reduced to the photometric standard HD 190603 on an almost constant part of its light curve. W, B, V, R values given in Table I for C2 correspond to this constant part of the curve. The magnitudes of C2 and C4 were reduced for differential extinction taking into account their colour indices.

The W, B, V, R - photometry of the star C2=BD+28°3434 is given in Table II. The colour -colour diagram is shown in Figure 2 where points 1,2 mark the positions of C2. The upper point (1) corresponds to the "constant" part of the light curve (JD 2 445 900 - 2 445 929), and the lower one - to the minimum light (JD 2 445 930 - 2 445 935).

Let us take the intrinsic colour for B0 -B1 supergiants to be equal to $(B-V)_o = -0.20$ as it follows from Figure 2. Then the colour excesses for positions 1 and 2 are $E_{B-V}(1)=0.41$, $E_{B-V}(2)=0.47$. If we take the absolute stellar magnitude for a B0I star $M_V=-6.4$ according to Underhill (1966), the corresponding distance modulus is $5 \cdot \lg d - 5 + A_V = 14.91$ (15.01), and the distance is $d \simeq 5$kpc.

Using the results obtained by Sharov (1963) we can estimate the interstellar extinction in the direction of Cygnus to be higher than 2^m/kpc. High extinction yields an anomalously low luminosity for the star BD+28°3434, $M_V \gtrsim -2^m.5$, which is inconsistent with the luminosity of type I supergiants. This low luminosity is rather consistent with the spectral type B3V.

In conclusion it is worth to note that in case the observed effect of the light fall is really an "ingress" into eclipse, the period of the "eclipsing binary system" BD+28°3434, showing resemblance to Algol - type variables by its light curve, should be more than 30^d.

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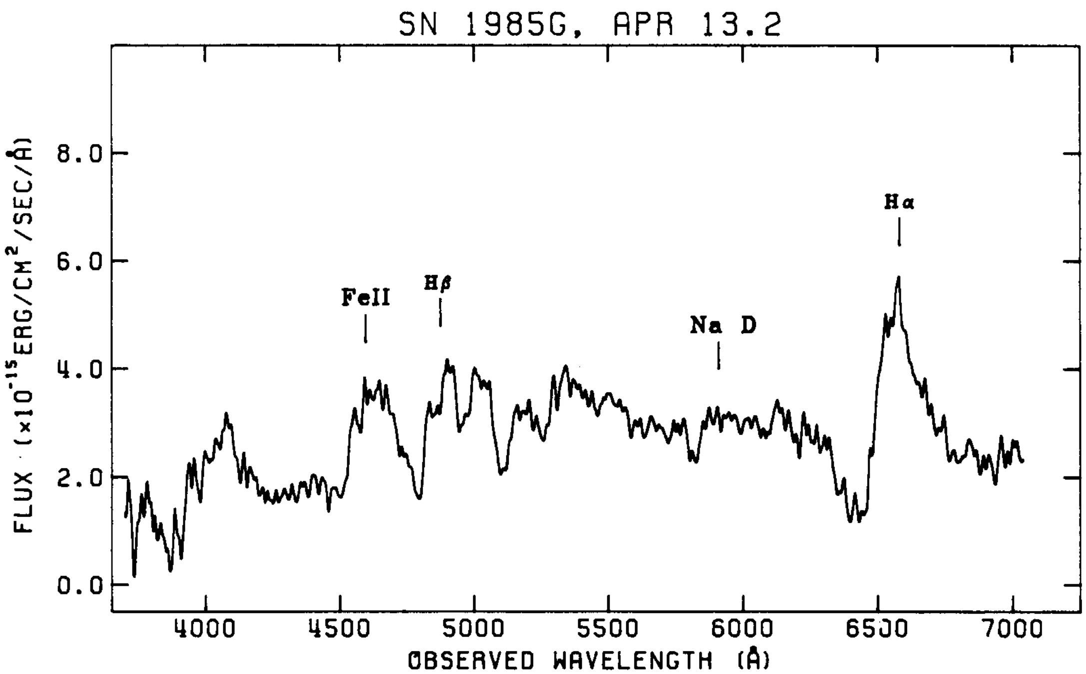
SPECTROPHOTOMETRIC OBSERVATIONS OF SUPERNOVA 1985G IN NGC 4451

We present observations of the Supernova 1985G in NGC 4451, a member of the Virgo Cluster. The spectra shown in Figures 1 and 2 were obtained on 1985 April 13.2 and May 27.2 with the Mark II intensified Reticon spectrometer attached to the 1.3m telescope at McGraw-Hill Observatory. Both spectra were obtained within 30° of the zenith, the later one under photometric conditions. Standard stars were observed over a much larger range of airmass and were combined to create mean adopted flux calibrations for each of the two dates of observation. Relative to these means, the flux standards exhibit a scatter of ±0.11 mag and ±0.02 mag at 5556Å for the respective April and May observations and show no significant wavelength dependent residuals. These spectra have been smoothed for illustration purposes using a Gaussian filter of FWHM equal to that of lines in the wavelength calibration lamp spectra. No redshift correction has been made, but tick marks have been added to the spectra to indicate the wavelengths of various spectral features in the rest frame of NGC 4451.

To facilitate comparison with models and other observations, we have determined the monochromatic magnitude at 5556Å as well as broadband B and B–V by convolving the B and V filter functions with the spectra. These data and various observational details are presented in Table I. Compared with the April 13 observation, the May 27 spectrum shows the development of many strong features in the 5300 - 6200Å spectral region and a narrowing of the Hα emission component. Expansion velocities have been determined by measuring the wavelength of the blue absorption edge of Hα; this gives 12,000 km/s with an uncertainty of ~ ±300 km/s for both of our observations. This is smaller than the 13,000 km/s velocity measured by Chalabaev, *et al.* (IAU Circ. 4052) from a spectrum obtained on April 10.

In IAU Circular No. 4049, H. Kozai reported V~14.5 on March 21 followed by a decrease to V~15.0 by March 25. Our observations give V=15.18 on April 13 and indicate an essentially constant B magnitude and slight increase in B–V over the following 44 days



SN 1985G, APR 13.2
FLUX (×10^-15 ERG/CM^2/SEC/Å)
8.0
6.0
4.0
2.0
0.0
FeII
Hβ
Na D
Hα
4000
4500
5000
5500
6000
6500
7000
OBSERVED WAVELENGTH (Å)

FIGURE 1.

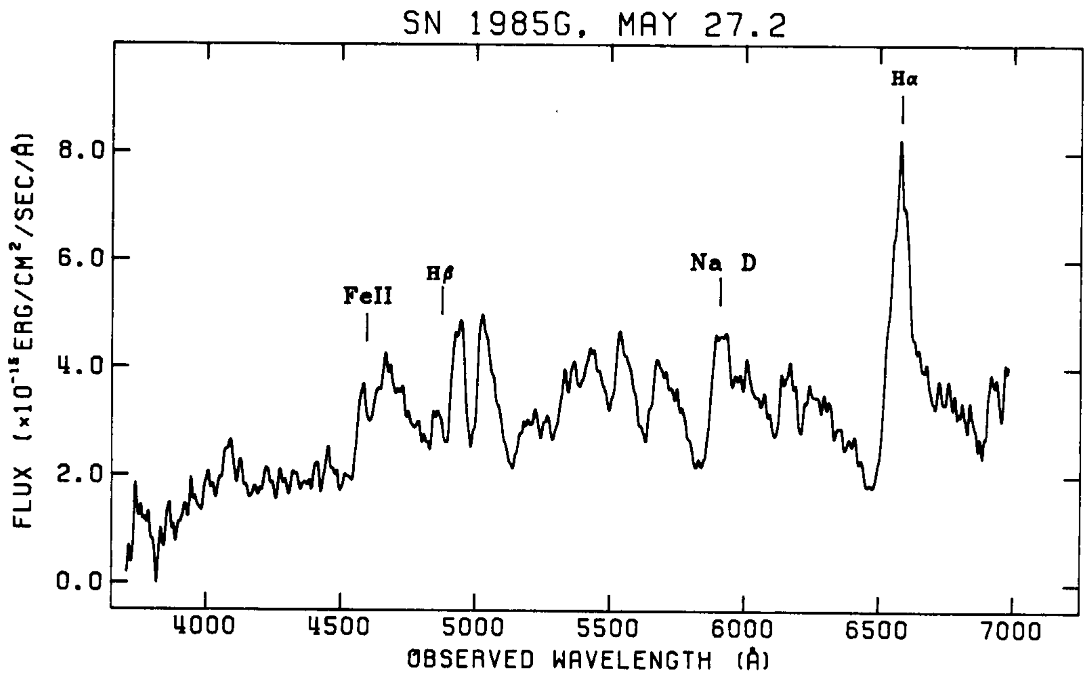

SN 1985G, MAY 27.2
FLUX (×10⁻¹⁵ ERG/CM²/SEC/Å)
8.0
6.0
4.0
2.0
0.0
FeII
Hβ
Na D
Hα
4000
4500
5000
5500
6000
6500
7000
OBSERVED WAVELENGTH (Å)

FIGURE 2.

TABLE I

Details of the Observations.

	Fig. 1	Fig. 2
1985 Date (UT)	April 13.2	May 27.2
Integration time on Object (sec)	1200	960
Instrumental Resolution (Å)	9	9
Monochromatic m_ν at 5556Å	15.12	14.81
B mag	16.05	16.03
B–V	0.87	0.96

This is consistent with the object being a Type II supernova with a plateau of somewhat long duration in the light curve.

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SPECTROPHOTOMETRY OF SUPERNOVA 1985H IN NGC 3359

A spectrum of the supernova 1985H was obtained on April 13, 1985 at McGraw-Hill Observatory. This supernova was discovered in NGC 3359, an SBc spiral in Ursa Major, by J. Nemec and S. Staples on April 3, 1985 (Kristian 1985). Our observation was made with the Mark II intensified Reticon spectrometer attached to the 1.3 meter telescope. A 300 line/mm grating was used, giving a dispersion of 2.3 Å/channel and a spectral resolution of about 9 Å. The total exposure time on the supernova was 39.2 minutes, and mid-exposure was at 4:23 UT. The spectral scans were reduced in the standard fashion, with wavelength calibration being accomplished using scans of comparison lamps, and absolute flux calibration being achieved using observations of two spectrophotometric standard stars (EG 71 and Ross 640). Measurements indicate that our flux calibration is accurate to better than ±20% over the entire useful range of the spectrum. A fully reduced spectrum is shown in Figure 1. It has been smoothed with a Gaussian profile whose width equals the FWHM of the comparison lamp lines. No redshift corrections have been applied.

The spectrum in Figure 1 is typical for a Type II supernova, showing strong P Cygni lines of Hα, Hβ, Na I D, plus a number of unidentified features. The tick marks indicating the various spectral features are located at the rest wavelengths of these lines in the rest frame of the galaxy (V_r = 1013 km/s (Huchra *et al.* 1983)). It is interesting to note the strong similarity between the spectrum presented here and the May 27 observation of supernova 1985G in NGC 4451 reported in the preceding IBVS note. If these spectra represent similar stages in the evolution of the two supernovae, then supernova 1985H must be between one and two months "older" than 1985G, but escaped detection until it was well past its maximum.

The expansion velocity of the supernova, measured from the blue edge of the Hα absorption feature, is 6200 km/s. The V magnitude and B−V color have been determined by convolving the appropriate filter functions with the observed spectrum. We find V = 17.0 and B−V = 1.5. Wheeler (1985) reported V = 16.4 for this object from an observation made on April 12. The difference of 0.6 magnitude cannot be accounted for by the ±0.2 magnitude uncertainty in our value for V indicated by the accuracy of our flux calibration.

The very red color of 1985H indicates that a substantial amount of absorption occurs in the vicinity of the supernova. Using the average light curves of Barbon *et al.* (1979), we

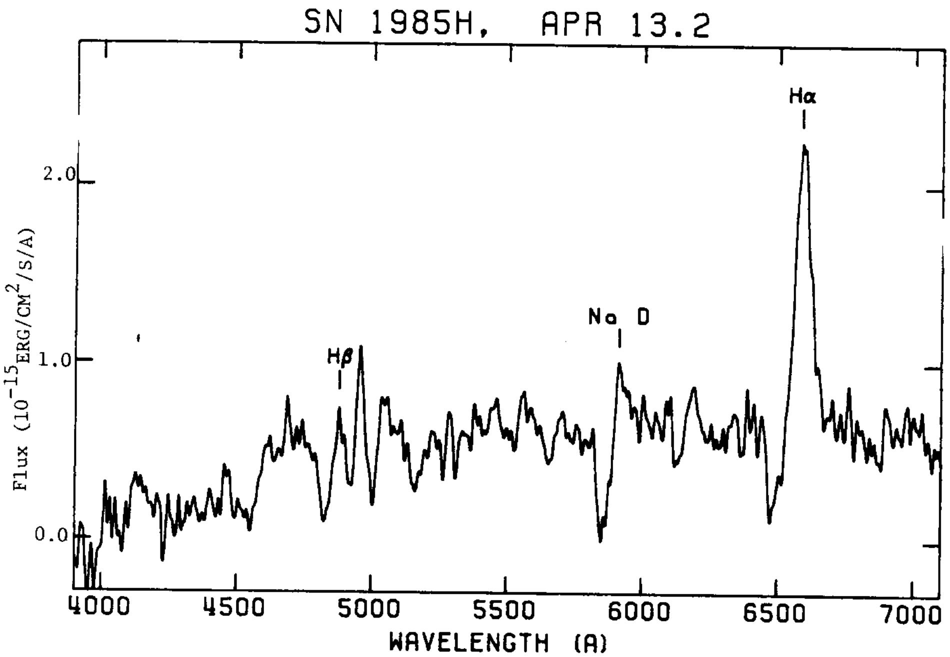

FIGURE 1

estimate that E(B−V) is between 0.5 and 0.6 magnitudes. The large amount of obscuration implied by this value for the color excess helps to explain the faintness of the supernova, and why it was not detected at an earlier stage.

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A SMALL ELLIPTICITY EFFECT IN THE RS CVn BINARY 33 PISCIUM

33 Psc = HR 3 = HD 28 first came to our attention when Young and Koniges (1977) and Lloyd Evans (1977) noted this SB1 showed Ca II H and K emission, indicating it is an RS CVn binary. Therefore we suspected photometry might show the characteristic "wave". Because of the large orbital eccentricity, e = 0.272 ± 0.017, found by Harper (1926) it was additionally interesting in connection with the question of synchronous rotation in eccentric orbits (Eaton et al. 1983). The spectral type appears in the literature most often as K1 III. The orbital period is $72^{d}.93$ (Harper 1926, 1935). The H and K emission is not very strong, only 2 on Wilson's 0-to-5 scale (Glebocki and Stawikowski 1979).

According to Eggen (1978) "numerous UBV observations indicate a range of about $0^{m}.05$ in V." Percy and Welch (1982), however, made differential photoelectric measures on 9 nights over a 118-day interval and found no indication of variability. The rms deviation of their 9 measures was only ± $0^{m}.004$.

Between July 1979 and January 1985 (JD 2444069.6 through 2446077.6) 11 different observers observed 33 Psc differentially with respect to the comparison star HR 29 = HD 587. Altogether they obtained 201 values of ΔV, each a mean of generally three intercomparisons between variable and comparison. A few observed in B and U also, but in this note we analyze only the more numerous ΔV values. This is summarized in Table I. All photometry was, of course, corrected for differential atmospheric extinction and transformed differentially to V of the UBV system with known transformation coefficients. Because 33 Psc and HR 29 differ in B-V color index by only $0^{m}.06$, the 5.5 years of photometry from 11 different observatories resulted in an unusually homogeneous set. Some earlier photometry of 33 Psc was obtained in 1978 by Robert E. Montle at the James C. Veen Observatory, but unfortunately his comparison star was 30 Psc, the known variable YY Psc.

To search for possible variability, we generated a periodogram by fitting a sinusoid to the ΔV values, with periods ranging between 1^{d} and 150^{d}. Nowhere in that range did the resulting full amplitude exceed $0^{m}.010$. We considered it significant, however, that a $0^{m}.008$ amplitude (and corre-

Table I

Tally of Observations

Observer	Observatory	Location	Telescope	Means
Barksdale	Barksdale	Florida	14-inch	8
Boyd	Fairborn	Arizona	10-inch	124
Eaton	Kitt Peak	Arizona	16-inch	10
Fried	Braeside	Arizona	16-inch	3
Henry	Dyer	Tennessee	24-inch	11
Henry	Kitt Peak	Arizona	16-inch	12
Hopkins	Hopkins-Phoenix	Arizona	8-inch	10
Pazzi	Nigel	South Africa	12-inch	6
Poe	Dyer	Tennessee	24-inch	5
Renner	Scuppernong	Wisconsin	10-inch	7
Rogers	Southwestern Oklahoma	Oklahoma	14-inch	4
Sabia	Keystone	Pennsylvania	9-inch	1

sponding diminution in the sum of the squares of the residuals) occurred at $36^{d}.51 \pm 0^{d}.12$, which is (within the uncertainty) exactly half the $72^{d}.93$ orbital period. This can be explained most simply as a detection of the cos 2Θ variation produced by the ellipticity effect. The amplitude at $72^{d}.93$ was only $0^{m}.001$, indicating that the cos Θ reflection effect was undetectable. A portion of the periodogram, between 31^{d} and 41^{d}, is shown in Figure 1.

Noting that 365 days is almost exactly 10 times $36^{d}.51$, we anticipate that the unavoidable 365-day observing window would produce aliases at $P = 365^{d}/9 = 40^{d}.6$ and $P = 365^{d}/11 = 33^{d}.2$. Indeed, as Figure 1 shows, prominent peaks do appear at $40^{d}.5 \pm 0^{d}.3$ and $33^{d}.2 \pm 0^{d}.1$.

Analysis of our residuals identified 5 values of ΔV which were larger than would be expected in a Gaussian distribution, i.e., greater than 3σ. To check whether these were influencing our results, we redid the analysis with these 5 values excluded. The results, however, were not significantly altered. Table II is a summary of parameters deduced from the two sets of data. Both estimates of the period, $36^{d}.51 \pm 0^{d}.12$ and $36^{d}.38 \pm 0^{d}.10$, are consistent with $36^{d}.465$, which is half the orbital period. The full amplitude of the light variation, an average for the two estimates, is $0^{m}.007$. Note that the rms derivation from the Fourier fit was reduced to $\pm 0^{m}.009$ when we used the abbreviated data set. The time of minimum light, given for the middle of the 5.5-year interval, should be useful as a recent time of conjunction.

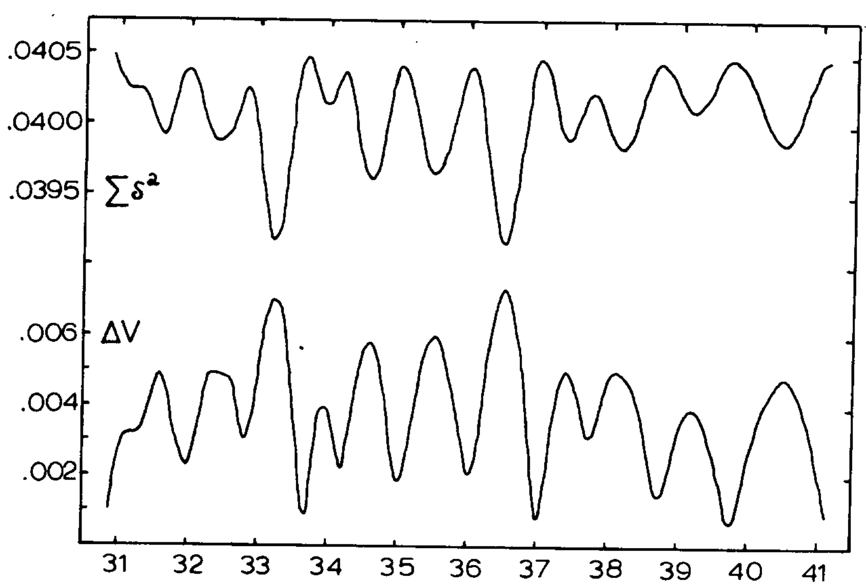

Figure 1

Periodogram for 5.5 years of V-band photometry of 33 Piscium. The abscissa is assumed period, in days. The lower part is the full amplitude of a sinusoidal fit. The upper part is the sum of the squares of the residuals from that fit. Note the 0.007 amplitude at 36.5 days, which is half the known orbital period; it probably arises from the ellipticity effect. Two other peaks, at 33.2 and 40.5 days, are aliases produced by the 365-day observing window.

Table II

Parameters from Fourier analysis

number of points	201	196
best period	$36^{d}.51 \pm 0^{d}.12$	$36^{d}.38 \pm 0^{d}.10$
mean ΔV	$-1^{m}.218 \pm 0^{m}.001$	$-1^{m}.219 \pm 0^{m}.001$
full amplitude in V	$0^{m}.008 \pm 0^{m}.003$	$0^{m}.006 \pm 0^{m}.002$
JD (minimum light)	2445072 ± 2	2445069 ± 2
rms deviation	$\pm\ 0^{m}.014$	$\pm\ 0^{m}.009$

Other possible periods seen in the complete periodogram may be significant but, because the amplitudes are so small and because the periods are neither close to nor commensurate with the orbital period, we are reluctant to make additional conclusions.

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PHOTOMETRIC CONSTANCY OF IS Gem

After the visual measures of Bemporad (1912), BD+32°1414=IS Gem was monitored, always visually, by Wroblewski (1962) and by Pogossiantz (1982). They report a variation of about 0.3 mag. and a periodicity of 40-50 days, although Pogossiantz's light curve does not seem to be much convincing. Spectra with a dispersion of 35 Å/mm discussed by Crimi and Mantegazza (1984) show a slight variation of the radial velocity close to the limits of observational errors and absence of spectral peculiarities.

IS Gem was measured photoelectrically at the 50 cm telescope and spectroscopically at the 137 cm telescope of the Osservatorio Astronomico di Merate, in the course of a program on variable stars of intermediate and late spectral types (Poretti, 1984; Poretti and LeBorgne, 1985). Photoelectric measures were carried out in V-light on 11 nights from 1983, October to 1984, February and on 2 nights in 1985, January. HR 2586 and HR 2660 were used as comparison star and check star respectively. For the instrumentation and data reduction techniques, see Poretti (1984).

The mean magnitudes obtained on these 13 nights prove constancy of IS Gem: the mean value is +0.189 (standard deviation: ±0.005) for HR 2586 minus IS Gem and +0.366 (s.d.:±0.009) for HR 2586 minus HR 2660. IS Gem must therefore be placed with VW Dra (Murnikova and Vasilyeva, 1979) in the list of constant stars erroneously classified as SRd variables.

IS Gem was also observed by GEOS from 1974 to 1982: a careful analysis of the visual estimates does not show any intrinsic variation larger than 0.1 mag. (Fumagalli, 1985), i.e. the probable error.

Spectroscopic observations and a more complete discussion of V measures will be published elsewhere later.

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THE J LIGHT CURVE OF CG CYGNI

We present the J light curve of the eclipsing binary CG Cygni ($P=0^{d}.63$) obtained with the 1.5 m infrared flux collector at the Observatorio del Teide, Tenerife, using a cooled InSb detector. The data were obtained during 4 out of 5 consecutive nights in September 1984. The comparison star was $BD+34^{\circ}4216$ and the principal standard star was BS8430.

In Figure 1 is the J light curve of CG Cygni with the differential magnitude plotted against the phase, calculated using the ephemeris of Milone and Ziebarth (1974)

$$JD(phase=0) = 2439425.1221 + 0^{d}.6311410\ E.$$

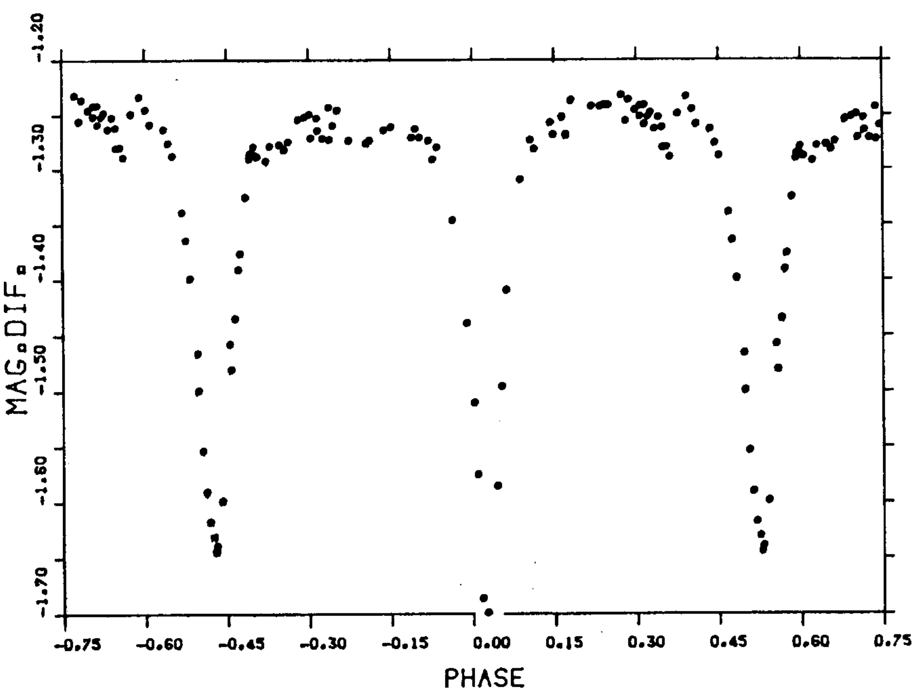

Figure 1: J light curve of CG Cygni.

The J light curve shows the asymmetry of the minima that has been previously observed in optical curves of CG Cygni (Milone et al. 1979; Jassur, 1980) and some other short period RS CVn-type binaries. Figure 1 also shows that the minima have advanced in phase by about 2.5% since 1966, confirming conclusively the progressive change first noted by Milone et al.
A fuller account of this work is being prepared for publication.

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VARIATIONS OF THE RADIATION FLUX FROM THE MAGNETIC VARIABLE STAR β CrB IN THE DEPRESSION λ 5200 Å

A famous chemically peculiar star β CrB (F0p, $V=3^m.47$) was observed by using the spectrophotometer in the range $\Delta\lambda=30$ Å, being centered at $\lambda_c=5215$ Å falling into depression at λ 5200 Å.

The observations were carried out during ten nights, from 18 May till 6 June 1984. The star γ CrB was adopted as a comparison star. The differential extinction of β CrB versus γ CrB was accounted upon. The value of the atmospheric extinction was estimated with respect to the star η UMa. The brightness magnitudes of β CrB and γ CrB were estimated alternatively, 1.0 minute long each. As a result of the observations, we obtained the values $\Delta m = m\gamma - m\beta$ with the time resolution 2 min.

The periodic variations were searched for during all the 10 nights (total number of measurements was N=551) within the interval 50-500 min. The basic methods used were those of Yurkevich (1971) and Deeming (1975). It has been found, that the variations of radiation flux do exist and could be described by a superposition of three sinusoidal oscillations with the periods $P_1=196^m.9$, $P_2=158^m.3$ and $P_3=58^m.6$.

The values of amplitudes being estimated by the method of Yurkevich and Deeming are in good agreement and correspond to $A_1=0^m.005$, $A_2=0^m.004$ and $A=0^m.004$ for P_1, P_2 and P_3, respectively. The power spectrum and the function of spectral window obtained by the method of Deeming are presented in Figure 1. At the top the mean curve of Δm variations is shown for the above indicated periods calculated by the method of Yurkevich. Absence of any significant peak in the function of spectral window for the periods around P_1, P_2 and P_3 on one hand and presence of the conjugate periods determined by the time gaps of sidereal day confirm reliability of the obtained results.

In Figure 1 the conjugate and basic periods are connected by a solid line. The averaged values of $\overline{\Delta m}$ for one night and the magnetic field variations with the period of the stellar rotation are compared in Figure 2.

Finally we have come to a conclusion that there exist two types of brightness variations of β CrB in the range of λ 5200 Å. They are: a) well- pronounced variations of $\overline{\Delta m}$ with the phase of star rotation that can be properly explained in the frames of an oblique rotator model (see Figure 2) and b) complex quasi-periodic variations of Δm during one night, which might be caused by pulsations of this star.

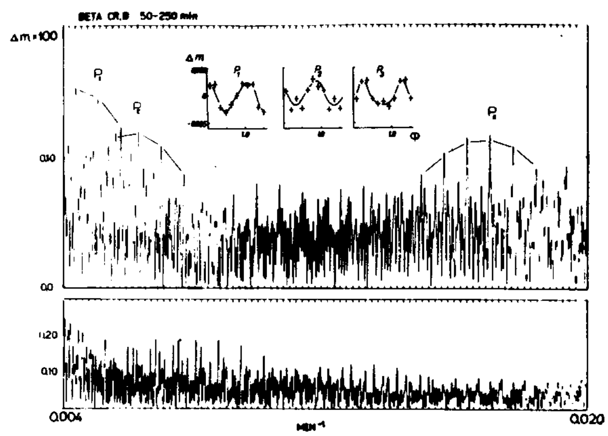

Figure 1

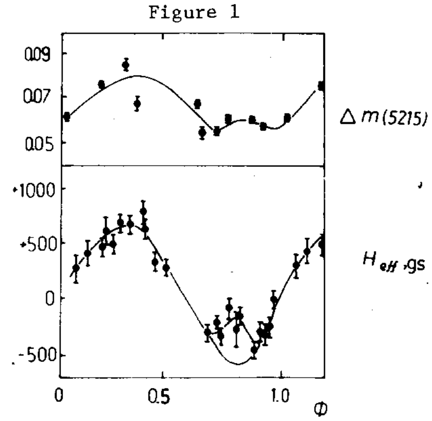

Figure 2

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PERIOD AMBIGUITY RESOLVED FOR HD 8358

Although UBV photometry of Fekel, Hall, and Henry (1984) succeeded in discovering that the chromospherically active G-type star HD 8358 was variable with a range of $0^m.14$ in V, they were not able to determine the photometric period unambiguously because their observations had been made only once each night at very nearly 1-day intervals. The three possible periods were $0^d.520 \pm 0^d.001$, $1^d.085 \pm 0^d.002$, and $12^d.75 \pm 0^d.25$. With all three periods the light curve shape was asymmetric in the same sense: rapid rise to maximum followed by a stillstand between maximum and minimum.

In this paper we present V-band photometry obtained with the Barksdale 14-inch reflector on 26 nights during the last three months of 1984. The individual ΔV magnitudes have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1985), where they are available as file no. 151. Each of the 636 values of ΔV is based on an intercomparison between variable and comparison star and has been corrected for differential atmospheric extinction and transformed differentially to V of the UBV system. The comparison star was BD - 0^o212 = SAO 109848 and Δ is in the sense variable minus comparison. Because on most nights HD 8358 was observed continuously for a large fraction of the night (up to 7.7 hours), this photometry suceeds in removing the ambiguity in the period: the shortest of the three, P = $0^d.52$, is correct.

Figure 1 is a plot of all 636 individual ΔV values, phase being computed with P = $0^d.520$. Here we see immediately that the light curve is now double-humped, i.e., markedly different from the shape two years earlier, seen in figure 1 of Fekel, Hall, and Henry (1984).

To refine the period, we fit the light curve by least squares using a Fourier series containing only terms in 2θ. The smallest sum of the squares of the residuals occurred at P = $0^d.52006 \pm 0^d.00007$. The resulting full amplitude was $0^m.065$. Light minima, taken at the middle of Barksdale's observing season, occurred at JD(hel.) 2446012.6919 and 2446012.9519. And the rms deviation was ± $0^m.033$, which is quite large and needs to be discussed.

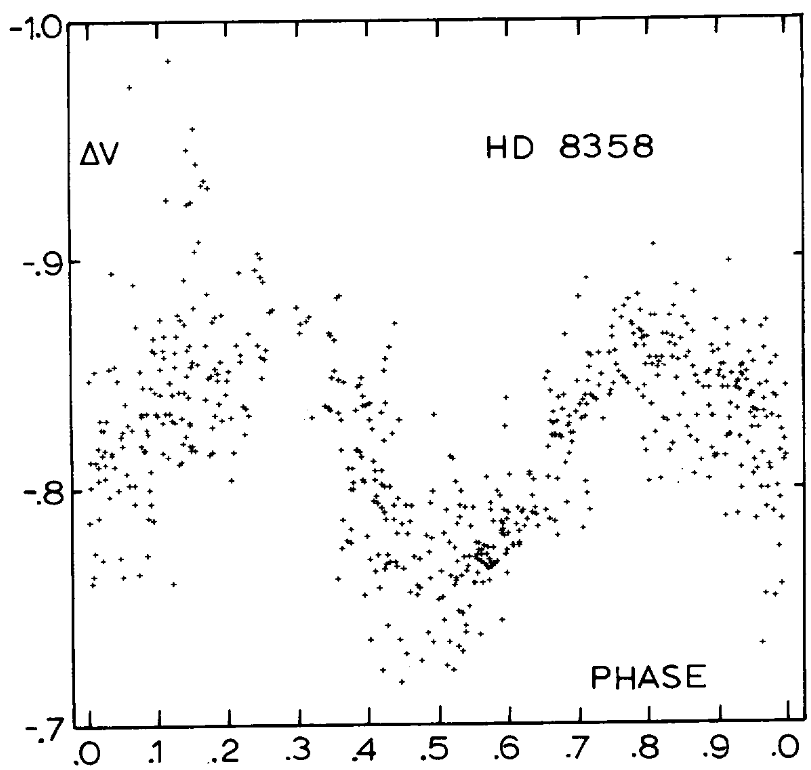

Figure 1

Light curve of the chromospherically active star HD 8358, where phase is computed with a 0.52-day period. The double-humped shape indicates two spot groups were present in late 1984. The large scatter, produced in part from intrinsic cycle-to-cycle changes, is discussed in the text.

Three factors are responsible for the large rms deviation. (1) A sin 2θ curve is an imperfect description of the mean light curve shape. (2) The data were not purged or sanitized in any way prior to analysis, so a few nights of inferior photometric quality probably were included. (3) The light curve underwent intrinsic changes in shape during the 144 orbital cycles which were observed; overlays of separate plots for individual nights demonstrated that the brightness at both maxima and both minima changed as much as $0\overset{m}{.}05$, with no obvious trend or pattern of repetition.

While this paper was in preparation, we received a preprint from Bopp et al. (1985) presenting extensive photometric, spectroscopic, and far-ultraviolet observations of HD 8358. Perhaps we can say here that they, too, found the light curve shape to change dramatically on a variety of time scales.

The light curve changes are surely a consequence of starspot activity. The double-humped shape seen in our Figure 1 indicates two spot groups were present in late 1984. The dramatic changes in shape and the rapidity of those changes make HD 8358 a good candidate for the study of starspot evolution. The rapidity itself, however, will require that future monitoring be extensive and as nearly uninterrupted as possible, in order to maintain proper cycle count from season to season and to define interesting multiple periodicities which may be present.

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PHOTOGRAPHIC OBSERVATIONS OF NGC 2346 DURING 1984 - 1985

We report further photographic observations of the central star of NGC 2346 obtained during the 1984 - 85 observing season. These continue from the observations reported for the three previous seasons, (see Marino and Williams, 1984, and the references therein).

The methods of observation and reduction are the same as in previous years. 66 photographs were taken by Williams using the equipment described previously. A further 4 photographs were taken by M. Bos of Auckland. All magnitudes were determined from the photographs by Marino.

The new photographic estimates are presented in Table I. The approximate times of observed maxima with cycle phase positions are given in Table II.

The sixteen day periodicity of the light curve continues in the current data. Maxima are maintaining the 0.8 phase position, half a cycle displaced from the maxima observed prior to cycle 167.0.

From early in the season maxima were as bright as $m_v = 11$ (c.f. $m_v = \sim 13$ at the end of the 1983 - 84 season). This was the steady magnitude of the central star prior to onset of the first occulting events in 1981 - 82.

The maxima appear to be becoming wider with time and the minima narrower indicating a continuing clearing of the obscuring cloud from our line of sight to the system. The magnitude at minima continued to be fainter than $m_v = 14$ for the full observing season.

Observations are to be continued during the next season.

Table I

Photographic observations of the central star of NGC 2346 between 1984 November and 1985 May

J.D. 2446000+		m_V	phase	J.D. 2446000+		m_V	phase
025.1	fainter than	14.4	181.30	133.8		11.9	188.09
026.0	fainter than	14.4	181.35	134.9		13.4	188.16
034.1		11.6	181.86	135.8		13.5	188.22
051.9		12.3	182.97	139.9		13.4	188.47
052.9		13.2	183.03*	140.9		11.9	188.54
054.9	fainter than	14.4	183.16*	141.8		11.4	188.59
057.9	fainter than	14.4	183.35	143.9		11.4	188.72
061.9		12.9	183.60	145.9		10.8	188.85
062.0		12.9	183.60*	155.8		13.5	189.47
065.0		11.0	183.79*	162.9		11.2	189.91
074.9	fainter than	14.0	184.41	164.8		11.4	190.03
075.9	fainter than	14.0	184.47	165.9		11.4	190.10
077.9		13.3	184.60	166.8		11.8	190.16
078.9		12.6	184.66	167.9		13.6	190.23
079.9		11.9	184.72	168.8	fainter than	14.4	190.28
080.9		11.2	184.73	169.9		14.2	190.35
082.9		12.0	184.85	170.8		13.8	190.41
084.9		13.1	185.04	171.8		13.1	190.47
086.9		14.2	185.16	176.8		10.8	190.78
087.9		14.6	185.22	177.8		11.1	190.84
088.9		14.6	185.29	178.9		11.0	190.91
092.9		12.9	185.54	184.8		14.2	191.28
095.9		11.5	185.72	185.8		14.5	191.35
096.9		11.7	185.79	191.8		10.8	191.72
097.9		11.5	185.85	192.8		10.8	191.78
098.9		11.7	185.91	193.8		11.0	191.85
099.9		11.9	185.97	194.8		11.5	191.91
102.9	fainter than	14.0	186.16	197.8		11.8	192.10
105.9	fainter than	14.0	186.35	201.8		14.0	192.35
108.9		13.3	186.54	202.8		13.0	192.41
110.9		11.7	186.66	204.8		11.3	192.53
113.9		11.0	186.85	212.8		11.2	193.03
116.9		11.4	187.04	213.8		11.3	193.10
119.9		14.0	187.22	215.8		12.6	193.22
120.8	fainter than	14.4	187.28				

* photographs by M. Bos, all others by H. Williams

Table II

Approximate times and phases of maxima for the central star of NGC 2346

J.D. 2446000+	m_v	phase	comments
034.1	11.6	181.86	
051.9	12.3	182.97	probably earlier
065.0	11.0	183.79	
080.9	11.2	184.73	
095.9	11.5	185.72	possibly later
113.9	11.0	186.85	
133.8	11.9	188.09	probably earlier
145.9	10.8	188.85	
162.9	12.2	189.91	probably earlier
176.8	10.8	190.78	
192.3	10.8	191.75	
212.8	11.2	193.03	earlier.

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Reference:

Marino, B.F. and Williams, H.O., 1984, I.B.V.S No. 2583.

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PHOTOMETRY OF HR 6384 - AN 80 DAY ELLIPSOIDAL BINARY ?

Ake and Parsons (1985), in I.B.V.S. Number 2686, drew attention to IUE spectra of the bright southern star HR 6384 which show the characteristics of a close binary system containing substantial circumstellar gas. They suggest that in order to have substantial interaction between the binary components the binary period is probably several hundred days. HR 6384 is not known as a variable star.

In Auckland we have made three colour UBV sets of photoelectric measures on thirteen nights during May - July 1985, as a start to a continuing programme to monitor light and colour variations of the system and identify periodic features if they exist.

The equipment used was the Mark 1 photoelectric system on the Edith Winstone Blackwell 50cm Cassegrain telescope, which has been described previously, (Walker and Marino, 1978).

HR 6438, (V = 5.88, B-V = +1.07, U-B = +0.86), from Hoffleit (1982) was used as the primary comparison star and the results have been reduced from these values. Observations were also made of the seventh magnitude star 6 arc minutes north of the programme star, and of HR 6442, as a check of non-variability of the comparison star. Mean V magnitude, colour, and standard deviations for the three stars are:

star	V	S.D.	B-V	S.D.	U-B	S.D.
HR 6438	6.153	0.026	+1.787	0.010	+1.340	0.010
star 6 min north	7.016	0.006	0.429	0.006	0.120	0.010
HR 6442	5.805	0.003	0.978	0.003	0.773	0.014

The results for HR 6384 are listed in Table I and plotted in Figure 1.

Table I

Three colour UBV observations of HR 6384

J.D. 2446000+	V	B-V	U-B	comments
189.9651	6.152	+1.779	+1.334	
191.9546	6.146	1.781	1.347	
205.9227	6.141	1.801	1.348	
211.9071	6.152	1.798	1.343	
218.9015	6.195	1.795	1.341	
225.9161	6.193	1.783	1.323	
233.0030	6.146	1.798	1.345	
242.8638	6.118	1.795	1.332	
243.9270	6.120	1.788	1.358	
245.8010	6.122	1.790	1.347	
252.8869	6.148	1.785	1.336	
258.9429	6.179	1.775	1.345	poor conditions
265.8754	6.180	1.768	1.322	

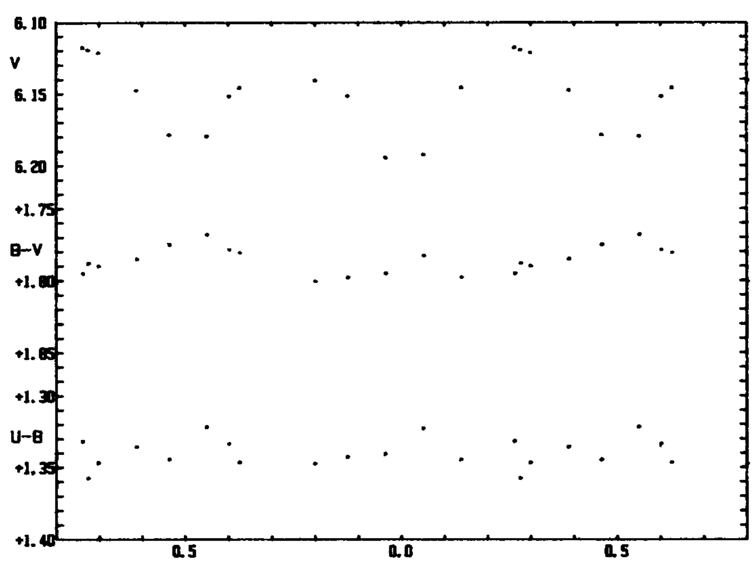

Figure 1 UBV Observations of HR 6384 (HD 155341) during the period JD 2446189 - 265 using the ephemeris JD 2446142 + 80 days

The programme star is clearly variable ranging from 6.118 to 6.195 (V) during the observing interval. Maxima and minima appear to recur at approximately 40 day intervals with the B-V curve being modulated to the V variations. On the assumption derived from the IUE spectra that the system is a binary with associated circumstellar matter, the light and colour curves appear consistent with an ellipsoidal binary having an orbital period of approximately 80 days.

Photoelectric photometry is continuing during the current observing season.

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HR 7671: A UU HERCULIS STAR OR ANOTHER IMITATION?

HR 7671 is a luminous F-type star at a high galactic latitude of $-21^{\circ}.5$. Though bright ($6^{m}.4$) it has a number of various classifications and poorly understood variability, as shown recently by Fernie (1985). Spectral types ranging from gF4 to F3 Ib can be found. The most recent MK spectral classification by R. Garrison yields F2 (shell) as quoted by Fernie. It is a low- amplitude long-period (?) variable known as BV 592 but monitored more extensively only recently by Fernie.

Thus HR 7671 fulfils in general most of the criteria for membership in the group of the UU Her stars - variable F-type supergiants at high galactic latitudes having long periods and low amplitudes (Sasselov, 1984). Fernie (1985) doubts HR 7671 should be considered a UU Her star because of its low metal content and much shorter periods. However, no high-dispersion spectroscopic study of HR 7671 has been published yet, except the abstract by McDonald (1976) which cannot provide the entire necessary information about the star. In case it is not a UU Her star, HR 7671 becomes one of the candidates for membership in the group of imitations of normal supergiants. We consider as an imitation every low-mass object sustaining a pseudophotosphere (for a decade or more) of supergiant's dimension and luminosity, and producing the corresponding absorption spectrum. Two examples seem to be PU Vul and HD 46703, masquerading quite well as F-supergiants. More details on the existence of imitations and the ways to distinguish them can be found elsewhere (Sasselov, 1985).

Hence we have included HR 7671 in our high-dispersion spectroscopic investigation of established and suspected UU Her stars. We obtained two spectrograms on 26 and 29 July 1985 respectively, using the Coudé spectrograph to the 2 m telescope of the Bulgarian National Astronomical Observatory (NAO) on Mt.Rozhen. The first spectrogram covers the red region from 4800 to 6900 ÅÅ with a nominal resolution of 0.36 Å. The second one covers the blue region from 3500 to 4900 ÅÅ with a resolution of 0.18 Å. At the same time we have started UBV photometry of HR 7671 with the 0.6 m telescope of NAO-Rozhen. Two estimates made so far are given below. The errors shown are internal ones.

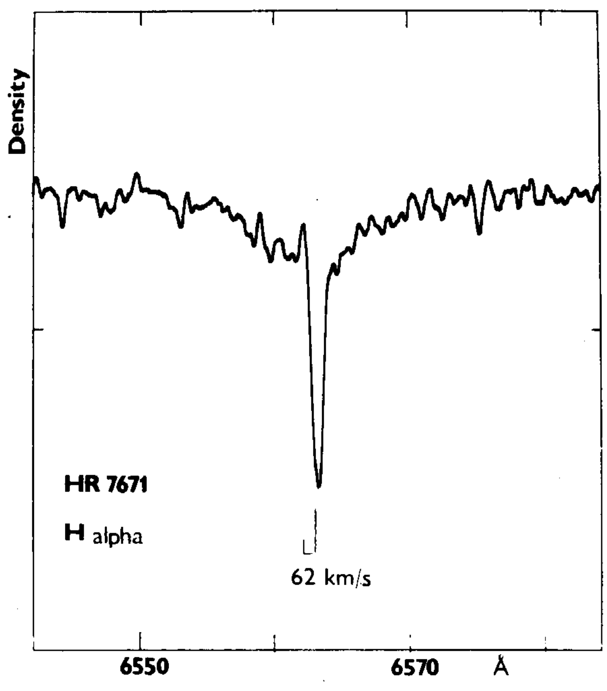

Figure 1

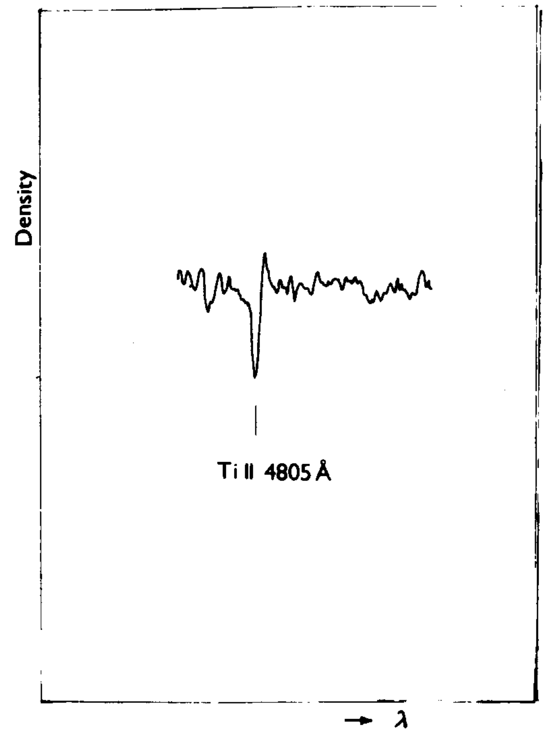

Figure 2

JD 2446274.42	(V) 6.398 ± 0.008	(B-V) +0.55 ± 0.010
JD 2446275.37	6.368 .008	+0.53 .010

We have used the comparison star suggested by Fernie - HR 7715 with V=5.867. Unfortunately it has no reliable B-V color index yet. We have used the rough value of 0.5 from Hirshfeld and Sinnott (1982).

A detailed abundance analysis of HR 7671 will be published elsewhere while here we would like to draw attention to some peculiarities found in the obtained spectra and important for its classification. As a whole the spectrum of HR 7671 is that of a typical F-supergiant, except for the somewhat weaker metallic lines, thus resembling the spectrum of PU Vul and unlike the one of UU Her (all spectra were obtained at NAO-Rozhen during July this year). The shell features noted by R.Garrison seem to be confirmed , especially in the appearance of the Hα line. This line has an interesting profile (Figure 1) with a well seen emission on the blue side of the absorption core. It is shifted some 60 km per second from the photospheric rest velocity of the Hα absorption. Slight emissions flanking the central absorption seem to be present also in the Na D line at 5895.92 Å. The Hα absorption profile itself has peculiar wide wings and a narrow core, thus resembling the Hα profile of the UU Her star HD 161796 - the latter showing no observable emission (Arellano Ferro, 1983). To some extent the Hα profile of HR 7671 has also much in common with the one of another UU Her star HR 4912 (Luck et al., 1983). However only the Hα line of the possible imitation HD 46703 has a dominating blue emission (Luck and Bond, 1984) which might indicate to the different structure and dynamics of the atmospheres of both types of stars. Hα emission is common in F-K supergiants including the UU Her stars and the long-period Cepheids (Climenhaga et al., 1981). However, emission is almost always present on the red side only.

It is moreover curious that the blue emission Hα line in HR 7671 is complemented by a couple of Fe II and Ti II lines near Hβ exhibiting pure P Cygni profiles. As an example the line of Ti II at 4805.10 Å is shown in Figure 2.

All these spectral features do not seem to favour the classification of HR 7671 as a UU Her star, bringing it closer to the small group of objects masquerading as supergiants, moreover if its low metal content and variability period(s) are also considered. According to the theoretical models of Shibahashi and Osaki (1981) normal supergiants blueward of the instability strip are unstable against low-harmonic nonradial f modes and periods longer than 40 days are expected (as observed in all UU Her stars). The imitations, having a totally different structure inwards apparently pulsate in a different way, as well (e.g. Fadeyev, 1984).

The exact status of HR 7671 remains as yet not finally established. Further photometry and radial velocities, as well as monitoring for possible changes in the profile of Hα are most desirable.

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MULTI-COLOR PHOTOELECTRIC PHOTOMETRY OF THE
STARSPOT ACTIVITY ON LAMBDA ANDROMEDAE DURING 1984/85

The long period RS CVn binary Lambda Andromedae (HR 8961, HD 222107; G8 IV-III; <V> = +3.88 mag) was observed photoelectrically on 30 nights from 1984 August 25 UT through 1985 February 21 UT. The observations were obtained at the Villanova University Observatory using the 38 cm Cassegrain telescope which utilizes a photoelectric photometer that is equipped with a refrigerated EMI 9658 photomultiplier tube and a microprocessor controlled integrating system. The characteristics of the intermediate-band blue, Strömgren y , Balmer H-alpha intermediate - and narrow-band filters are, respectively: λ_{max}=4530 Å, FWHM=180 Å; λ_{max}=5500 Å, FWHM=260 Å; λ_{max}=6600 Å, FWHM=272 Å; λ_{max}=6568 Å, FWHM=38 Å, It is to be noted that the bandwidth of the red intermediate-band filter is broad enough such that the included line feature does not significantly contribute to the measure. Therefore, the red intermediate bandpass measure is essentially that of the continuum centered at 6600 Å. The comparison star was Psi And (HR 9003, HD 223047; G5 Ib; V=+4.95 mag), while HR 9011 (HD 223229; B3 IV; V=+6.07 mag) served as the check star. No significant variations were detected between the check and comparison stars on the 3 nights that the check star was observed. The observing sequence was the conventional pattern of sky-comparison-variable-comparison-sky, with each measurement being approximately 40 seconds in duration. Typically, about 1 hour of data were collected per night. The effects of differential atmospheric extinction were removed using extinction coefficients determined from the observation of standard stars. Normal points were computed for the observations of each night, with up to 12 measurements forming a mean. H-alpha indices were computed from the intermediate - and narrow-band red data, forming an alpha-index that is a measurement of the net H-alpha line strength. The alpha-index is defined in the usual way, via the equation

$$\text{alpha-index} = -2.5 \log (F_n/F_i) + \text{constant}$$

where F_n and F_i are the stellar fluxes recorded by the narrow and intermediate bandpass filters, respectively. Nightly mean differential magnitudes were computed for the $\lambda\lambda$4530, 5500, 6600, and 6568 observations in the sense variable minus comparison. Two differential color indices were computed from the nightly mean differential magnitudes according to the following relations:

$$\Delta(b-y)_{v-c} = \Delta MAG(V-C)_{4530} - \Delta MAG(V-C)_{5500}$$

$$\Delta(b-r)_{v-c} = \Delta MAG(V-C)_{4530} - \Delta MAG(V-C)_{6600}$$

Additionally, a differential alpha-index was computed for each night using the transformation to the standard Villanova alpha system (Baliunas, Ciccone, and Guinan 1975) through the observations of standard stars. The numerical values of the blue, yellow, and red (H-alpha intermediate - and narrow-band) nightly mean differential magnitudes, as well as the nightly mean differential color and alpha indices, have been tabulated as a function of heliocentric Julian day (HJD) and have been submitted to the IAU Commission 27 Archive of Unpublished Observations of Variable Stars (Breger, 1985). The mean errors (standard deviations) for the nightly $\lambda\lambda$4530, 5500, 6600, $\Delta(b-y)_{v-c}$, $\Delta(b-r)_{v-c}$ and $\Delta\alpha(V-C)$ data sets are, respectively: 0.007, 0.005, 0.006, 0.009, 0.009, 0.010 mag.

Figure 1 presents the blue and red light curves, along the $\Delta(b-r)_{v-c}$ and $\Delta\alpha(V-C)$ indices.The light curves exhibit the quasi-sinusoidal shape that is a characteristic of the RS CVn-type systems, believed to be produced by the rotational modulation in brightness from starspots. Assuming that the photometrically inferred (from previous studies) mean rotation period of $\approx$ 54 days is still relevant, the observations that we present here span $\approx$3.4 cycles. The light curves contain an interval of 35 days, from HJD 2445978 through 2446012 inclusive, during which we were unable to collect data as a consequence of unfavorable weather conditions. A relative light maximum may have occurred during this time. Our observations record 3 individual light maxima, occurring at approximately HJD 2445944, 2446054, and 2446104, as well as a light minimum near HJD 2446080. The interval between HJD 2446054 and 2446104 is only 50 days, differing markedly from the 54 day value one would anticipate. This discrepancy may result, in part, from the less than satisfactory phase coverage of our observations. The light variation is wavelength dependent with the blue observations having a greater light amplitude than the yellow (not shown) and the red observations. For example, during the time of greatest light variation (i.e. between HJD 2446054 and 2446080) the range of light between maximum and minimum is $\approx$0.10 mag, $\approx$0.08 mag, and $\approx$0.07 mag for the blue, yellow, and red observations, respectively.

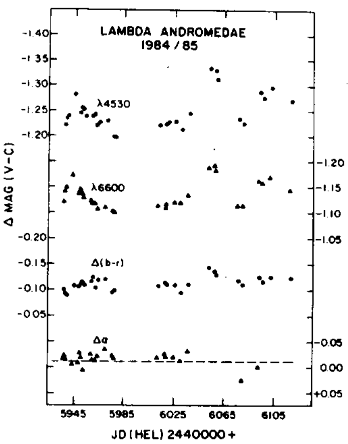

Figure 1: The photoelectric observations of Lambda Andromedae made with respect to the comparison star, Psi Andromedae during 1984-85. The differential blue (λ4530) and red (λ6600) magnitudes are plotted along with the differential (b-r) and α indices. More negative values of Δα indicate a net weakening of the Balmer Hα absorption feature. The level of no net Hα emission is indicated in the figure by a broken line.

A weak correlation exists for both the $\Delta(b-r)_{v-c}$ and $\Delta(b-y)_{v-c}$ (not shown) color indices in that they are bluest near HJD 2446054, corresponding to the light maximum which has the largest amplitude of the 3 recorded maxima. The correlation is more pronounced for the $\Delta(b-r)_{v-c}$ data than for the $\Delta(b-y)_{v-c}$ data. The mean values for the $\Delta(b-r)_{v-c}$ and the $\Delta(b-y)_{v-c}$ data sets are, respectively, -0.114 mag and -0.104 mag.

No apparent correlation exists between the light curve variations and the differential H-alpha index. Based upon the spectral types for Lambda And and Psi And (the comparison star), $\Delta\alpha(V-C) \approx -0.015$ mag corresponds to no H-alpha emission. The mean value for the $\Delta\alpha(V-C)$ data set is ≈ -0.016 mag. Note that the data point recorded at HJD 2446079 deviates most from the mean, revealing the strongest H-alpha absorption of our observations.

The photometric behavior of Lambda And prior to autumn 1983 was distinguished by large amplitude (typically 0.20 mag at λ 5500), quasi - sinusoidal waveforms, occasionally possessing two maxima per rotation cycle. Bopp and Noah (1980), Dorren, Guinan, and Paczkowski (1982), and Dorren and Guinan(1984) have explained the ever changing shape and amplitude of the light curves as being due to the rotational modulation of 2 large circular spots or spot complexes. Unpublished observations obtained at Villanova University from late 1983 through July 1984 reveal that the light output from Lambda And was essentially constant. In the context of the starspot model, such behavior can be explained by either the spots being located near the star's rotational pole, or, the fragmentation of the 2 large spots into numerous, smaller spots which are evenly distributed across the visible stellar surface.

As shown in the figure, the light curves vary in shape and light amplitude with time. These cycle-to-cycle variations are similar to those found previously for this star (Boyd et al. 1983, Dorren and Guinan 1984), and have been interpreted as arising, in part, from differential rotation of one spot complex relative to the other (Dorren and Guinan 1984). Furthermore, the wavelength dependence of the amplitudes of our light curves is consistent with the presence of dark starspots 800 degrees cooler than the surrounding photosphere (Bopp and Noah 1980, Dorren and Guinan 1984). With respect to the photometric behavior of Lambda And between late 1983 and July 1984 explained in the previous paragraph, the observations presented here may be indicative of longitudinal concentration of the spot complexes coupled with latitudinal migration away from the pole. Continued monitoring throughout the 1985/86 observing season should help bring clarity towards understanding the current surface and atmospheric activity of Lambda And.

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96 HERCULIS: A REMARKABLE EARLY-TYPE MULTIPLE SYSTEM

96 Her (HR 6738, HD 164852, BD+20^{o}3649, SAO 85672) is a bright B star. The HD spectral type of 96 Her is B3. Hoffleit and Jaschek (1982) quote B3V.

Radial-velocity variations of 96 Her were discovered by Mitchell (1911) on 25 Yerkes spectrograms. He found a range from -98 to +74 km/s and reported the presence of four components. The derived period was 50.2 days. Frost et al. (1926) remeasured ten of his plates as single and remarked that: "no attempt was made to measure separately the components observed by Mitchell in the spectrum of this star". Miss A.M. Hobe at Lick measured two plates for radial velocity (Campbell and Moore, 1928). She observed and measured a faint second component on both plates. Later, Plaskett and Pearce (1930) presented 10 radial velocities based on fair He I and Ca II lines and on wide H I lines. They supposed that the observed range of RV is the result of accidental errors of measurement and refuted the binary nature of 96 Her. Kodaira (1971) measured radial velocities of Balmer lines from H beta to H 15 on 30 Mt. Wilson spectrograms of 96 Her. Taking into account also older observations (with exception of Mitchell's data), he concluded that 96 Her is a SB 1 and derived period of 40.04 days. He also stressed that:"reexamination of multiple lines in higher-dispersion spectrograph is necessary". The inspection on three LWR high-resolution spectra taken in August 1983 with the IUE satellite revealed striking variations of Mg II lines 2795, 2802, 2790, 2797 Å and also some Fe II lines within a three day interval.
This finding revived the suspicion that 96 Her is a multiple system and prompted us to start the ground-based observations.

Our observational material covers the period JD 45570-46136 and consists of:
1. 14 blue-violet (3650-4900 Å) spectrograms obtained with the Cassegrain spectrograph attached to the 1.88 m telescope of the David Dunlap Observatory (DDO). The reciprocal dispersion was 8Å/mm (with the exception of one 12Å/mm plate). Vacuum sensitized IIIa^{J} emulsion was used.
2. Two red (4800-6800 Å) and 13 blue-violet (3500-4900 Å) spectrograms secured with the coudé spectrograph of the 2 m RCC telescope of National Astronomical

Table I

Orbital elements of 96 Her AB

Period	12.4573	±	.008	days
$T_{max}RV$	45895.41	±	.02	J.D.
e	0.536	±	.008	
ω	321°.3	±	1°.3	
K_1	57.6	±	.9	km/s
K_2	57.5	±	.9	km/s
γ	-15.5	±	.4	km/s
$m_1 \sin^3 i$	0.591			$m_\odot$
$m_2 \sin^3 i$	0.592			$m_\odot$
$a_1 \sin^3 i$	12.0			$R_\odot$
$a_2 \sin^3 i$	12.0			$R_\odot$

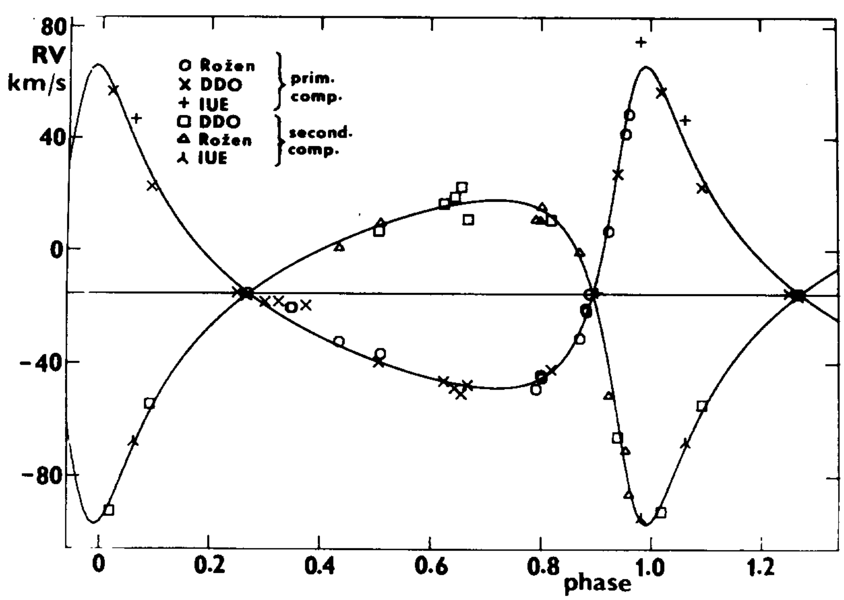

Figure 1: Radial velocities and computed curves for the spectroscopic pair 96 Her AB corresponding to the orbital solution of Table I. Phases are plotted from T max RV.

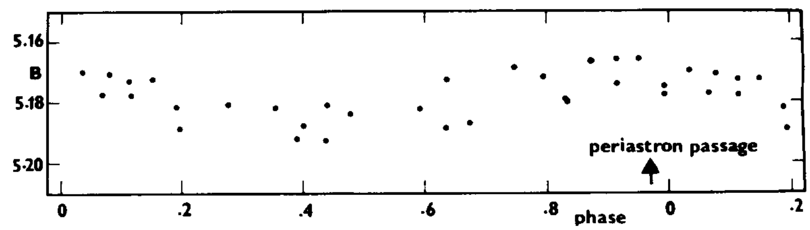

Figure 2: The light curve of 96 Her in B. Phases are derived from the orbital solution given in Table I and are counted from T max RV.

Observatory at Rožen (NAOR). The dispersion of the blue-violet spectra was 9Å/mm, while the red ones had a dispersion of 18Å/mm. Kodak IIaO emulsion was used (103aF emulsion for the red plates).

3. Three LWR high-resolution spectra taken with the International Ultraviolet Explorer (IUE), see Boggess et al. (1978) for a description of the IUE satellite and its instrumentation.

All the spectra were measured for radial velocity. The plates taken at NAOR were measured with the oscilloscopic comparator of the Observatory. The device was controlled by the multipurpose routine written by Y. Bellas. This routine was also used for deriving the radial velocity. The spectrograms obtained at DDO were digitized using the PDS microdensitometer, and the radial velocities were measured by fitting parabolas to the lower halves of the line profiles. The UV data were extracted form the plots produced with a software written by one of us (J.H.). More details on the reduction techniques will be given in the forthcoming study of 96 Her.

Many spectrograms show definite doubling of the lines (including the Balmer lines). On several plates 3 components are visible. This is undoubtedly the result of a higher quality of our observational material. The velocity of the third component varies on a short time scale. This fact suggests that there is another binary in the system. The spectra of the primary (A) and secondary (B) are comparable, with the lines of the secondary being slightly weaker. The spectrum of the third component is somewhat weaker. The spectral types and rotational broadening of all observable contributors to the spectra seem to be similar (B 2-3, v.sini 30-40 km/s). The available measurements of the radial velocity can be used only for deriving the elements of the system AB. Periodicities in the velocities derived from the components A and B were searched for with a period-finding program by Morbey (1978). The resulting period was 12.7 days. The orbital elements of the system 96 Her AB were then computed using the program SPEL - written by J.H. - which is based on direct minimization of the $(O-C)^2$. They are collected in Table I and displayed graphically as a phase diagram in Figure 1.

96 Her has been selected as one check star in the on-going international program of photoelectric monitoring of bright Be stars (Harmanec et al., 1980) and was observed in the period JD 45065-45178 at the Hvar Observatory. These observations reveal that the B magnitude of 96 Her varies with the orbital period of the system AB. The light curve is presented in Figure 2. The light maximum coincides with the time of periastron passage. We can speculate that a kind of pulsation driven by the tides is the source of the photometric variability.

Clearly, 96 Herculis is a very interesting early-type multiple system which deserves attention of spectroscopists and photometrists.

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UBV OBSERVATIONS OF HD5303

In 1983 a call was issued to potential participants in an international programme of observation of RS CVn and UV Ceti-type stars (Rodono et al., 1983). Carter Observatory (New Zealand) responded to this call with a plan to carry out flare patrol of some stars of the UV Ceti-type, and also some broad band monitoring of examples of both kind of object. Most of the standard broad band photometry was carried out at the Black Birch outstation (near Blenheim), though some work was also done at the Mt John University Observatory (near Lake Tekapo).

Included in the programme was the 7th magnitude southern variable HD5303 (Collier et al., 1981), which Hearnshaw and Oliver (1977) found to be a member of the RS CVn class. Photometry of the system, apart from that reported by Collier et al. (op.cit.), has also been presented previously by Thompson (1982), Coates et al. (1982, 1983a, b) and Rucinski (1983). Budding (1984) preliminarily reported no obvious indications of the "wave-like variation" towards the latter end of 1983 over the phase range from secondary to primary minimum, and supported the essential validity of the period determination of Coates et al. (1983b). (Some details on instrumentation and procedure are also given in that account.)

Over 19 nights of observation, between Aug. 29, 1983 and March 20, 1984, UBV photometry was carried out using the 41 cm Ruth Crisp telescope at Black Birch. Reductions have been carried out using the VAX computer operated by the Applied Maths Division of DSIR (NZ) in the University of Wellington. Analysis of these reduced data is now underway with the same facilities.

Reduced light curves in the local UBV system are shown in Figure 1. This local colour system is reasonably close to the standard one-nominal calibration coefficients (Hardie, 1962) are $\varepsilon = \mp 0.16$; μ, $\psi = 1.07$- but a newer calibration involving a number of standard star observations dispersed through the above-mentioned interval, is also in progress.

The main comparison star was HD5210. Though Innis et al. (1984) appear to have found some discrepancies between HD5210 and HD5499 on some nights, HD5210 appears to have been sensibly constant during the observations reported here. When checked against HD5370 in 18 good quality distributed observations, we obtain:

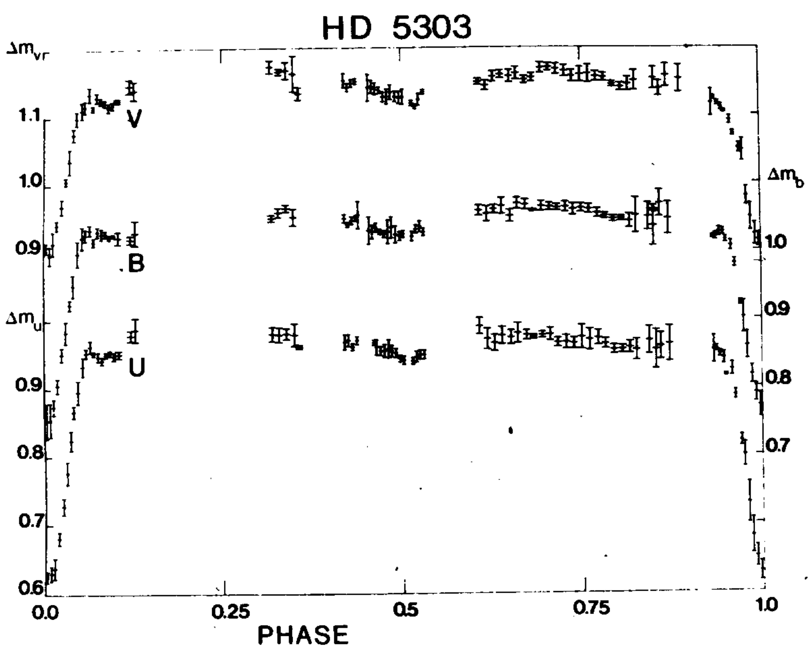

Figure 1

dV=0.247, (s.d.=0.007), dB=0.325 (s.d.=0.005), and dU=0.307 (s.d.=0.008). Eight reliable checks against HD4815 yield: dV=3.520 (s.d.=0.010), dB=2.798 (s.d.=0.006), dU=1.529 (s.d.=0.008). Unfortunately, we have not made many checks against HD 5499, but the few readings of that star that were taken do suggest that it may be HD5499 which is the source of the discrepancies.

Times of primary minima can be given as

1.HJD 2445578.9392 ± 0.0004

2.HJD 2445606.9165 ± 0.0002

3. HJD 2445757.993 ± 0.005

These times were determined by the folding paper method. Their accuracies are based on the agreement between the 3 filter results. The third one (Feb.27) shows greater scatter due to incomplete coverage, and higher air masses affecting the photometry. From the most reliable of these estimates (the second) and the epoch quoted by Coates et al. (1983b), we are able to derive an improved period of 2.797672 days.

The greater spread which can be seen in the error bars (which correspond to s.d. of data points within each bin) around phase 0.82 is related to the largish airmass (>2) for the night (March 20) when this data was gathered. A similar situation applies to the greater spread and apparent discrepancies at phase 0.32; though it is just possible that there is some real systematic difference in the differential magnitudes between the values of Sep. 2 and Feb. 28 (~6 month interval).

Apart from these effects, everything alse looks like a reasonably normal eclipsing binary light curve for a pair of intermediate type stars. The slight "hook" effect after primary minimum, noticed by Coates et al. (1984), seems to be also there in Figure 1. Another noticeable feature of Figure 1 is the rounding of the regions between minima ("ellipticity effect"), which seems to be more marked as we move from the U to the V data. This implies that the cooler star is the more distorted one. This may be in keeping with the standard RS CVn binary configuration (Popper and Ulrich, 1977), in which the more massive component is slightly evolved towards the giant branch. The effect of the G star's expansion must, however, outweigh the proportional effect of its greater mass in disturbing the form of the F-type optical primary.

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OBSERVATIONS OF SUPERNOVA IN NGC 3169

The supernova in NGC 3169 was discovered independently by N.Metlova and Kiyomi Okazaki on March 26, 1984 and by R.Evans on March 29 (IAU Circ.No. 3931). Its precise optical position was determined by H.Kosai and R.W.Argyle (IAU Circ. No. 3936) to be $\alpha=10^h11^m35^s\!.37$, $\delta=+3^\circ43'07''\!.6$ (1950.0); offset from the nucleus 60"W, 15"N.

Photographic U, B and V observations of the supernova were carried out with the 50/70 cm Maksutov telescope and the 40 cm astrograph of Sternberg State Astronomical Institute Crimean Station and also with the 70 cm reflector in Moscow. Observations were continued until May 3; 4 plates in U, 24 in B and 10 in V have been obtained. The supernova was also found visible on two plates taken with the 40 cm astrograph about a month before discovery.

Figure 1 shows the sequence of comparison stars around the supernova, their U, B and V magnitudes are reported in Table I. Stars 1-7 were measured photoelectrically with the 60 cm reflector of Sternberg Astronomical Institute Crimean Station, magnitudes of other stars have been measured on plates obtained with the Racine wedge.

Table I. Magnitudes of comparison stars

star	B	V	U
1	8.35	7.76	8.22
2	10.19	9.62	10.12
3	10.91	9.96	11.47
4	11.80	11.28	11.77
5	13.27	12.50	14.40:
6	13.74	13.28	13.70
7	14.52	14.54	14.48:
8	14.66	14.38	14.5
9	15.58	15.02	15.6
10	15.89	15.33	16.0
11	16.14	15.18	
12	16.36	15.95	
13	16.87	16.39	
14	17.43	16.10	
15	17.28	16.88	
16	17.4	17.3	
17	17.9		
18	18.3	17.5	

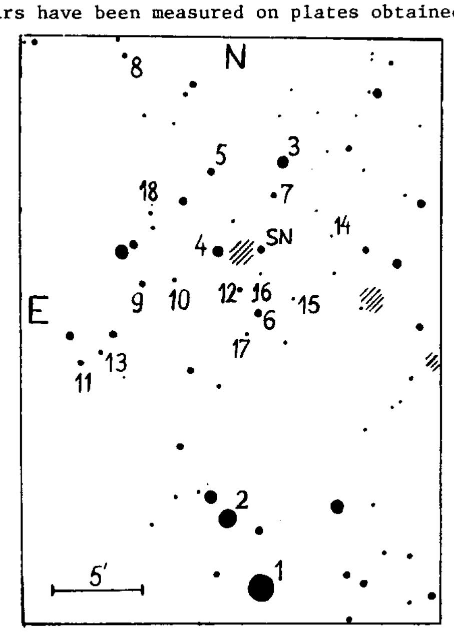

Figure 1

Table II

Observations of the supernova

JD 2445..	telescope	B	V	U
757.46	40 cm	18.1		
758.43	"	17.7		
761.44	"	> 18		
786.35	"	15.36		
789.25	"	15.29		
.26	50 cm		15.10	
.28	40 cm	15.31		
.31	"	15.36		
.35	"	15.18		
.38	"	15.35		
.41	"	15.18		
.46	"	15.30		
790.29	"	15.21		
739.28	"	15.18		
.30	50 cm			14.65
.34	"	15.27		
.37	"		15.17	
794.29	"			14.78
.33	"	15.24		
.35	"		15.13	
795.43	"			14.75
796.39	40 cm	15.39		
.40	50 cm	15.28		
.42	"		15.06	
797.42	40 cm	15.54		
.45	50 cm			15.0
798.28	70 cm		15.08	
.30	"	15.38		
799.36	"	15.52		
.38	"		15.28	
808.26	40 cm	16.35		
811.39	70 cm	16.10		
813.35	40 cm	16.60		
815.28	70 cm		16.08	
.30	"	16.61		
820.31	"	17.05		
.32	"		16.35	
821.29	"		16.40	
.39	"	17.0		
823.33	40 cm	17.5		
824.29	50 cm		16.87	

Magnitudes of the supernova are reported in Table II and the light curves are represented in Figure 2. The mean error of a magnitude is between $0^m.1$ and $0^m.2$, the magnitudes of the supernova below $B=17^m$ are more uncertain, their error is of order $0^m.3$ - $0^m.5$.

The maximum brightness was reached on JD 2445792±2 (April 1) with $B_{max}=15^m.2\pm0^m.1$, $V_{max}=15^m.1\pm0^m.1$. The light and colour curves are typical of type II supernova of "linear" subclass (Barbon et al., 1979, Tsvetkov, 1985). The rate of decline was 0.07 mag/d in B and 0.055 mag/d in V. The colour index (B-V) increased from $0^m.1$ to $0^m.6$ in 40 days, (U-B) was about $-0^m.5$ near maximum light. Comparison with the intrinsic colour curve for type II supernovae (Tsvetkov, 1985) yields the colour excess $E_{B-V}=0^m.1\pm0^m.05$.

According to Burstein and Heiles (1984), galactic absorption in the direction of NGC 3169 is $A_B=0^m.04$, and the colour excess of the supernova is due to absorption in NGC 3169.

The radial velocity of NGC 3169 is $V_0 = 1051$ km s^{-1} (de Vaucouleurs et al., 1976), assuming for the Hubble constant the value $H_0=75$ km s^{-1} Mpc^{-1} the distance should be 14 Mpc, and the absolute magnitude of the supernova at maximum light $M_B^0=-15^m.9\pm0^m.3$.

Comparison of these parameters with the data for other type II supernovae (Tsvetkov, 1985) shows that the supernova in NGC 3169 is distinguished by its low luminosity at maximum light and high rate of brightness decline.

Spectroscopic observations of the supernova have been reported by Gaskell (1984) and Dopita et al. (1984). The characteristic feature of the spectrum is strong, narrow Balmer emission superimposed on an otherwise normal type II supernova spectrum. It is supposed that this peculiar feature is due to a strong episode of mass loss from the precursor star immediately prior to the supernova event.

As we have already mentioned, the supernova is visible on two plates obtained before discovery, on February 26 and 27, but it is invisible on a plate taken on March 1, although the limiting magnitude was nearly the same for all three plates, about 18^m-$18^m.5$. The brightness of the supernova was certainly not increasing, and perhaps even declined from February 27 to March 1.

It is possible that this supernova had a premaximum plateau, the existence of which for some type II supernovae has been suspected by de Vaucouleurs (1974), or an outburst before the main explosion. The absolute B magnitude of the supernova at that time was about -13^m. The supernova is invisible that is $B>17^m.5$, on plates obtained earlier in February, and nothing is visible on the Palomar Sky Survey at the position of the supernova.

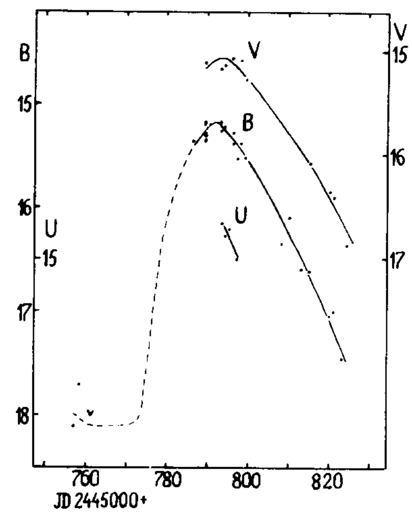

Figure 2

There is a possibility that the existence of a premaximum plateau or outburst may be connected with the spectral peculiarity of this supernova. It is also interesting to note that this is the first type II supernova discovered in Sa galaxy.

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NEW MINIMUM TIMES AND PERIOD CHANGES OF SW LACERTAE

SW Lac is a W UMa type binary and well known to have a variable period (see Panchatsaram and Abhyankar, 1981). A sudden period change in 1977 was announced by Mikolajewska and Mikolajewski (1981).

The photoelectric observations of the system were made on seven nights from July 15 to 27, 1985 at the Ege University Observatory. The 48 cm Cassegrain reflector equipped with an EMI 9781 A photomultiplier, B, V filters and a usual DC amplifier were used at the observations. BD+37°4715 and BD+37°4711 were chosen as comparison and check stars, respectively.

From these observations two times of secondary and six times of primary minima were determined. They are listed in the following table. The O-C values are calculated with the ephemeris of Kreiner and Frasinka (1977);

$$\text{Min I} = \text{JD Hel. } 2442\,697.404 + 0^{d}.320724716.E.$$

Hopp et al. (1982) noted that no period change has been occurred since the period jump in 1977. We collected all the available O-C values obtained since June 1968 and plotted in Figure 1. Some of the O-C values obtained visually and published in BBSAG were grouped and shown as circles in this figure. From this figure it is seen that the variations of the O-C values against the epoch numbers may be separated into two parts: viz. 1800<E<4300 and 4300<E<11200. In this case linear light elements agree well with the O-C values. An application of the least squares to these parts gave the following ephemeris:

for the first segment, 1800<E<4300

$$\text{Min I} = \text{JD Hel. } 2442\,697.3885 + 0^{d}.320722939.E$$
$$\pm 30 \qquad \pm 1068$$

for the second segment, 4300<E<11200

$$\text{Min I} = \text{JD Hel. } 2442\,697.4018 + 0^{d}.320719765.E.$$
$$\pm 11 \qquad \pm 124$$

It seems, from the Figure 1 that two jumps have been occurred in the period of SW Lac: the first at about 1977 and the second about July 1979.

Naturally, we are interested in the behaviour of light curves of the system. For this reason the system will be monitored in coming months and the resultant light curves and their variations will be presented and discussed elsewhere.

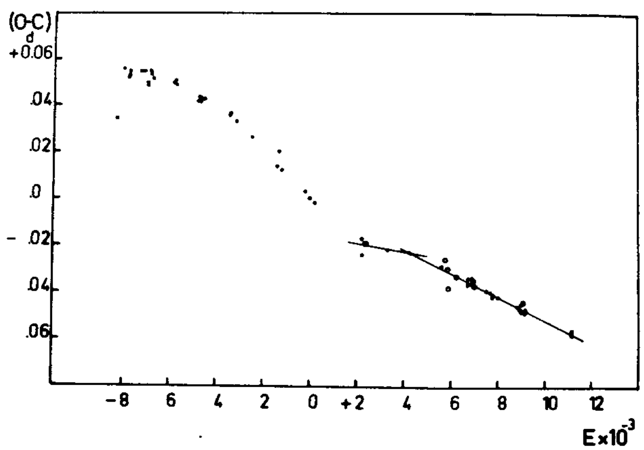

Figure 1

Table I
New photoelectric minima times of SW Lac

Hel. J.D. 2446 000+	O-C	E	Colour
262.3636	-0.d0560	11115.5	b
.3633	.0563	11115.5	v
264.4470	.0573	11122	b
.4467	.0576	11122	v
270.3797	.0580	11140.5	b,v
270.5404	.0577	11141	b
.5408	.0573	11141	v
271.5028	.0574	11144	b
.5030	.0572	11144	v
272.4656	.0568	11147	b
.4655	.0570	11147	v
273.4271	.0575	11150	b
.4268	.0578	11150	v
274.3887	.0581	11153	b
.3891	.0576	11153	v

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PHOTOELECTRIC OBSERVATIONS OF ER VULPECULAE

The peculiar eclipsing binary ER Vul was discovered spectroscopically by Northcott and Bakos (1956). The photoelectric observations made by Northcott and Bakos (1967) revealed its light variation. When the star was included in the list of short period group of the RS CVn binaries by Hall (1976) it called more attention. The light curve variations were discussed by Al-Naimiy(1978), Hrivnak (1982) and Kadouri (1981). The H and K emissions of singly ionised calcium were observed by Bond (1970).

The system ER Vul was observed at Ege University Observatory from 1981 to 1985. The observations were made with the 48 cm Cassegrain reflector, which was equipped with an unrefrigerated EMI 9781 A photomultiplier with B and V filters of the standard UBV system. BD+27^{o}3946 was used as the comparison star.

Table I
The times of minima of ER Vul.

Hel J.D. 244 0000+	O-C	E	Colour
5900.3536	+0^{d}.0028	8191	b
.3522	.0014	8191	v
5901.4043	.0064	8192.5	b
.4036	.0057	8192.5	v
5902.4481	.0030	8194	b
.4468	.0017	8194	v
5933.5126	.0023	8238.5	b
.5119	.0016	8238.5	v
5939.4465	.0024	8247	b
.4472	.0031	8247	v
6004.3776	.0108	8340	b
.3808	.0140	8340	v
6235.4368	.0008	8671	b
.4406	.0046	8671	v
6241.3738	.0040	8679.5	b
.3712	.0014	8679.5	v
6248.3577	.0070	8689.5	b
.3513	+.0006	8689.5	v
6256.3774	-.0014	8701	b
.3806	+.0018	8701	v

The times of minima derived from the observations of last two years are given in Table I. The O - C residuals are the differences between observed and predicted times of minima according to the ephemeris:

$$\text{Min I} = \text{JD Hel. } 2440\ 182.2621 + 0^{d}.69809409.E\ .$$

The star will be monitored again in the coming months and the light curves will be presented and discussed elsewhere.

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THE DWARF-NOVA IZ PEGASI = SVS 2549

The variable star IZ Pegasi (SVS 2549) was studied by a group of amateur variable star observers using the Moscow plate collection. Six large outbursts of the star were detected by photographic data, confirming its UG-SS type (Goranskij et al., 1985).

An outburst of the star is seen on the Palomar Sky Survey charts (Goranskij et al., 1985).

Another outburst is also seen in the Vehrenberg Atlas Stellarum 1950 on the charts No. 158 and 159 (1967 October 1 = JD 2439764) with the magnitude $m_B \simeq 13.5$.

E. SCHWEITZER

Association Francaise des
Observateurs d'Etoiles Variables -
Strasbourg, 67100

France

Reference :

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MINIMUM TIMING OF RZ Cas

Primary minimum of the eclipsing binary RZ Cas was observed through HαN and HαW filters, during 3 nights 17, 23, and 29 December 1984, using the 20" cassegrain telescope of Biruni Observatory and an RCA4509 phototube.

The variable star was observed against BD+67°215, and BD+69°171 was used as the check star. Differential observations were corrected for extinction, and the HαW light curve is shown in the Figure. Phases were calculated according to the ephemeris (Parenago, 1952):

$$\text{HJD } 2417355.4233 + 1^{d}.1952519 \text{ E}$$

Time of minimum was found to be 2446028.2601 by fitting a parabola to the observations within 0.05 phase of the primary minimum. An O-C of -0.0610 days was added to the calculated JDs to bring the primary minimum to the zero phase. This O-C together with the minimum given by Parenago suggest a period of 1.1952494 days.

As reported by other observers, an approximately flat bottom with a duration of about 15 minutes exists.

Results for HαN are not offered, because of large scattering of data, and low precision of results.

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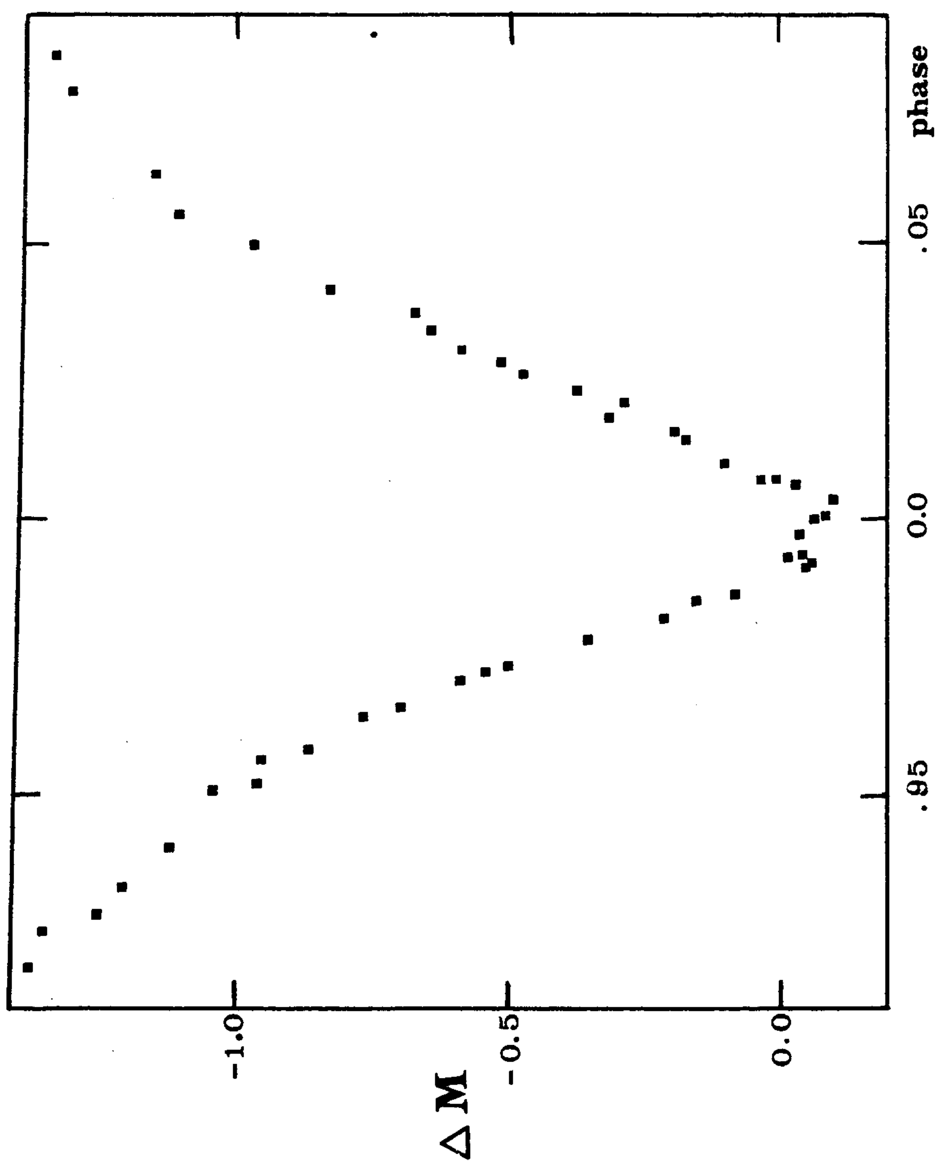
Reference:

Parenago, P.P., 1952, Variable Stars 9, 125.



ΔM
-1.0
-0.5
0.0
.95
0.0
.05
phase

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PHOTOELECTRIC OBSERVATIONS OF TWO MAJOR FLARES ON UV CETI IN OCTOBER 1983

In 1983 an international program of RS CVn and flare star observations was organized by M. Rodono of the Catania Astrophysical Observatory, Italy (Rodono 1983). This program involved ground-based radio and optical observations carried out in conjunction with IUE satellite observations. One of the stars initially included in this program was UV Ceti (L726-8), and we obtained telescope time at Mount Stromlo Observatory, Australia, for the period 30 September - 7 October. After our observing session was over and we returned to our home cities, we learnt that UV Ceti had been dropped from the international program. Nevertheless, we think there is value in documenting our observations, given the detection of two major flares.

Continuous monitoring of UV Ceti took place on two nights only, 30 September and 1 October, for a total of 4 hours 42 minutes, with a single channel photon-counting EMI Gencom Starlight-1 photometer (see Wolpert 1982) and the 76 cm "Reynolds Reflector". Observations were carried out in the B band of the Johnson UBV system. The photometer was interfaced through UART circuitry to an Hitachi MB-6890 Personal Computer. All machine programs to monitor, store and analyse the photometer output were written in BASIC. A chart output of the photon counter's digital readings provided a real time visual means of flare detection.

Standard stars HD 9228, 10254 and 10824 were selected from Cousins and Stoy (1963) and Cousins, Lake and Stoy (1966), and comparison stars B and C on the finder charts provided by Rodono were used. Continuous monitoring of the program star was undertaken, using a 10 second integration time; the monitoring intervals are indicated in Figure 1.

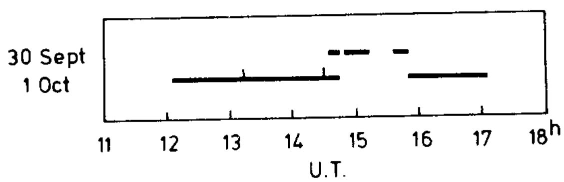

Figure 1

UV Ceti monitoring periods, September-October, 1983.
The two flares detected are indicated by spikes.

Problems associated with flare detection and identification during monitoring runs have been discussed by Kunkel (1973), Moffett (1974) and Gurzadyan (1980), amongst others. The detection criterion we adopted for a flare was the existence of several successive readings above the quiescent level of the star, where the maximum magnitude level exceeded three standard deviations. On this basis, no flares were detected during the short monitoring run on 30 September, but on 1 October two major events were recorded. Details of these are provided in Table I (following the reporting system recommended by Andrews et al. 1969), and light curves are given in

Table I

Characteristics of Observed Flares

Date 1983	Flare Number	U.T. of Max. h. m. s.	t_b (sec)	t_a (sec)	Duration (sec)	Δm_B	σ (mag)	Air Mass
Oct. 1	1	13 13 57	18	450	468	2.46	0.06	1.16
Oct. 1	2	(14 30 00)	--	(720)	(>740)	>2.00	0.04	1.06

Figures 2 and 3. The gaps in the light curves indicate breaks in the continuous monitoring to check the centering of the star in the 30 arc second aperture. In Table 1, t_b and t_a give the pre-maximum and post-maximum flare duration, respectively, and "Duration" = $t_b + t_a$. The second last column gives the standard deviation of random noise during the pre-flare quiescent state. It should be noted that because the commencement of Flare No. 2 was missed and its peak intensity may not have been recorded, some values in Table 1 are in parentheses, and the t_b column is blank. Another reason for viewing some of the data in Table 1 with some degree of caution is the problem of accurately defining the flare start and end points, but particularly the latter (see Kunkel 1973; Oskanian 1968).

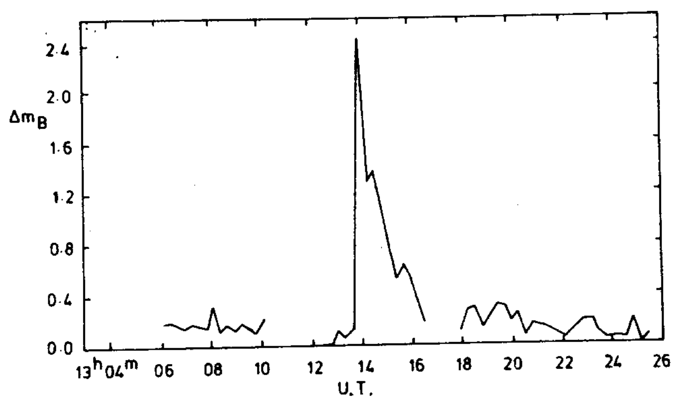

Figure 2

Light Curve of Flare No. 1

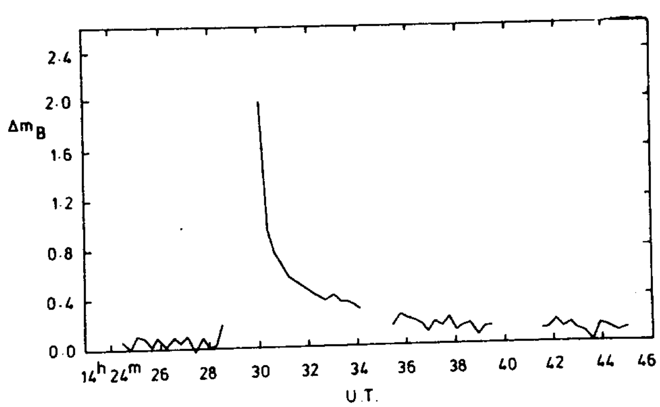

Figure 3

Light Curve of Flare No. 2

Of all known flare stars, UV Ceti is the most active in the visual wavelength band (Bateson 1971), which is to be expected given that there is an inverse relationship between flare frequency ("f", in flares per hour) and absolute magnitude (M_V). For the U band, this is given by the following equation (after Gurzadyan 1980:14):

$$\log f_U = -1.78 + 0.148M_V$$

The absolute magnitude of UV Ceti is 14.78. Flare frequency, meanwhile, is dependent on wavelength of observation:

$$f_U > f_B > f_V$$

We obtained a value of 0.43 for f_B as a result of our observations (but it is important to note that in order to obtain a more statistically reliable value for f_B, a larger number of flares would have to have been observed). Gurzadyan (1980:15) has also shown that flare frequency is not constant, but can exhibit considerable variation on an annual basis. For example, Kunkel (1973) observed that f_U appeared to increase by of the order of 40% over the two years he monitored the star, while Lacy et al. (1978) noted a marked difference in flare frequency between 1976 and 1978. Bateson (1971) has suggested that UV Ceti exhibits a 6-year cycle of flare activity, not in terms of flare frequency per se, but rather the total flare energy output per year. He has proposed 1963 and 1969 as "peak" years, in which case our 1983 observations lie between two maxima (1981 and 1987). Bateson's interesting hypothesis has yet to be subjected to critical examination.

The two flares on 1 October 1983 occurred within 1 hour and 16 minutes of one another, and in this regard our results mimic those of other researchers who report two or more major flares in quick succession, at a rate that differs quite markedly from the flare frequency (e.g., Bateson and Kohler 1968; Higgins et al. 1968; Ichimura et al. 1970; Osawa et al. 1968). This is a feature noted of other flare stars also, and prompted Jarrett and Eksteen (1969:133) to report that flares "...tended to occur within a few hours of one another." In fact, this is not always the case:

Lacy et al. (1976) and Petersen et al. (1984) have clearly demonstrated that the "separation interval" between successive flares is random, and that flare occurrence follows a Poisson distribution.

Both of our flares can be classed as "major flares" (i.e., $\Delta m_B > 1.0$), which are also comparatively common for UV Ceti given that an inverse linear relationship has been established between Δm and M_V. Gurzadyan (1980:19) defined a parameter he terms the "distribution function of flare amplitude", denoted by $F(\Delta m)$, which is given by the equation

$$F(\Delta m) = \frac{n(\Delta m)}{\Sigma n(\Delta m)}$$

where $n(\Delta m)$ is the number of flares with amplitudes between Δm and $\Delta m + 1$, and $\Sigma n(\Delta m)$ is the total number of flares recorded (in any one wavelength band per unit interval of time). Using his own data, derived from 142 UV Ceti flares observed in the B band, Gurzadyan (1980:20) provides the values for $F(\Delta m)$ listed in Table II.

Table II

Distribution function of B band flares, UV Ceti

	Δm				
	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5
$F(\Delta m)$	0.76	0.17	0.04	0.03	0.00

If these figures are indicative of the 1983 situation, we can count ourselves exceedingly lucky in detecting two major flares of such magnitude, given that only 7% of all UV Ceti flares could be expected to display Δm_B values of 2.0 or greater.

Although our light curve for Flare No. 2 is not complete, it would appear that both of the outbursts we detected were discrete flares rather than the more complex "flare events" defined by Moffett (1974). Of the four different types of flare light curves identified by Oskanian (1968), both of our outbursts belong to Type 1, which is characterised by a very rapid rise time, and comparatively rapid decline. Oskanian found this to be the most common type in the case of UV Ceti flares.

In Figure 2 there is a critical short section of light curve missing immediately before the outburst, but the basic pattern suggests that the flare was preceded by a "dip" or "negative flare" of about three minutes duration and $\Delta m_B \sim 0.15$. For many years the existence of such phenomena was in doubt, but their occurrence is now well established, particularly after the remarkable example provided by EQ Pegasi in 1980 (Giampapa et al. 1982). Preflare dips have been noted for UV Ceti by Cristaldi et al. (1980), who produced documentation associating these rare events with 11% of all flares they detected between 1968 and 1976 (where n = 174).

Finally, the post-flare baseline fluctuations that have been reported by Bateson and Kohler (1968) were not apparent during our series of observations.

We would like to thank the Mount Stromlo and Siding Spring Observatories for the use of the Reynolds Reflector, and Victoria College for contributing towards the cost of this project.

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NEW UBV OBSERVATIONS OF SV Cen

The contact binary SV Cen was recently discussed in detail by Drechsel et al. (1982,=DR82) and by Herczeg and Drechsel (1985, = HD 85). We have observed it in July and August 1984 with the 20" telescope of the South African Astronomical Observatory in Sutherland. Unfortunately, only a few fractions of the light curve could be obtained. The secondary minimum was missed, and both observations of the primary minimum are incomplete.

Table I lists the observing dates. Figs. 1 and 2 give plots of the averaged observations in V and the colour indices B-V and U-B. The relative accuracy in all colours is estimated to be about $0^m.005$. The calibration should, in each night, be better than $0^m.01$. The comparison star was CP-59°3946, for which we used (from comparison with E-region stars) V = 7.932, B-V = 0.082, and U-V = -0.647, the colours somewhat deviating from what DR82 assumed.

Table I: Dates of observations.

HJD 2445900+	Orbital phase
6.24 - 6.31	0.58 - 0.62
7.26 - 7.30	0.20 - 0.22
9.20	0.37
10.21 -10.29	0.97 - 0.02
15.21 -15.29	0.99 - 0.04
18.20 -18.26	0.79 - 0.83
19.22 -19.24	0.41 - 0.42

Table II: Times T=HJD -2445910 and magnitudes m of primary minima.

	T1	Error	m	T2	Error	m
V	0.2500	±.0002	9.972	5.2253	±.0005	9.936
B	0.2497	.0002	10.094	5.2251	.0006	10.058
U	0.2509	.0003	9.559	5.2265	.0006	9.498
B-V	0.247	.003	.120	5.224	.005	.122
U-B	0.261	.003	-.536	5.243	.005	-.555
U-V	0.256	.002	-.417	5.231	.004	-.438
All*	0.2500	.0001	-	5.2253	.0004	-

*All observations, B and U corrected to V by average B-V and U-V (quadratic fit of the data shown in Figure 5).

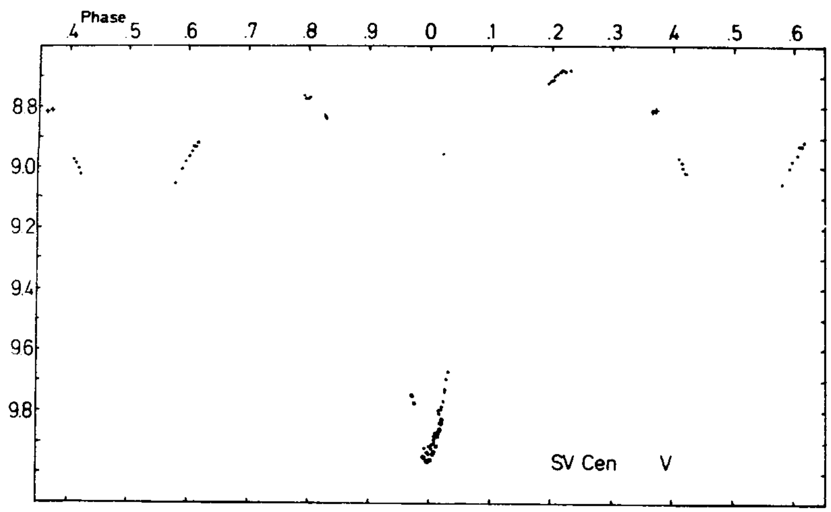

Figure 1. The V observations. Crosses: Uncertain calibration
Rings: epoch no.1557.

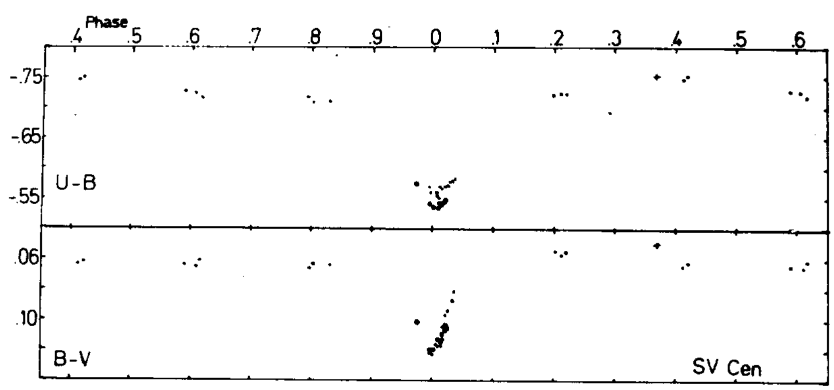

Figure 2. The colour indices. Crosses: Uncertain calibration.
Rings: epoch no.1557.

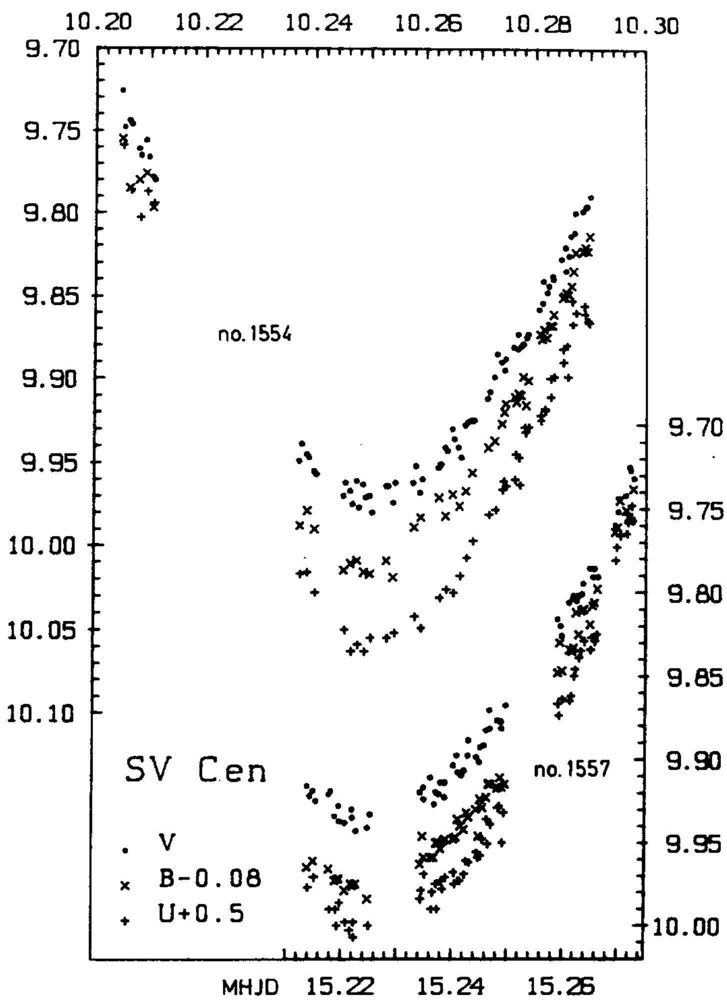

Figure 3. The minimum observations. MHJD = HJD - 2445900

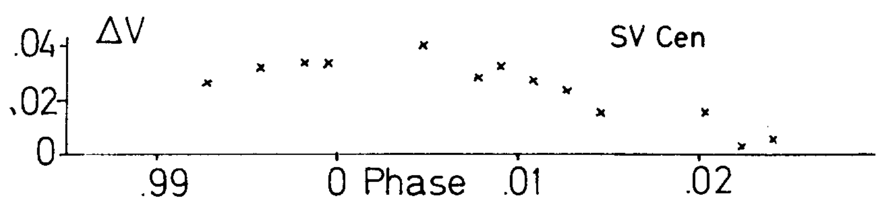

Figure 4. Difference in V for the two minima.

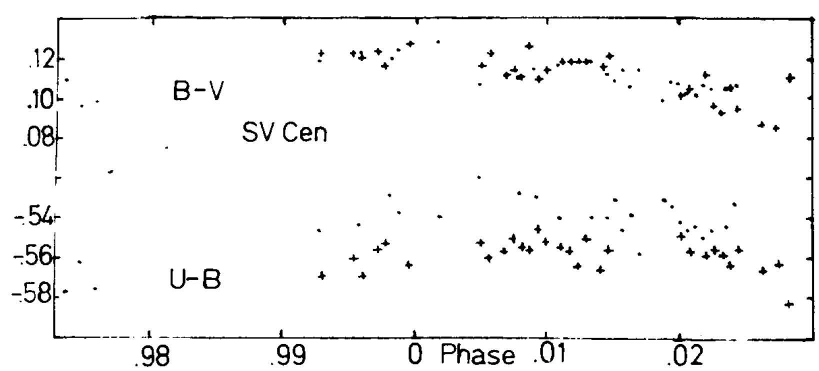

Figure 5. Colour indices during minima. Dots: epoch no.1554, crosses: epoch no.1557.

The shape of the observed parts of the light curve in V fits reasonably well into the light curve of DR82. The star was, however, now brighter by about $0^m.04$ at phases .2 and .4, and by about $0^m.08$ at phases .6 and .8, so that the difference of the maxima before and after the primary minimum is decreased as compared to DR82. The brightness increase at phase 0 (where DR82 give V = 10.00 but their light curve suggests 10.08) is probably still larger.

Taking into account the different assumptions on the comparison star, the average colour indices are similar to those of DR82. However, we find a larger amplitude and slight variability outside eclipses. Some additional observations in R and I in the first and second night (phases .6 and .2) gave V-R = .055 and .041, V-I = .125 and .115 (each ± .005 estimated error) which also indicates slight variability.

The primary minima no. 1554 and 1557 - numbered according to HD 85 - were observed in some detail. Fig.3 gives plots of the individual 10-sec integrations.

The shape of the two minima was slightly different. The second minimum was brighter in V and B by $0^m.03$, in U by $0^m.05$. The difference appears to be restricted to the immediate neighbourhood of the minimum (Fig. 4), approaching zero at phase 0.02 and lasting somewhat longer in U than in V. The maximum difference occurred probably shortly after the minimum, at about phase 0.005 ± 0.005. Fig. 5 gives the colour indices B-V and U-B at minimum. There is no significant difference in the shape.

The primary minimum times were obtained by a polynomial fit (Breinhorst et al. 1973), the Kwee method (Kwee and van Woerden 1956) being inapplicable in both cases. Table II lists the minimum times. The minima occur, within the error tolerances, simultaneously in V and B, but slightly later in U. The actual period is $1^d.65843 \pm 0^d.00013$ which is in good agreement with the value of $1^d.65847$ expected by HD 85. The minimum times are also within the error tolerances of the prediction of HD 85.

In conclusion, we find long-term variability of a few percent in the light curve and the colour indices, as well as short-term variability for the primary minima. The minimum times are as expected.

We thank the SAAO for granting observing time and D. Laing, J. Menzies, J. Rahe and H. Drechsel for advice. The Austrian Fonds zur Förderung der wissenschaftlichen Forschung (project no. 5454) contributed to the costs.

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NEW UBV OBSERVATIONS OF BH Cen

The contact binary BH Cen was recently discussed in some detail by Sisteró et al. (1983, = SGC). We have observed it in July and August 1984 with the 20" telescope of the South African Astronomical Observatory in Sutherland. Unfortunately, only part of the light curve could be obtained. In particular, we were unable to observe a primary minimum.

Table I lists the observing dates. Figures 1 and 2 give plots of the observations in V and the colour indices B-V and U-B. The relative accuracy in all colours is estimated to be about $0\overset{m}{.}005$. The calibration should, in each night, be better than $0\overset{m}{.}01$. The comparison star was CPD-62°2186, for which we used (from comparison with E region stars) V= 8.076, B-V= .068, U-B = -.855 which is slightly different from the values adopted by SGC.

Our observations reproduce the shape of the light curve of SGC reasonably well. The star was, however, fainter in V by $0\overset{m}{.}04$, depending somewhat on the phase (Figure 3), so that a slight change of the light curve is indicated. The colour indices show, within the error tolerances, the same shape and are nearly equal: Δ(B-V) (SGC-we) = $0\overset{m}{.}002 \pm 0.002$, and Δ(U-B) (SGC-we) = $-0\overset{m}{.}011 \pm$ 0.002 (p.e. of average). Considering the different assumptions on the colours of CPD-62°2186, we would however expect to find differences Δ(B-V) = $0\overset{m}{.}02$, Δ(U-B) = $0\overset{m}{.}03$. It is therefore possible that the star became slightly redder. The amplitudes in the 3 colours are the same as given by SGC within about $0\overset{m}{.}01$. This is also true for the primary minimum of which only two slopes were observed. We estimate that it was $0\overset{m}{.}04$ deeper than the secondary minimum. A slight change as compared to SGC is, however, possible.

Within the observed range, B-V is not significantly phase-dependent (in slight contrast to SGC), while U-B is definitely redder near both the primary and the secondary minimum.

Table I: Dates of observations

HJD-2445900	phase
6.21- 6.23	.96 - .98
7.21- 7.24	.22 - .26
8.21- 8.30	.48 - .60
10.22-10.29	.02 - .12
15.20-15.28	.32 - .41
18.22-18.27	.13 - .19
19.20-19.25	.37 - .43

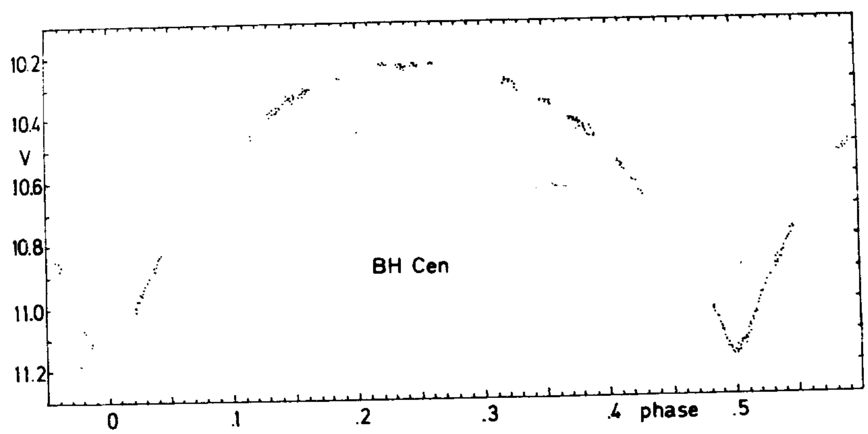

Figure 1. Individual observations in V (10 sec integration)

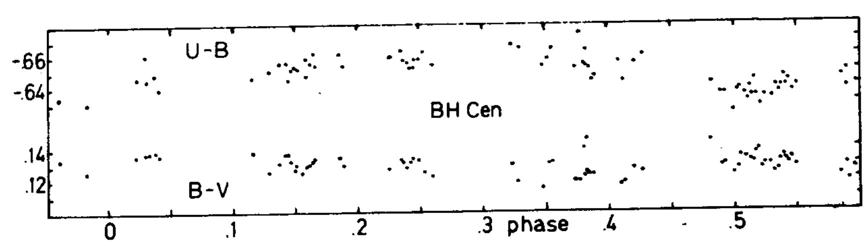

Figure 2. Observations of colour indices, averaged over about 30 sec integration

Table II: R and I observations

HJD-2445900	V-R	V-I	Ph
6.23	.13	.27	.99
7.23	.11	.22	.25
8.25	.13	.26	.54

The only overlap in our observations - near orbital phase 0.4 - is slightly discrepant with a difference of about $0^m.01$. While this is still within the observational uncertainties, the possibility cannot be ruled out that the light curve may show some small short-term variability. Such variability would possibly account for the rather long period determined by Leung and Schneider (1977, = LS) from a light curve fit.

Table II gives the few additional observations in R and I. Again, reddening near the minima is indicated.

Table III: Average period $\bar{P}$ to 1984

Year	HJD 2400000+	ref.	number	$\bar{P}$	error
1919	22084	Oosterhoff 1928	1	0.7915845	± 10
1927	25025	Oosterhoff 1930	1	844	10
1928	~25364	Oosterhoff 1930	7	842	6
1929	25714	Oosterhoff 1930	1	848	10
1967	39621	LS	1	914	2
1979	~44018	Sisterò 1979	5	945	2
1980	~44355	SGC	2	951	2
1981	~44680	Herczeg 1984	2	945	2

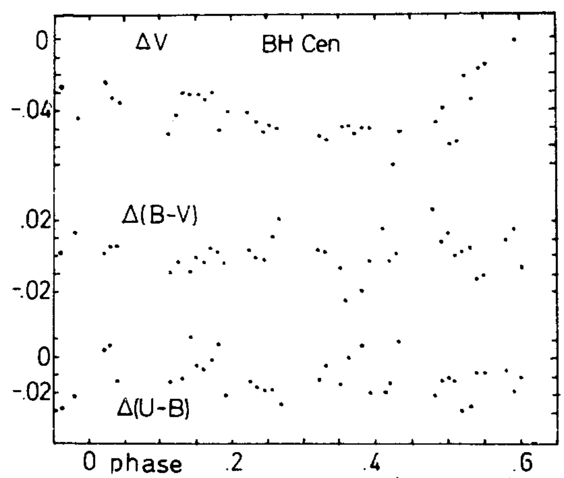

Figure 3. Differences in light curve, SGC minus our observations

The observed secondary minimum was symmetric within the uncertainties. The minimum occurred at HJD = 2445908.2209±0.0001.

We were unable to evaluate the present period with sufficient accuracy. Table III gives average periods for our minimum combined with those published earlier. Between 1918 and 1984, the period increase seems to be nearly quadratic.

SGC suggested a triple system with a period of about 50 years (see also Herczeg 1984). We rather propose a secondary period of slightly more than a hundred years, with which it is possible to reproduce all the 11 known photoelectric minima within about 1.2 minutes, and nine out of the 10 photographic minima within about 20 minutes (the minimum at HJD 2425351.536 seems to be early by about 1 hour). A good fit is

$$P = 0^{d}.7915883 + 0^{d}.0000094 \sin(2\pi(t-2440800)/100 \text{ years}).$$

It places the half-amplitude of the light time variation at about 100 minutes, corresponding, for $i = 90^{\circ}$, to an orbital radius of about 12 AU. The mass of the tertiary component would be 5 $M_\odot$, its distance to BH Cen about 60 AU.

We found, however, that a constant intrinsic period combined with nearly any secondary period between about 60 and about 160 years, as well as a quadratic approximation to the period of BH Cen can also, within reasonable uncertainties, fit the data. All fits place the time of minimum period between the photographic and the photoelectric observations. Further observations are obviously necessary to decide definitely whether or not the period change is intrinsic, or how large the secondary period is.

The present period and period change is little affected by this uncertainty. Our best estimate for the prediction of further minima is

$$PM = HJD\ 2445907.8251 + 0.7915957\ E + 10^{-9}\ E^2.$$

In conclusion, we find the light curve of BH Cen to be variable by a few hundredth of a magnitude within a few years, with the unverified possibility of variations within a few periods. The period change is strongly nonlinear. A periodic period change, with constant intrinsic period, can well reproduce all observations but the data are still inconclusive.

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INFORMATION BULLETIN ON VARIABLE STARS

Number 2788

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BD+37°2641

This star was announced to be a possible eclipsing binary by Peniche et al. (1985).

I examined the star on 515 Sonneberg Sky Patrol Plates (JD 243 5868... 45822). Both variability and the EA-type is confirmed.

The following elements were received:

min. (hel) = JD 2438883.457+$0^d.8469935$. E
($10^m.2$ - $11^m.0$/$10^m.85$ ph) - In addition to SA 59 (Harvard/Groningen).
D I = $0^P.15$
D II = $0^P.13$
Centre/Edge/Relation was considered (Huth, 1967).

15 Min. I and 10 Min. II were found (see Table I):

Table I

Min. I

JD(hel) 24..	E	O-C
35960.479	-3451	- $0^d.003$
37028.536	-2190	- 005
045.486	-2170	+ 005
38169.458	- 843	+ 017
849.567	- 40	- 010
883.454	0	- 003
933.426	+ 59	- 004
39968.465	+1281	+ 009
40068.389	+1399	- 012
101.428	+1438	- 006
41181.360	+2713	+ 010
666.671	+3286	- 007
43655.421	+5634	+ 003
45381.601	+7672	+ 010
493.405	+7804	+ 011
46189.62 *	+8626	000

Min. II

JD(hel) 24..	E	O-C
37823.452	-1251.5	+ 007
38852.555	- 36.5	+ 013
39025.327	+ 167.5	- 001
379.355	+ 585.5	- 017
499.648	+ 727.5	+ 003
538.609	+ 773.5	+ 003
611.447	+ 859.5	- 001
40531.275	+1945.5	- 008
41056.428	+2565.5	+ 009
42185.443	+3898.5	- 018
45077.93 **	+7313.5	- 01

* Locher (1985)

** Peniche et al. (1985)

Further particulars will be published in "Mitteilungen der Bruno - H. - Bürgel - Sternwarte Hartha".

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ERRATUM

In Figure 2 of the announcement on HD 50845 in IBVS No. 2710, the wavelength interval between the arrows is 30 Å, and not 5 Å, as indicated.

J. SAHADE

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PHOTOELECTRIC OBSERVATIONS OF THE SYMBIOTIC STAR AG DRACONIS

This well-known symbiotic star has been observed photographically and photoelectrically by several authors. The observations of Meinunger (1979) showed periodic variations in the U-magnitude with a period of 554^d.

After a quiet phase till JD 244 4450 two outbursts with amplitudes in B of about 1.7 mag and 1.3 mag followed (Luthardt 1983). Since March 1982 I have been observing AG Dra photoelectrically in U, B and V with the 60 cm mirror II of Sonneberg Observatory. During this time the star was at first in the

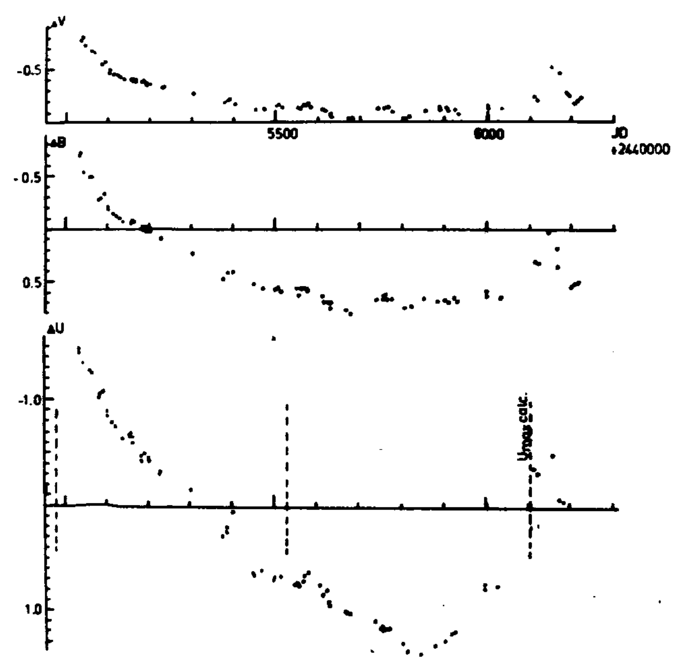

Figure 1

declining phase following the last outburst. The star reached a low state in B and V at JD 244 5650, but in U the decline continued till JD 244 5850. A quiet phase, showing only small variations, followed in B and V, but in U the brightness increased soon after a short minimum. At JD 244 6100 a new, but small, outburst began. The amplitude amounted to 0.45 mag in V, 0.70 mag in B and 1.90 mag in U. Since JD 244 6200 AG Dra has dropped in minimum again.

It is remarkable that the variations in U correspond with the elements of Meinunger (1979). Also the maxima of the two last outbursts in V and B correspond with the calculated maxima for U.

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13 September 1985

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SPECTROPHOTOMETRIC INVESTIGATION OF MAGNETIC VARIABLE STAR AF (73) Dra.

The investigations of AF Dra carried out by Preston (1967a), Babcock (1958), Preston (1967b) show variability in the magnetic field amplitude, in the radial velocity and in the intensity of absorption lines of some chemical elements. Moreover the lines of Ti, Mn, Y, Ba, and Eu compared with iron and chromium show considerable variations correlating with the magnetic field intensity. Herein there are no estimations of abundance parameters lg (N/H) for separate chemical elements. Spectral characteristics of AF Dra A3IVp does not give sufficient information on the peculiarities of its atmosphere. Probably in this case first the metal abundances in the stellar atmosphere should be determined as it had been suggested by Foy (1979) and only then the spectral type and luminosity class should be ascertained.

In the present work two spectrograms of AF Dra obtained in SAO, Academy of Sciences of the USSR, with the 6 m telescope have been studied. The spectra have been exposed in near phases (ϕ=0.3) but the results of the investigation are given for each spectrogram separately. Some differences in the parameters obtained may be due not only to the errors of determination but also to their rapid variability. The spectrograms are obtained with the dispersion 9 Å/mm in the wavelength interval from 3800 to 4900 Å. The parameters of excitation temperature Θ_{ex}, electron pressure lg Pe, abundances of a number of chemical elements (lg N/H) have been determined by the "curve of growth" method using the most perfect system of oscillator strength developed in Oxford and the solar data obtained at the Main Astronomical Observatory of the Ukrainian Academy of Sciences. After the analogous scope of material is collected enough for other phases of the magnetic field variation, it may be possible to unambiguously estimate the chemical composition of the atmosphere of AF Dra and determine principal regularities of its spectral peculiarities.

It should be noted that in the spectrograms studied the lines of elements lighter than titanium are practically absent. The strong line of ionized magnesium Mg 4481.1 is an exception. The line of ionized calcium Ca II is

Table I

	J.D.$_{☉}$=2444817.4990^d	J.D.$_{☉}$=2444817.5024^d	Sun
	Θ_{ex}=0.819	Θ_{ex}=0.793	
	lgP_e=0.40	lgP_e=0.28	
	lg (N/H)	lg (N/H)	lg (N/H)
Mg	7.89(1)	7.79(1)	7.49(Kurucz, 1979)
Ti	4.70(17)	4.80(16)	4.88(Kostik, 1983)
Cr	6.13(28)	6.33(15)	5.69(Kostik, 1983)
Mn	5.74(8)	5.34(5)	5.15(Kurucz, 1979)
Fe	6.68(58)	6.92(48)	7.44(Blackwell, 1980)
Co	5.37(7)	5.52(7)	4.98(Gurtovenko, 1983)
Sr	1.85(2)	1.74(2)	2.77(Kurucz, 1979)
Y	2.80(3)	2.21(3)	1.57(Kurucz, 1979)
Zr	-	1.88(4)	2.37(Kurucz, 1979)
Eu	2.23(2)	2.40(2)	0.51(Biemont, 1982)

weakened abnormally (W_λ=0.3 Å) as compared with stationary stars of A3 spectral type (W_λ=1.5-2.0Å). The lines of neutral and ionized nickel are absent too.

Table I gives the Julian dates of observations J.D. with corresponding parameters of excitation temperature Θ_{exc}, electron pressure lg P_e determined from ionization equation and the parameter of abundance lg(N/H) for those elements, the lines of which are surely identified in the spectrograms. The number of lines is given in brackets. The solar data are given for comparison with the source of information.

On the basis of results obtained one can suppose the following. Absence of lines of some elements in the spectra studied does not mean that the given element is absent in the stellar atmosphere. Its lines can appear in other phases. The overabundance and significant difference in the yttrium and europeum abundance in separate spectra may be due to enhanced ionization of these atoms influenced by the magnetic field. The parameters of iron and chromium are only of real quantitative significance because of the greatest stability of their atoms.

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Number 2791

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LIGHT CURVE VARIATION OF PZ CASSIOPEIAE

The semi-regular variable star PZ Cassiopeiae was investigated using the patrol plates of Odessa astronomical observatory seven-camera astrograph obtained in 1957-1983. They were exposed through a yellow filter on the emulsion ZP-3. The exposure time was 30 min.

The times of light extrema observed are given in Table I. For them the following elements were obtained(L.S. Kudashkina, Astron.Tsirk.No.1351, 1984):

$$\text{Max JD} = 2436809.6 + 801^{d}.3\ E$$

$$\text{Min JD} = 2437164.1 + 801^{d}.3\ E$$

The diagram for residuals (O-C) for the above elements is shown in Figure 1. Maximum and the subsequent minimum have the same cycle number. Qualitative similarity of (O-C) curves for maximum and minimum shows that cycle duration is changing, possible in a regular way. The dependence of duration of the ascending and descending branches on cycle number (which corresponds to the nearest maximum) is shown in Figure 2. As these two curves are opposite in phase, cyclicity (about 18 years) cannot be excluded. Ascending branch is shorter than the descrending one during half of this cycle but in the second half of the cycle the situation is inverse.

Table I

E	Max	O-C	Min	O-C
0	2436900	91	2437180	16
1	7600	-10	7940	-25
2	8320	-22	8700	-67
3	9000	-214	9610:	42
4	9840	-175	2440520	151
5	2440800	-16	1220	49
6	1600	-17	1980	8
7	2680:	162	2800	27
8	3400	180	3600:	26
9	4120	99	4360:	-16
10	4800	-23	5260:	83
11	5660	36		

Author is grateful to Yu.S. Romanov and I.L. Andronov for useful discussions.

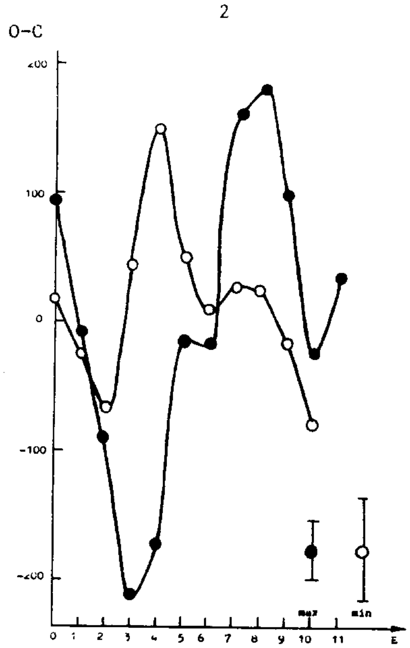

Figure 1

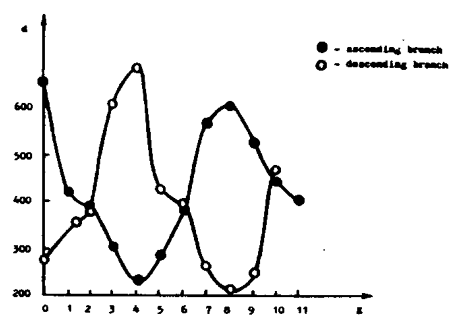

Figure 2

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NEW PHOTOELECTRIC OBSERVATIONS OF SZ Her

Photoelectric observations of the binary star SZ Her, BD+33°2930, were made on 7 nights (May and June 1985) at the Stephen F. Austin State University Observatory. The telescope utilized was a computer-controlled 46 cm Ritchey-Chrétien which automatically moves between objects at the end of each filter cycle (Michaels, 1981, and Markworth and Michaels, 1982). The photometer was a Thorn EMI Gencom, Inc. "Starlight-1" photon counting system and was interfaced to a Commodore 64 computer for data acquisition. The "Starlight-1" was equipped with an uncooled EMI 9798A S-20 response PMT. The 615 observations were made in the natural V and R system of the telescope/photometer combination with the R observations presented in Figure 1.

From these observations 6 primary and 2 secondary times of minima were obtained. Since the eclipses were fairly symmetric during this epoch, the bisection of chords method was used to determine mideclipse with the results presented in Table I (Henden, 1982).

The observed times of minima were late by an average of 52 minutes from the predicted values. The predicted minima were computed using the ephemeris given below (Wood et al, 1980).

$$\text{Hel JD}_{min} = 2434987.3852 + 0\overset{d}{.}81809387 \cdot$$

Table I

Filter	JD(2440000+) min	Type
V	6210.8518 ±.0004	Pri
R	6210.8518 ±.0006	Pri
V	6224.7558 ±.0004	Pri
R	6224.7584 ±.0005	Pri
V	6231.7199 ±.0052	Sec
R	6231.7154 ±.0017	Sec
V	6237.8473 ±.0008	Pri
R	6237.8473 ±.0005	Pri

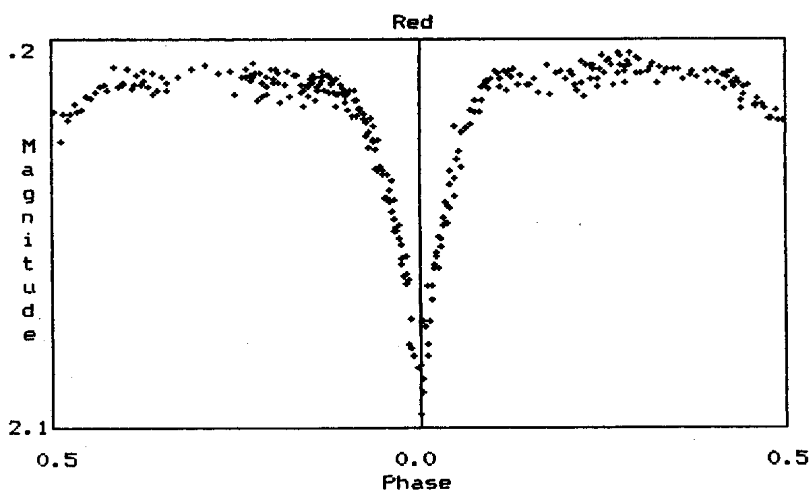

Figure 1

The individual differential magnitudes of SZ Her in the sense (variable-comparison)

An extensive literature search is now under way to locate the over 300 times of minima published for SZ Her. A complete period and light curve analysis will be published elsewhere.

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PHOTOELECTRIC MINIMA OF ECLIPSING BINARIES

The following table gives photoelectric minima obtained during the years 1983/84 at the Ege University Observatory, Izmir (Turkey) and the Nürnberg Observatory (Germany). Minima of eclipsing binaries observed at both observatories 1960-1982 were published in Astr. Nachr. 288, 69(1964); 289, 191 (1966); 291, 111(1968); I.B.V.S. No. 456 (1970), 530 (1971), 647 (1972), 937 (1974), 1053 (1975), 1163 (1976), 1358 (1977), 1449 (1978), 1924 (1981), 2189 (1982), and 2385 (1983).

The table gives the heliocentric minima, three different O-C's, the type of filter, UBV, the abbreviations of the names of the observers and the type of the instruments used (Izmir: 48 cm Cassegrain, Nürnberg: 34 cm Cassegrain, both with phototube 1P21.

Abbreviations of the observer's names:

Be = F. Betten
Bu = A. Buchler
Ca = M. Can Akan
Er = A.Y. Ertan
Gd = N. Güdür
Gl = Ö. Gülmen
Gr = R. Gröbel
Ib = C. Ibanoğlu
Ka = H. Karl
Ls = G. Lichtschlag
Ma = D. Matschat
Sn = S. Evren
Sr = C. Sezer
Tm = O. Tümer
Tn = Z. Tunca

Remarks:

O-C (I): GCVS, Moscow 1969/70 or First or Second or Third Supplement to the Third Edition of the GCVS. Moscow 1971, 1974 and 1976.

O-C (II): SAC 56, Krakow 1984.

O-C (III): AO Cam 2445745.6396 + $0^d.329921$. E (E. Evans, D.H. Grossoehme, E.J. Mayer Jr., IBVS 2497, 1984)

DM Del 2445 523.4368 + $0^d.8446747$. E (C. Sezer, N.Güdür, Ö. Gülmen, IBVS 2591, 1984)

RT Lac 2444 873.3648 + $5^d.0739496$. E - $2^d.7 \cdot 10^{-8}$. E^2 (Z. Tunca, C. Ibanoğlu, O. Tümer, A.Y. Ertan, S. Evren, Astrophys. Space Science 93,431, 1983)

Table

Star	Min.hel. 244	O-C (I)	O-C (II)	O-C (III)	Filt.	Obs.	Instr.	Rem.
RT And	5673.3256	-0.0194	-0.0029		V	Gr	34	
AB And	6002.4573	+0.0028	+0.0006		V	Be/Ka	34	Min II
BX And	5576.484:	+0.001:=	+0.001:		V	Gr	34	Min II
" "	5638.411	+0.001 =	+0.001		V	Gr/Ls	34	
CN And	5546.4531:	-0.0129:			V	Gr	34	Min II
" "	5994.438:	-0.014:			V	Ls	34	Min II
SS Ari	5651.3318:	-0.0926:	-0.0061:		V	Gr/Ls	34	
TZ Boo	5814.3651	-0.0136			V	Gr	34	
i Boo	5468.4684	+0.0098=	+0.0098		B	Sn	48	Min II
" "	5468.4649	+0.0063=	+0.0063		V	Sn	48	Min II
" "	5482.5245	+0.0055=	+0.0055		B	Sn	48	
" "	5482.5259	+0.0069=	+0.0069		V	Sn	48	
" "	5870.4565	+0.0061=	+0.0061		V	Gr/Ls	34	Min II
AO Cam	6006.4281			-0.0141	V	Be/Gr	34	Min II
" "	6022.429:			-0.014:	V	Be/Ka	34	
" "	6036.2858			-0.0142	V	Gr/Ls	34	
" "	6036.4498			-0.0152	V	Gr/Ls	34	Min II
" "	6036.6157			-0.0142	V	Gr/Ls	34	
DO Cas	5629.4529:	-0.0084:	-0.0020:		V	Gr/Ls	34	
PV Cas	5685.3637	-0.0059(m)	-0.0008		V	Gr/Ls	34	
V375 Cas	5561.4814	-0.0247	+0.0136		V	Gr	34	
V381 Cas	5562.413	-0.079			V	Gr/Ma	34	
RW CrB	5818.4497	0.0000=	0.0000		V	Gr/Ls	34	
BR Cyg	5526.4951	-0.0022=	-0.0022		V	Gr	34	
GO Cyg	5866.4836	+0.0246	+0.0334		B, V	Gd	48	Min II
" "	5954.4082	+0.0231	+0.0321		B, V	Gd	48	
" "	5972.3528	+0.0236	+0.0326		B	Gd	48	
" "	5972.3535	+0.0243	+0.0333		V	Gd	48	
DM Del	5200.345	+0.042	-0.014	-0.004	B, V	Gd	48	Min II
" "	5523.4355	+0.0452	-0.0105	-0.0013	B, V	Gl	48	
" "	5605.3694	+0.0459	-0.0099	-0.0008	B, V	Gd/Sr	48	
" "	5613.396	+0.048	-0.008	+0.001	B, V	Sr	48	Min II
" "	5619.3059	+0.0453	-0.0105	-0.0015	B, V	Gl	48	Min II
TZ Dra	5888.4779	-0.0024=	-0.0024		V	Gr	34	
UZ Dra	5878.4650	+0.0025	+0.0032		B	Sr	48	
UZ Dra	5878.4643	+0.0018	+0.0025		V	Sr	48	

Table (cont.)

Star	Min.hel. 244	0-C (I)	0-C (II)	0-C (III)	Filt.	Obs.	Instr.	Rem.
UZ Dra	5914.3391	+0.0023	+0.0030		B, V	Sr	48	
" "	5958.3660	+0.0016	+0.0002		B, V	Sr	48	Min II
" "	5971.4105	+0.0009	-0.0005		B, V	Sr	48	Min II
HS Her	5864.529:	-0.013:=	-0.013:		V	Gr/Ls	34	
MM Her	5543.4730	-0.0799	+0.0119		B, V	Sn	48	
" "	5547.4657	-0.0674	0.0245		B, V	Sn	48	Min II
" "	5551.4350	-0.0783	+0.0136		B, V	Sn	48	
" "	5559.3911	-0.0826	+0.0094		B	Sn/Tm	48	
" "	5559.3928	-0.0809	+0.0111		V	Sn/Tm	48	
RT Lac	5629.3843	-0.0412	-0.0086	+0.0016	B	Sn/Ca	48	
" "	5629.3850	-0.0405	-0.0079	+0.0023	V	Sn/Ca	48	
" "	5903.3674	-0.0548	-0.0216	-0.0081	B	Sn/Ca	48	
" "	5903.3688	-0.0534	-0.0202	-0.0067	V	Sn/Ca	48	
" "	5908.4422	-0.0540	-0.0208	-0.0072	B	Ib	48	
" "	5908.4438	-0.0524	-0.0192	-0.0056	V	Ib	48	
" "	5969.3265	-0.0578	-0.0245	-0.0101	B	Tm	48	
" "	5969.3286	-0.0557	-0.0224	-0.0080	V	Tm	48	
SW Lac	5336.2831	-0.0217	+0.0011		B	Gr	34	
" "	5336.2841	-0.0207	+0.0021		V	Gr	34	
" "	5556.4575	-0.0214	+0.0022		V	Gr	34	Min II
" "	5672.2365	-0.0222	+0.0017		V	Bu/Ls	34	Min II
" "	6004.3467:	-0.0173:	+0.0078:		V	Gr/Ls	34	
XY Leo	5810.450	(-0.095)	+0.006		V	Bu/Gr	34	Min II
AM Leo	5808.4204	-0.0071	-0.0210		V	Gr/Ls	34	
AT Peg	5615.2538	+0.0184	+0.0117		B	Gl	48	
" "	5957.360	+0.019	+0.021		B, V	Gl	48	Min II
AG Per	5626.4097	-0.0007	+0.0926		B, V	Gd	48	Min II
LX Per	5609.3820	-0.0344=	-0.0344		B	In/Tm	48	
" "	5609.3806	-0.0358=	-0.0358		V	Ib/Tm	48	
" "	5629.4788	-0.0331=	-0.0331		B, V	Sn/Ca	48	Min II
V471 Tau	4876.47018	-0.00217		-0.00008	B	Tm/Tn	48	
" "	4911.38954	-0.00210		+0.00002	B	Er/Tm	48	
" "	5612.38065	-0.00266		-0.00002	B	Ib/Tm	48	
" "	5614.46546	-0.00258		+0.00006	B	Tm	48	
" "	5695.24889	-0.00258		+0.00012	B	Ib/Tn	48	

Table (cont.)

Star	Min.hel. 244	O-C (I)	O-C (II)	O-C (III)	Filt.	Obs.	Instr.	Rem.
ER Vul	5220.4101	-0.0147	-0.0036		B	Er/Tm	48	
" "	5220.4073	-0.0175	-0.0064		V	Er/Tm	48	
" "	5221.4559	-0.0161	-0.0049		B, V	Er	48	Min II
" "	5900.3536	-0.0167	-0.0046		B	Sn/Ca	48	
" "	5900.3522	-0.0181	-0.0060		V	Sn/Ca	48	
" "	5901.4043	-0.0132	-0.0010		B	Ib/Sn/Ca	48	Min II
" "	5901.4036	-0.0139	-0.0017		V	Ib/Sn/Ca	48	Min II
" "	5902.4481	-0.0165	-0.0044		B	Sn/Ca	48	
" "	5902.4468	-0.0178	-0.0057		V	Sn/Ca	48	
" "	5933.5126	-0.0173	-0.0051		B	Sn/Ca	48	Min II
" "	5933.5119	-0.0180	-0.0058		V	Sn/Ca	48	Min II
" "	5939.4465	-0.0172	-0.0050		B	Sn/Ca	48	
" "	5939.4472	-0.0165	-0.0043		V	Sn/Ca	48	
HD199497	5136.4045			+0.0009	B, V	Gd/Rn	48	Min II
" "	5145.4995			0.0000	B, V	Gd	48	Min II
" "	5146.4058			-0.0033	B, V	Sr/Rn	48	
" "	5149.5053			+0.0036	B, V	Sr	48	Min II
" "	5150.4082			-0.0031	B, V	Gd/Rn	48	
" "	5177.3357			+0.0005	B, V	Gd	48	
" "	5177.5184			+0.0013	B, V	Gd	48	Min II

V 471 Tau 2440 610.06614 + $0^d.52118301$. E (S. Evren, C.Ibanoğlu, IBVS 2573, 1984)

HD 199497 2445 146.4091 + $0^d.3638368$. E (C. Sezer, O. Gülmen, N. Güdür, IBVS 2553, 1984)

The (O-C)'s for secondary minima (Min II) were calculated on the supposition, that they are symmetric between primary minima (if no special data are given).

m = only GCVS gives secondary minimum.

The sign = between O-C (I) and O-C (II) indicates that the elements (I) and (II) are equal.

The sign: means that the time of minimum (last decimal) is uncertain.

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BD-7°1108 , A NEW DELTA SCUTI VARIABLE

The star BD-7°1108 in the Orion OB1 association was measured in the Geneva photometric system as part of a photometric program for all stars belonging to the Curchod and Hauck (1979) catalogue of Am stars. This 10^{th} mag. star appeared to vary significantly within one observation requiring 12 minutes of integration time. Consequently, we have observed this star frequently during 14 nights in late 1984 at the Swiss station at La Silla Observatory, Chile. Between JD 2445738. and JD 2446043. we have gathered 128 measurements showing a standard deviation of 0.066 mag. In the subsequent analysis an early observation obtained on JD 2445347. is also included.

We have used a Fourier method (Deeming, 1975) and a phase dispersion minimization technique (Stellingwerf, 1978) to determine the frequency of 12.7087 ± 0.0003 c/d, with a corresponding period of 0.078686 ± 0.000002 days. The error in frequency represents (1/10T) c/d, T being the time base of the data. The phase diagram of all but two observations is presented (Figure 1). Those two observations deviate by more than 0.04 mag from the fitted light curve, shown as a continuous curve in Figure 1. The fit includes the first harmonic of 12.7087 c/d in order to reduce the residual scatter to 0.010 mag in the V-filter and 0.009 mag.in the Geneva [B-V] colour index. Such a residual scatter is representative of the noise level expected in the observations of a 10^{th} mag. star in the system as indicated by Figure 8 in the Third Catalogue of Stars measured in the Geneva Observatory Photometric System (Rufener, 1981). The observed full amplitudes are 0.18 mag. in V and 0.26 mag. in B. Colour variations are in antiphase with the light variations (Figure 2).

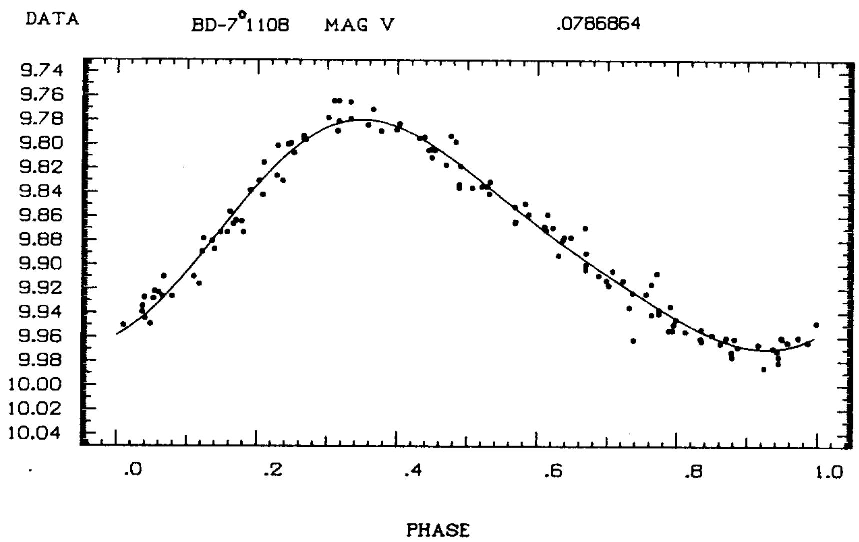

Figure 1: Phase diagram of the 127 V-magnitudes.
The fit represents: $f(t) = 9^m\!.878 + 0^m\!.092 \cos(2\pi\ \ 12.7087(t-t_0)+0.70) + 0^m\!.013 \cos(2\pi\ \ 25.4174(t-t_0)+0.40)$ with t_0 equal to JD 2445347.0.

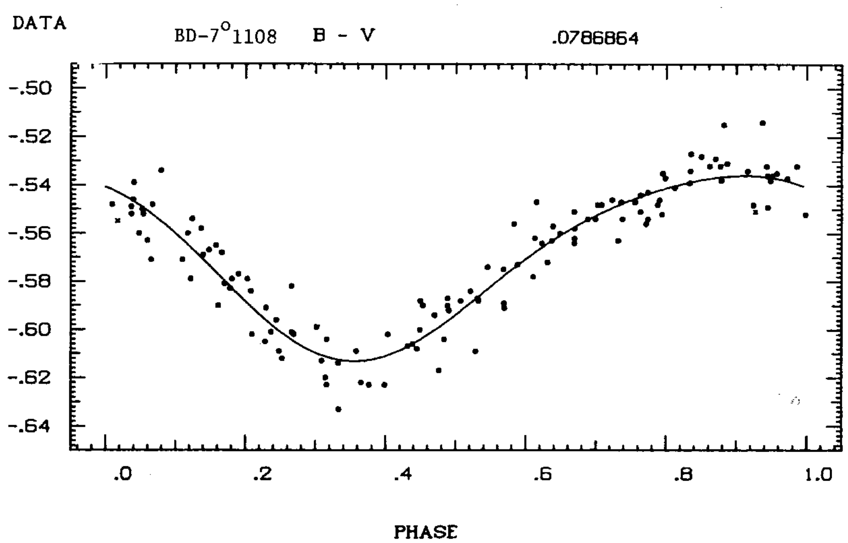

Figure 2: Phase diagram of the 129 [B-V] Geneva colours. The crosses represent the two observations not plotted in Figure 1.
The fit here is: $f(t) = -0^m\!.570 + 0^m\!.038 \cos(2\pi\ \ 12.7087(t-t_0)+0.80) + 0^m\!.005 \cos(2\pi\ \ 25.4174(t-t_0)-0.95)$

In conclusion, we report the Delta Scuti type variability of BD-7^{o}1108 with a period of 1^{h} 53^{min} and a V-amplitude of 0.18 mag. The photometric parameters d=1.193 and B2-V1 = 0.120 locate this star inside the instability strip of the observational HR-diagram for A and F type stars in the Geneva system.

Smith(1972) classified this star as metallic lined with SP(K) = A6, SP(H) = A9 and SP(ML) = F2. From the photometric point of view we cannot confirm the metallicity character as both, the Δm_2-parameter (= -0.027) and the m-parameter (= -0.042) have values resembling those of the normal A stars . Hauck (1978) derived a mean $\overline{\Delta m_2}$ = -0.009 for normal A stars versus $\overline{\Delta m_2}$ = +0.013 for classical Am stars, while Nicolet and Cramer (1983) found that Am stars tend to have $0.035 < m < 0.120$. The metallicity character of BD-7^{o}1108 has already been questioned by Hesser, Mc Clintock and Henry (1977).

A more detailed study of the observations of BD-7.1108 is presently being undertaken. The individual observations will be published at a later stage.

We gratefully acknowledge Dr. Ir. M. Burnet for observing some fine light curves of BD-7^{o}1108 at La Silla, Dr. G. Burki for kindly putting his computer programs at our disposal and Prof. F. Rufener to have pointed out the variable character of BD-7^{o}1108 and to have provided for observing facilities with the instruments of the Observatoire de Genève.

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NEW CLASSIFICATION FOR SU COLUMBAE

SU Col has been supposed to be a CW star with a period of P = $21^{d}.55$ in Veröff. Remeis - Sternwarte Bamberg 7, Nr. 76 (1968). On the basis of the spectrum taken on this star, Dr. W.P. Bidelman, Cleveland, Ohio, doubted this classification (communication by letter).
I found the following improved data:

RR Lyrae star, Max. = 242 8763.655 + $0^{d}.487361$. E.

More details will be published in Mitt. Veränderl. Sterne, Sonneberg.

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ERRATUM

In IBVS 2755, there is an error in M. Dumont's adress. Instead of "Observatoire du Pic di Midi et de Toulouse,14 avenue Edouard Belin,F-31400 Toulouse", M. Dumont's address is "Groupe Européen d'Observation Stellaire (GEOS), 12 rue Bézout, F-75014 Paris (France).

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THE ABSOLUTE MAGNITUDE OF THE FLARE STAR
AZ CANCRI (LHS2034).

AZ Cancri (LP425-140, LHS2034, G1316.1, Y2067.01), listed as a flare star by Haro and Chavira (1966), was discussed as a possible very low luminosity M dwarf by Bidelman and Hoffleit (1983). On the basis of a trigonometric parallax (0."139) determined by Luyten (1965) from 21 Palomar Schmidt plates, the estimated M_{pg} would make the star one of the intrinsically faintest known. We report three kinds of new observational data which provide a much more accurate absolute magnitude estimate for this star.

First, a preliminary U.S. Naval Observatory trigonometric parallax of 0."0608 $\pm$ 0."0067 (m.e.) is in conflict with the earlier value. Secondly, a single photometric measurement with the USNO 1.5 meter reflector gives V = 17.68, B-V = 2.02, V-I = 4.34 with I on the Kron-Mayall system. These yield an absolute visual magnitude M_V = 16.60 $\pm$ 0.24, and suggest that the star may be about 0.5 magnitude above the mean M_V, V-I main sequence for old disk stars (Pesch and Dahn 1982). Finally, two excellent red CCD spectra obtained with the KPNO Mayall 4 meter telescope and cryogenic camera in 1984 permit the object to be classified as M6.5Ve, in agreement with the parallax and colors. Spectra and VRI colors reported in Hartwick et al. (1984) are consistent with the above conclusions. Strong hydrogen line emission was present in our CCD spectra. The estimated tangential velocity is 71 km/s. The above results are consistent with the star being either (1) a young object approaching the main sequence, or (2) an unresolved double, where the contributions to the visual light of both components account for the M_V value being overluminous and possibly for the vigorous flaring activity.

We thank Dr. H.E. Bond for suggesting that we obtain the KPNO CCD spectra of this star.

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STRÖMGREN uvby PHOTOMETRY OF THE RS CVn-LIKE BINARIES σ CrB AND HD 166181

An observational program is currently being developed to obtain accurate four-colour uvby as well as Hβ light curves of some selected RS CVn binary stars. Since the information contained in the Strömgren uvby indices has proven to be highly rewarding in the study of active late type stars (Rucinski, 1983), we present here the standard indices derived for the binary systems σ CrB and HD 166181. They have been monitored with particular interest due to existing contradictions between previous photometric studies as well as their conspicuous chromospheric emission lines detected in the optical and the ultraviolet.

TZ CrB = σ^2 CrB is the brighter component of the visual binary ADS 9979 = σ CrB and is known to present important cromospheric and coronal activity (Bopp, 1984) from observations in the ultraviolet and X-ray ranges (Tarafdar and Agrawal, 1984). The system does not present eclipses but Skillman and Hall (1978) suggested the existence of a wavelike distortion with an amplitude of $\sim 0^m.05$ in V, characteristic of most of the RS CVn-like binary systems. Since the observations presented considerable scatter, they also proposed the existence of a superposed δ Scuti type cyclic variability with a period of around 0.1 days. Although these results were not in contradiction with later observations carried out by Bakos (1984), a more detailed, but still uncomplete, photometric study by Vivekananda Rao et al. (1985) did not confirm the proposed variations and amplitudes.

With respect to HD 166181 there exist only few photometric observations. It is known to be a single-lined spectroscopic binary with important CaII H and K emissions (Nadal et al. (1974) and Eggen (1978) reported a variation of $\sim 0^m.1$ in V later confirmed in a more detailed photometric study by Mekkadan et al. (1980), which also show a well-defined wavelike distortion light curve.

The observations presented in this note were carried out during one single night (JD 2446256) using the 75cm reflecting telescope at the Observatory of Sierra Nevada (Granada, Spain) located at 3000m over the sea level. A 4+2 channel, Danish design, photometer was used which measures simultaneously in the four uvby bands and, respectively, in the n and w bands centered on the Hβ line. A detailed description of this instrument is given by Florentin-Nielsen (1983). Throughout the observations we used a 45" circular diaphragm, which means that for TZ CrB, the close visual companion σ^1 CrB was also included in the field.

Almost continuous monitoring of σ CrB and HD 166181 was performed during around $0^d.1$ each. Particular attention was paid to the extintion coefficients during the night. The comparison and constant stars were analyzed searching for possible instrumental drifts and second order terms. A linear extinction curve was found to reproduce perfectly the observations in all four colours with the following coefficients: $k_u = 0.486 \pm 0.008$, $k_v = 0.267 \pm 0.004$, $k_b = 0.173 \pm 0.005$ and $k_y = 0.130 \pm 0.004$.

In Figure 1, we have plotted the y-band instrumental magnitude difference of σ CrB with respect to the comparison star HR 5968 in the sense comparison-variable. In Figure 2, a similar plot has been made for the variable star HD 166181 with respect to the comparison star HD 166435. In both cases fractions of the above mentioned Julian Date, including heliocentric corrections, are given on the abscissa.

Average values of the instrumental colour differences with respect to the mentioned comparison stars, in the sense variable-comparison, were found to be as follows:

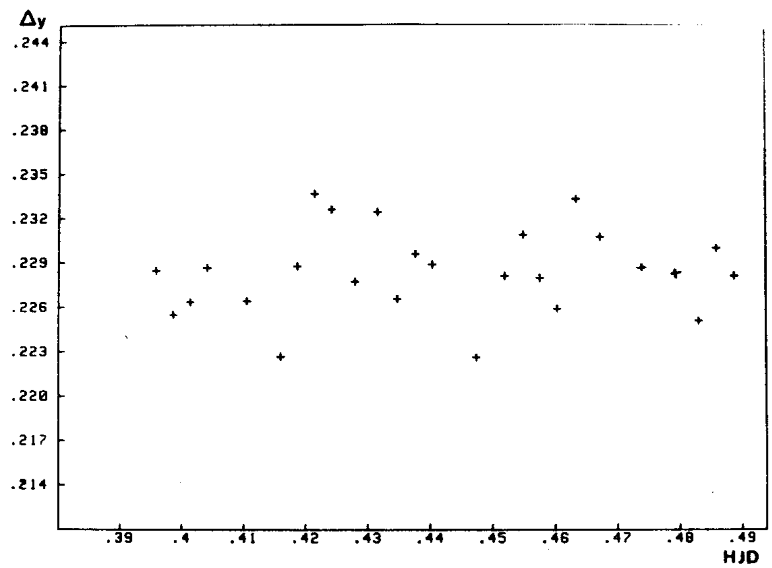

Figure 1

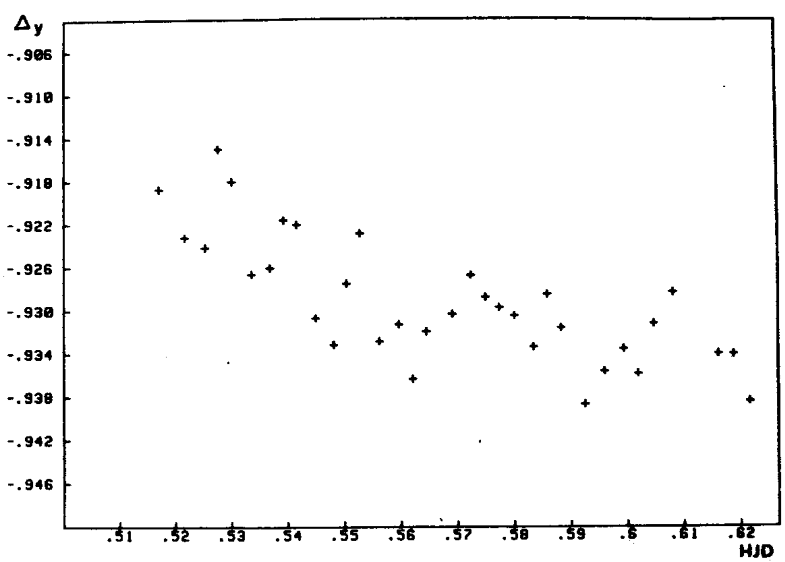

Figure 2

	Δy	$\Delta b-y$	Δm_1	Δc_1
σ CrB - HR5968	-0.228 3	-0.012 2	+0.011 4	-0.024 5
HD166181 - HD166435	+0.929 6	+0.072 4	+0.028 6	-0.029 10

The phase coverage was around $0^p.08$ (centered at $0^p.37$) for σ CrB according to the ephemeris given by Bakos (1984) and $0^p.06$ (centered at $0^p.96$) for HD166181 using the values given by Mekkadan et al. (1980).

A slight tendency in the instrumental magnitude difference between HD166181 and its comparison star is clearly seen in Figure 2 contrary to the constant light level shown by Figure 1 in the case of σ CrB. It should be expected thence, considering the different orbital periods and phase coverage, that the photometric variations of σ CrB, if any, be considerably smaller than in the case of HD 166181. A detailed discussion of the complete light curves in the four uvby colours will, however, be published elsewhere.

Concerning the suggested δ Scuti type variability of σ CrB (Skillman and Hall, 1978), our observations which cover one complete cycle according to the proposed period of 0.1 days during one single night, confirms the previous result by Vivekananda Rao et al. (1985) that no such variations are present in σ CrB.

After transformation to the standard Strömgren uvby photometric system, the following magnitudes and colour indices were obtained:

	V	b-y	m_1	c_1
σ CrB	5.18	0.384	0.185	0.308
HD 166181	7.77	0.480	0.239	0.295

Comparison of these values with preliminary empirical calibrations for late type stars by Olsen (1984) indicate that σ CrB behaves as a normal dwarf star with a slightly low m_1 index. On the other hand, HD 166181 is apparently more evolved but resembling a metal-deficient dwarf star in its photometric properties.

Concerning the visual binary σ CrB, we could observe separately the component stars using a smaller diaphragm during one night of very good seeing. As a result, we finally obtained the following magnitude differences in the sense σ^1 CrB - TZ CrB:

$$\Delta V = 0.98, \quad \Delta b\text{-}y = 0.011, \quad \Delta m_1 = 0.022, \quad \Delta c_1 = -0.018,$$

after correction for dead time and sky background and transformation to the standard system. These values are in good agreement with the spectral type difference and the preliminary calibration by Olsen (1984). Using the combined light values and the magnitude differences, the standard indices for TZ CrB isolated from its visual companion could be obtained and, as a result, the observed slight metal deficiency appeared to be more evident.

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TIMES OF MINIMA AND NEW ELEMENTS OF GX LACERTAE

GX Lacertae (BD + 56°2855 = HD 240 055) was discovered as a probable eclipsing binary by Uitterdijk (1934) on photographic plates. Its photometric elements were first determined by Kreiner (1968). No more observations of GX Lac, either photometric or spectroscopic, have been made since 1967.

During the period July 1981 - November 1984 GX Lac was observed photoelectrically with the 50 cm reflector at the Cracow Astronomical Observatory. The observations were made using the standard V filter and the star "b" from the Wright's chart of CO Lac (Wright, 1937) was used as a comparison star.

From these data three times of minima, as given below, were determined using the tracing-paper method.

J.D. hel	E	$O-C_1$	$O-C_2$	Remarks
244 5189.486 ± .003	856	+0.2943	+0.0007	prim.
5993.413 ± .005	982.5	+0.3264	-0.0105	sec.
6009.312 ± .003	985	+0.3282	+0.0003	prim.

The $O-C_1$ values were calculated using the elements:

J.D. 243 9749.3973 + $6^d.3549$ x E (Kreiner, 1968)

On the basis of these three minima, the period was corrected P = $6^d.355243$ and the $O-C_2$ values were calculated from the new elements:

J.D. 243 9749.3973 + $6^d.355243$ x E

For the epoch of the photographic diminishing of brightness of GX Lac, published by Uitterdijk (1934), $O-C_2=-0^d.04$, so the period seems to be correct and constant in time.

The light curve of GX Lac and orbital elements will be published elsewhere.

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PHOTOELECTRIC OBSERVATIONS OF TX Cas

More than seventy years have elapsed since the eclipsing binary system TX Cas was discovered by Leavitt in 1907. However, the system was only observed visually and photographically until 1981. Recently some photoelectric minima times were given by Fernandes (1982) and Kreiner and Tremko (1984).

For this reason the system was observed photoelectrically at Beijing observatory in two intervals, from December 1982 to January 1983 and from October 1984 to January 1985 with the 60 cm reflector by using Strömgren four colour system. In the second interval a total of 367 photoelectric b and y observations were made on 13 nights and combined into the first photoelectric light curves.

The moment of the primary minimum was determined using Kwee and Van Woerden's method, and in addition, one time of primary minimum and three times of secondary minimum were determined by using the mean light curve. These moments are given in Table I.

Table I

J.D.Hel.244 0000 +	m.e.	Min.
5330.020	0.004	I
6003.1882	0.0007	I
6028.067	0.002	II
6030.991	0.002	II
6060.260	0.004	II

The star BD + 62°478 was used as a comparison star and BD + 62°481 as the check star. All observations were corrected for the differential extinction. Figure 1 gives the b and y light curves of the eclipsing binary TX Cas. Using the photoelectric minima given in Table II, the new ephemeris has been derived by the weighted least squares method as follow:

$$\text{J.D.Hel.Min.I} = 2\,446\,003.1893 + 2^{d}.926\,835 \cdot E$$
$$\pm .0014 \quad \pm .000\,007$$

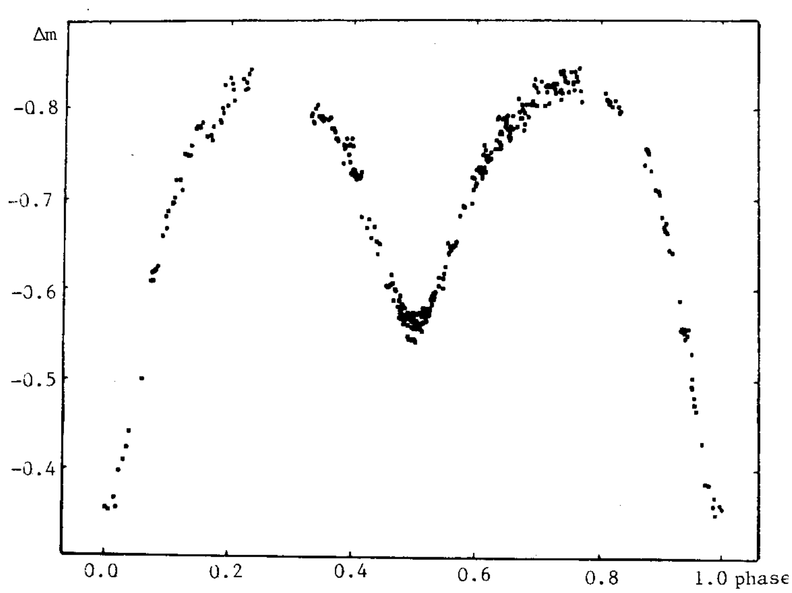

Figure 1.a The y light curve of TX Cas

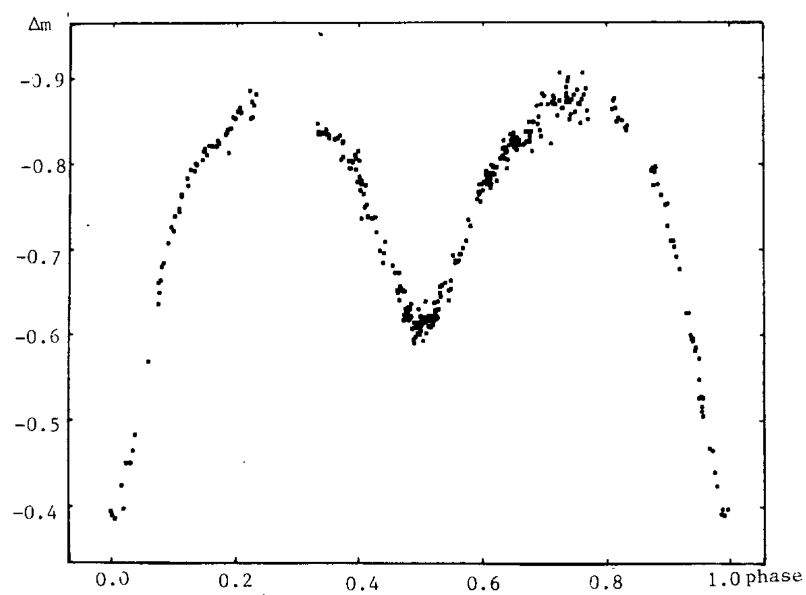

Figure 1.b The b light curve of TX Cas

Table II

J.D. Hel. 240 0000 +	E	(O–C)	Min.	Method	Ref.
17551.6380	-9721.0	$0^{d}.3144$	I	v	(1)
19708.3750	-8984.0	-0.0333	I	v	(2)
20448.9230	-8731.0	0.0229	I	v	(3)
29677.2280	-5578.0	-0.0139	I	v	(4)
30224.5000	-5391.0	-0.0619	I	v	(5)
30350.4670	-5348.0	0.0508	I	v	(6)
30792.3120	-5197.0	-0.0578	I	pg	(7)
33186.4790	-4379.0	-0.0499	I	pg	(7)
33599.1550	-4238.0	-0.0590	I	–	(8)
35390.4280	-3626.0	-0.0151	I	pg	(7)
36596.3150	-3214.0	0.0119	I	pg	(7)
36824.5410	-3136.0	-0.0560	I	pg	(7)
37316.3400	-2968.0	0.0330	I	pg	(7)
37588.3940	-2875.0	-0.1096	I	pg	(7)
39672.4780	-2163.0	0.0609	I	pg	(7)
39827.4780	-2110.0	-0.0619	I	pg	(7)
39915.3330	-2080.0	-0.0122	I	pg	(7)
40619.2490	-1839.5	-0.0024	II	pg	(7)
40679.3280	-1819.0	0.0763	I	pg	(7)
40828.5170	-1768.0	-0.0038	I	pg	(7)
40831.5280	-1767.0	0.0803	I	pg	(7)
41166.4600	-1652.5	-0.1114	II	pg	(7)
41361.2990	-1586.0	0.0924	I	pg	(7)
41539.5280	-1525.0	-0.2161	I	pg	(7)
41677.3010	-1478.0	-0.0048	I	pg	(7)
41990.4730	-1371.0	-0.0052	I	pg	(7)
42988.5620	-1030.0	0.0297	I	pg	(7)
43477.2750	-863.0	-0.0404	I	pg	(7)
43749.4800	-770.0	-0.0320	I	pg	(7)
44712.4476	-441.0	0.0037	I	pe	(9)
45056.3510	-323.5	0.0028	II	v	(10)
45233.4340	-263.0	0.0117	I	pe	(5)
45280.2710	-247.0	0.0192	I	pe	(5)
45330.0200	-230.0	0.0118	I	pe	(11)
45593.4390	-140.0	0.0148	I	pe	(5)
46003.1882	0.0	0.0057	I	pe	(11)
46028.0670	8.5	0.0063	II	pe	(11)
46030.9910	9.5	0.0034	II	pe	(11)
46060.2600	19.5	0.0040	II	pe	(11)

(1) Pickering; (2) Zinner; (3) McDiarmid; (4) Gaposchkin; (5) Kreiner; (6) GCVS (1948); (7) Rätz; (8) SAC 54; (9) Fernandes; (10) Hübscher, Braune; (11) present paper

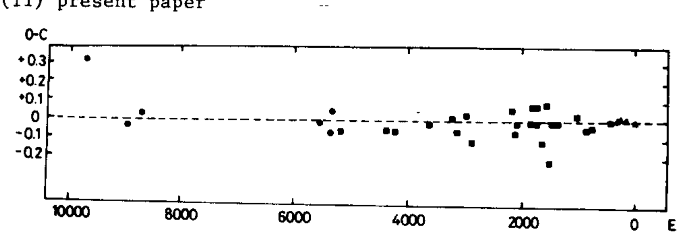

Figure 2. The O–C diagram of the times of minimum light of TX Cas
▲ photoelectric, ■ photographic, ● visual observations

Table II lists the historic minima and their O-C based on the above ephemeris. The O-C diagram (see Figure 2) shows that the period of TX Cas is not subjected to any long-term variation except for some probable short-term fluctuations.

A further detailed analysis of these light curves will be given elsewhere.

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U OPHIUCHI: AN ECLIPSING BINARY WITH RAPID APSIDAL MOTION

(BAV-Mitteilungen Nr.40)

U Ophiuchi is a detached system, with well-determined masses and absolute dimensions. The period variations are an intriguing characteristic of the variable, and an explanation in terms of light-time effect in a possible triple system was put forward already by Parenago (1949). A truly periodic representation, however, still remains somewhat unconvincing (Herczeg, 1980). Difficulties are also manifest in diverging values of the parameters for the light-time orbit given by different authors (e.g., Koch and Koegler, 1977, Panchatsaram, 1981).

A clue to these problems might be sought in the observed times of Min II, that follow roughly the trend of the primary minima, but with systematic deviations. As already noticed by Koch and Koegler, shorter - term fluctuations on a time scale of ≅ 20 yr are apparent in the phase of secondary eclipse relative to mid-primary. Yet the authors ruled out an explanation based on apsidal motion. The reason was that the variations seemed to lack rigorous periodicity; besides, there seemed to be "a clear preference for secondary eclipse to occur before the half-period moment".

A thorough period study of the available photoelectric minima times (including a reanalysis of the early photoelectric observations by Huffer (Huffer and Kopal 1951) and Magalashvili (1949)) has convinced us, however, that their conclusions were based on scanty and incomplete data. In Fig.1 we present interpolated values of the quantity $(t_{II} - t_{I} - P/2)$ for the observed secondary minima. A cosine fit to these data gives an entirely satisfactory approximation. Straightforward interpretation in terms of a rotating eccentric close orbit yields the preliminary values of

$$e = 0.0032 \pm 0.0002 , \qquad U = 20.7 \pm 0.3 \text{ yr}$$

for orbital eccentricity and period of apsidal revolution, respectively.

After subtraction of the phase shifts due to apsidal motion, the O-C plot

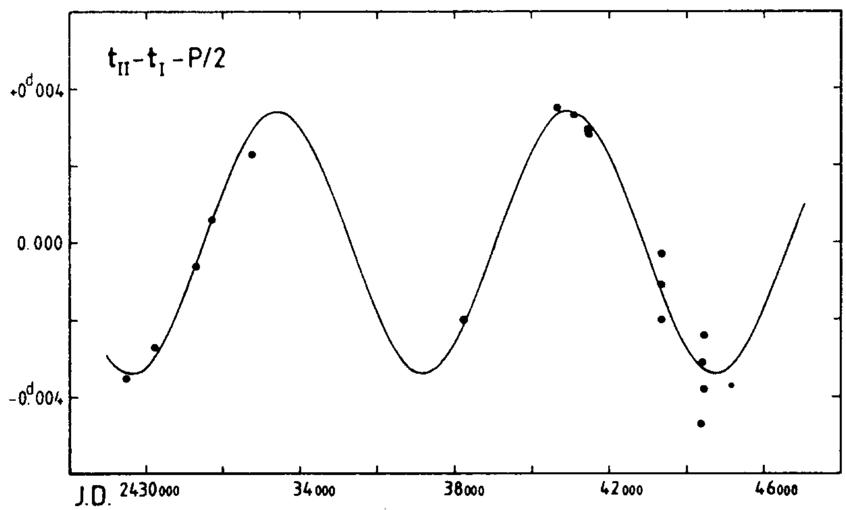

Figure 1: Time variation of the displacement of secondary minimum of U Oph relative to mid-primary. The continuous curve is the function $0^d.0034 \cos (337° + 17°.38 (t - 1969.72))$.

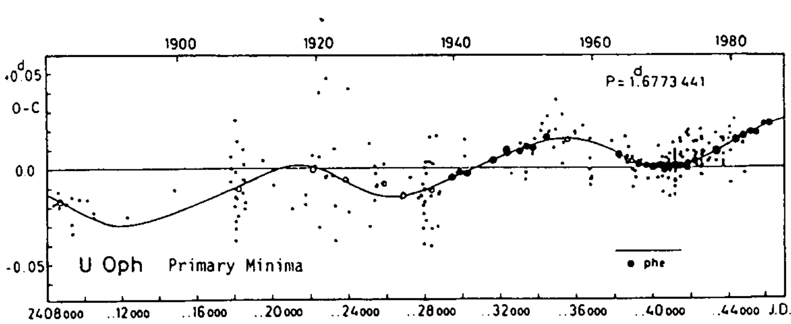

Figure 2: (O-C) diagram of the observed times of primary minimum 1881 - 1985. Modified after Frieboes-Conde and Herczeg (1973), Fig. 19. The continuous curve is the predicted O-C curve for Min I according to our final elements for light-time orbit and apsidal motion.

was compared with a grid of standard light-time curves. Apsidal motion parameters and light-time orbit were adjusted by means of a differential corrections procedure. The final set of elements so obtained satisfies the photoelectric data as well as the large number of visual minima times accumulated during the last hundred years.

Although U Oph is not neglected by photoelectric observers, we wish to emphasize that more minima times of secondary eclipse are needed — not only to improve on light-time orbit, eccentricity and apsidal motion parameters, but also to ensure that random variations from other causes do not introduce systematic errors in their determination. The importance of observing apsidal motion in eclipsing binaries with reliable absolute dimensions as a test for theoretical models of stellar structure and stellar evolution theory is well-known.

The full details and implications of this period study, including a discussion of the evolutionary status of U Ophiuchi, will be presented elsewhere (Kämper, 1985).

I would like to thank W.Braune, Berlin, for pointing out this system, and D.Lichtenknecker, Hasselt, for his help in searching the literature.

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Note: Two phe times of minimum given by Popovici 1971 (IBVS No. 508) must certainly be attributed to U Peg, not to U Oph.