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EDITORS: L. SZABADOS and K. OLAH
TECHNICAL EDITOR: A. HOLL
TYPESETTING: K. ŐRI
KONKOLY OBSERVATORY
H-1525 BUDAPEST
P.O. Box 67, HUNGARY
IBVS@ogyalla.konkoly.hu
URL: http://www.konkoly.hu/IBVS/IBVS.html
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A NEW APSIDAL MOTION DETERMINATION FOR DI HERCULIS

DI Herculis (HD 175227) is an 8th magnitude eclipsing binary consisting of two main sequence B stars (B4 V and B5 V) moving in a highly eccentric orbit (e = 0.49) with a period of approximately 10.55 days. Rudkjøbing (1959) first called attention to this system as a possible test of general relativity since the relativistic contribution to the total apsidal motion is expected to be greater than that arising from classical (Newtonian) effects. For DI Her, the classical contribution to the apsidal motion rate, which arises from tidal and rotational deformation of the stars, is expected to be $\dot{\omega}_{cl} = 1.93^\circ/100\mathrm{yr} \pm 0.26^\circ/100\mathrm{yr}$ while the theoretically expected general relativistic contribution is $\dot{\omega}_{gr} = 2.34^\circ/100\mathrm{yr} \pm 0.15^\circ/100\mathrm{yr}$ yielding a combined predicted value of $\dot{\omega}_{cl+gr} = 4.27^\circ/100\mathrm{yr} \pm 0.30^\circ/100\mathrm{yr}$ (Guinan and Maloney, 1985). The rate of the observered apsidal motion of DI Her is well determined from measurements of the times of primary and secondary eclipse. However, in all studies done so far for DI Her, the results indicate an apsidal advance significantly smaller than predicted from theory. For example, Guinan and Maloney (1985) found a value of $\dot{\omega}_{obs} = 0.65^\circ/100\mathrm{yr} \pm 0.11^\circ/100\mathrm{yr}$ and Reisenberger and Guinan (1989) found $\dot{\omega}_{obs} = 1.00^\circ/100\mathrm{yr} \pm 0.30^\circ/100\mathrm{yr}$. The observations used in these studies span a period of about 84 years and indicate an apsidal motion rate 4–7 times smaller than expected from theory. This discrepancy between the observed and theoretical apsidal motions for this star is very puzzling. One of the possible explanations for the smaller than expected observed apsidal motion in DI Her is the presence of a third body which would perturb the orbit of the close eclipsing pair (see Guinan and Maloney 1985, Reisenberger and Guinan 1989, and Khaliullin, Khodykin, and Zakharov 1991).

We have continued to observe DI Her extending the observational baseline to provide a more accurate determination of the rate of apsidal motion and also to search for evidence of small period oscillations due to the presence of a possible third body. Here we report on three new times of minimum light obtained by us using a 0.8m Automatic Photoelectric Telescope (APT); these data are combined with all the previous photoelectric timings to search for evidence of a third body and to refine the determination of the apsidal motion.

Photoelectric photometry was carried out during the spring of 1993 and 1994 resulting in three new timings of minimum light — a secondary eclipse on June 13, 1993 UT, and two primary eclipses on June 26, 1993 UT and May 19, 1994 UT. Observations were made using the Fairborn-Villanova 0.8m APT on Mt. Hopkins, Arizona; observations were taken in Johnson U, B, and V filters. Differential magnitudes were computed in the sense variable minus comparison (V-C) where HD 174932 (V=+8.9; B9) served as the comparison star while HD 343238 (V=+9.7; A2) served as the check star. Extinction corrections were applied using atmospheric extinction coefficients determined from observations of the comparison star, and local standard times were converted into heliocentric Julian days (HJD). The data were reduced using software developed at Villanova University by G.P. McCook. The details of the reduction procedure have been described

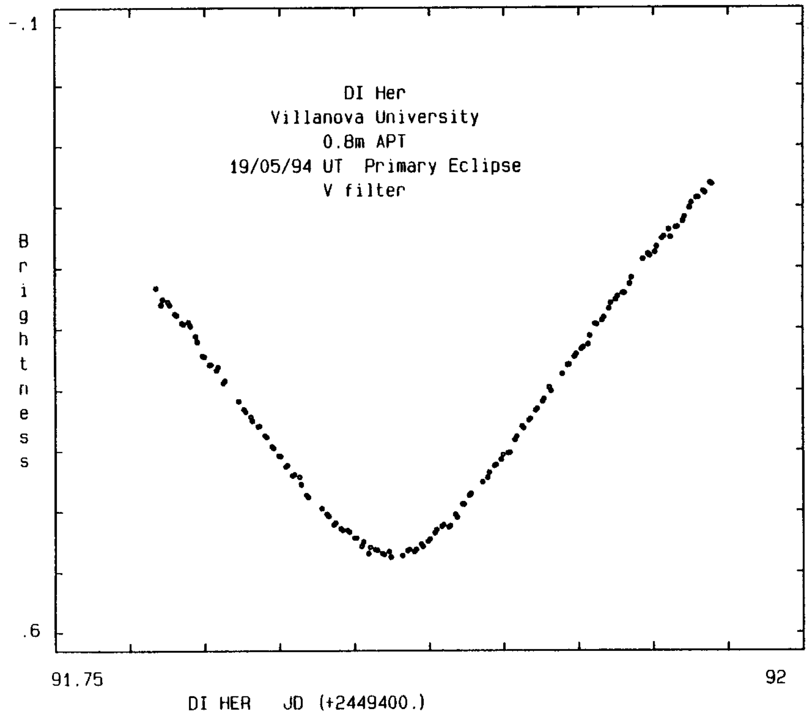

Figure 1. A plot of the differential V-magnitudes obtained during primary eclipse of DI Her on 19 May 1994 UT.

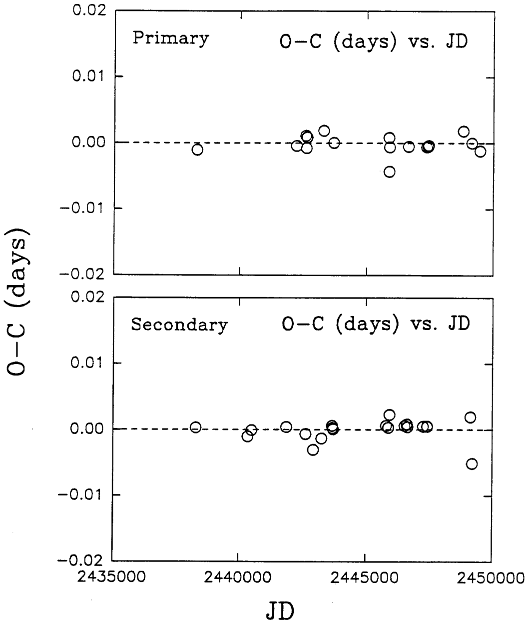

Figure 2. The plots of the (O-C) values versus Julian Date for the photoelectric times of primary and secondary eclipses. The (O-C)s were computedfrom equations (1) and (2) and show no evidence of significant systematic variations expected to arise from a third body.

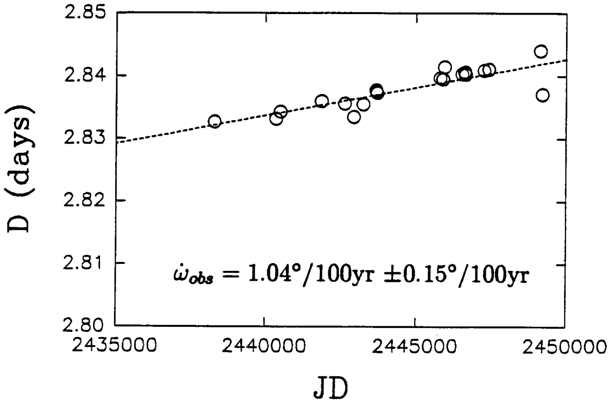

Figure 3. Plot of the displacement of the secondary minimum from a half period point of DI Her, in days, (D=($t_1 + t_2 - 0.5P$)), versus Julaian Date number.

elsewhere by Guinan *et al.* (1987). The differential V-magnitudes of the primary eclipse observed on 19 May 1994 UT are shown in Figure 1.

The times of minimum light were initially determined by a computerized version of the familiar "tracing-paper" method. The reduced data are plotted on the screen as observed and then plotted again with the time axis reversed. The second curve is then positioned so that the two curves appear superimposed and the time of minimum then appears at the same point on both curves. We then formally applied a second order (parabolic) and fourth order least squares fit on the data for the eclipses. The agreements between the times given by the computerized "tracing-paper" method and the least squares fits are very good. The best fits were obtained using the fourth order calculations. Because of the large number of data points (about 200 per night per filter) and good distribution through the minimum, we have obtained very precise determinations of the eclipse timings. The final times of minimum light were obtained by determining the time of minimum independently in the B and V filters, performing the fourth order least squares fit, and averaging the two results. We did not use the U band observations in these determinations because they were noisier than the B and V band data. Our three new times of minima and their corresponding (O-C) values determined using the ephemeris given by Reisenberger and Guinan (1989) are:

T (min II)	=	HJD 2449151.8260 ±0.0005	(O-C)	=	+0.0015	day
T (min I)	=	HJD 2449164.8082 ±0.0002	(O-C)	=	−0.0005	day
T (min I)	=	HJD 2449491.8622 ±0.0002	(O-C)	=	−0.0017	day

It should be noted that the higher observational error indicated for the secondary minimum results, in part, because the lowest portion of the minimum was not covered. As a result of this, this timing should be given a somewhat lower weight.

These eclipse timings and those given by Khodykin and Volkov (1989), Caton and Burns (1993), and Lacy and Fox (1994) were combined with only the more accurate photoelectric timings that have been tabulated by Guinan and Maloney (1985) and Reisenberger and Guinan (1989). Linear least squares fits were made independently to the primary and secondary eclipse data and the following light elements were determined:

$$\mathrm{T\ (min\ I)} = \mathrm{HJD}\ 2442233.3480 + 10.55016766 \qquad (1)$$
$$\mathrm{T\ (min\ II)} = \mathrm{HJD}\ 2442241.4600 + 10.55017413 \qquad (2)$$

In Figure 2, we have plotted the (O-C)s found from these fits for both primary and secondary eclipses. This figure includes data from 1963 to 1994. As shown in these plots, there is no evidence of any systematic or periodic variations in the (O-C)s to a level of about ±0.001 days that would suggest the light time effect from a putative third body. These data do not rule out the possibility of a companion, but certainly do not lend any support to this hypothesis. It should also be noted that there is no significant change (to within ±0.01 mag) in the observed eclipse depth compared to previous photoelectric photometry. This indicates that the orbital inclination has been constant to within about $\pm 0.006^\circ$ and therefore there is no observed evidence for perturbations from a third body.

Following the procedure described by Guinan and Maloney (1985), an apsidal motion rate of $\dot{\omega}_{obs} = 1.04^\circ/100\mathrm{yr}\ \pm 0.15^\circ/100\mathrm{yr}$ was determined from the change with time of the displacement of the secondary minimum from the half period point. Figure 3 shows the change in the displacement of the secondary minimum, D = $(t_1 + t_2 - 0.5P)$ with time where t_1 and t_2 are the times of primary and secondary eclipse, respectively. The apsidal motion rate found here is essentially the same rate as found previously by Reisenberger and Guinan (1989) and in close agreement to the values given by Guinan and Maloney (1985) and Khodyin and Volkov (1989).

We plan to continue our study of DI Her and will attempt to obtain more photoelectric timings of primary and secondary eclipses during the next several years to further refine the observed rate of apsidal motion and to continue the search for evidence of a third body.

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Edward F. GUINAN
James J. MARSHALL
Frank P. MALONEY
Department of Astronomy
and Astrophysics
Villanova University
Villanova, PA 19085
USA

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A PHOTOMETRIC CAMPAIGN ON OW GEMINORUM

The eclipsing nature of the 8th magnitude variable star OW Gem (BD+17°1281, HDE 258878) was discovered by Kaiser (Kaiser et al., 1988), who also determined the period of 1258.6 days from a study of Harvard patrol plates (Kaiser, 1988). The remarkable primary eclipse is more than 1.5 magnitudes deep and two weeks in duration. Williams (1989) found the secondary eclipse, $0^{\mathrm{m}}.1$ deep, at phase 0.23, indicating that the orbit is highly eccentric.

Griffin and Duquennoy (1993) published a first general investigation of the system, based on radial velocity measures over a full orbital cycle and matches of model light curves to the available eclipse photometry. They found that the system contains two luminous giants, the primary spectral type being F2 Ib-II and the secondary about G8 IIb. Component masses are close to $6\mathrm{M}_{\odot}$ and $4\mathrm{M}_{\odot}$.

The orbital eccentricity is 0.52, in such an orientation ($\omega = 140°$) that the stars have twice the separation at secondary eclipse as at primary eclipse. As a result, the primary eclipse lasts 16 days, the secondary 30 days.

Eclipses and a double-lined spectrum make OW Gem a favorable subject for comprehensive investigation. Radial velocity observations are continuing, so better understanding of the system is now constrained by the available photometry–mostly visual and photographic estimates for the primary eclipse and sparse photoelectric observations in only one color for the secondary eclipse.

Since the 1988 primary and 1989 secondary minima, the eclipses have occurred near solar conjunction. During 1995, however, both eclipses will be favorably placed for observation, the primary eclipse occurring from February 4-20 and the secondary eclipse from November 17 - December 17.

Observations from widely spaced longitudes will help to fill in the eclipse light curves and avoid weather gaps during the northern hemisphere's winter months. We therefore invite suitably equipped observers to participate in an international photometric campaign on OW Gem during 1995, with the lead author serving as coordinator.

Participating observers should be able to achieve $0^{\mathrm{m}}.01$ precision down to 9.9 in V and 10.6 in B during the primary eclipse. The secondary minimum, 8.3 V, 9.0 B, is brighter, but the demand for precision remains high in order to define the shallow eclipse. Multiple passband observations are very desirable and infrared observations would show a deeper secondary eclipse than visible ones. Because observations from a variety of instruments and detectors must be combined, observers are asked to take particular care in determining color transformation coefficients and standardizing the observed differential magnitudes.

All observers should use the same comparison and check stars. The designated comparison star is SAO 95777 (BD +17°1280, HD 258848), 9.0 V, marked as star #2 on the chart in IBVS No. 3196 (Kaiser et al. 1988). The check star is GSC 1332:0578, 9.9 V, star marked #3 on the chart. These stars are similar in color to the variable and are located

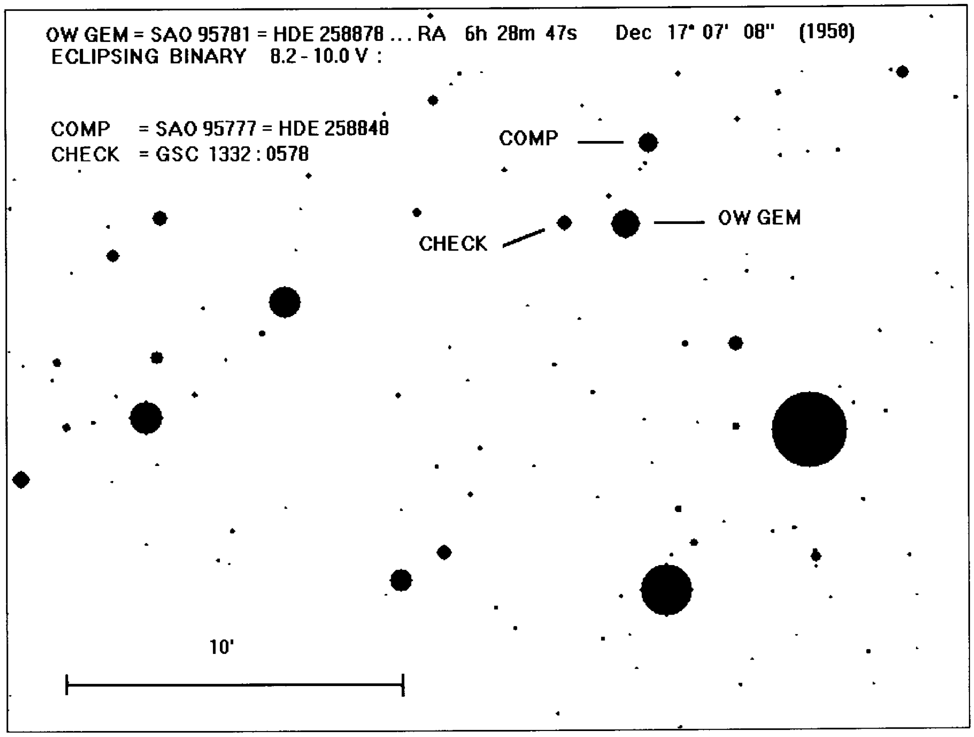

Figure 1. Finding chart for OW Geminorum

within 3.5 arcminutes, which will assist observers using CCD detectors with limited fields. Figure 1 shows a finding chart for the system.

All interested observers are urged to register with the lead author. We intend to distribute a circular with final information prior to the first 1995 event and again following each of the two eclipses.

Dirk TERRELL
Department of Physics and Astronomy
University of Calgary
Calgary, Alberta T2N 1N4
E-Mail: terrell@algol.iras.ucalgary.ca

Daniel H. KAISER
Crescent Moon Observatory,
2631 Washington St., Columbus,
IN 47201, USA
E-Mail: d.kaiser2@genie.geis.com

David B. WILLIAMS
9270-A Racquetball Way,
Indianapolis, IN 46260, USA

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Budapest
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HU ISSN 0374 – 0676

PHOTOELECTRIC PHOTOMETRY OF OO Aql

OO Aquilae (BD+8°4224, HD 187183, SAO 125084) is a ninth-magnitude binary with a W Ursae Maioris-type light curve and relatively deep minima. Photoelectric light curves have been published by Binnendjik (1968) and Lafta and Grainger (1985). Binnendijk found over several seasons that the shape of the light curves varied with time. Demircan and Güdür (1981) have published B and V observations, and have also gathered a large number of times minimum light as a part of a period study. In addition, a number of other observers have published occasional times of minimum light.

A spectral type of G5 has been assigned to the system by Roman (1956), and K0 by Hill et al. (1975) based upon classification spectra.

Photoelectric UBV observations of the W UMa type eclipsing binary OO Aql were carried out in the years 1991, 1992 and 1993 at Ankara University Observatory. During a program of photoelectric observations of eclipsing binaries the system was observed in 1991 in two colours (B and V) and in 1992 and 1993 in three colours (U, B and V). The observations were made with a 30-cm Maksutov telescope equipped with an SSP5-A photometer head which is used with an Hamamatsu R1414 photomultiplier tube. Before 29 September 1991 the observations were made by using an EMI 9789QB photomultiplier attached to the Maksutov telescope. The filters used are in close accordance with the standard UBV bands.

The same comparison star BD+8°4220 was chosen as by Demircan and Güdür (1981), and Lafta and Grainger (1985) for nearness in position and brightness to OO Aql. All differential observations were reduced outside the atmosphere using the extinction coefficients calculated in the usual way, and heliocentric correction was made for all the observations. The phases were calculated with the new light elements as:

$$T_0 = 2448853.38634 + 0\overset{d}{.}50678848 \times E$$

The observations are shown in Figures 1, 2 and 3 for the years 1991, 1992 and 1993 respectively together with the (B−V) and (U−B) colour curves. 1991 observations in Figure 1 were made with both photomultipliers cited above.

Total of six primary and six secondary times of minima were calculated using Kwee and van Woerden's (1956) method and listed in Table 1 with their mean errors. The columns in Table 1 are minima type, heliocentric Julian Date, mean error (I) which found by Kwee and van Woerden's (1956) method and filters used respectively. The last two columns are the averaged minima times (mean) and mean errors (II) calculated using the function given as follows:

$$t_{min(mean)} = \frac{\sum_i (t_i/\sigma_i^2)}{\sum_i (1/\sigma_i^2)}$$

$$\text{and } \sigma_{mean}^2 = \frac{1}{\sum_i (1/\sigma_i^2)} \quad \text{(Mean err. II)}$$

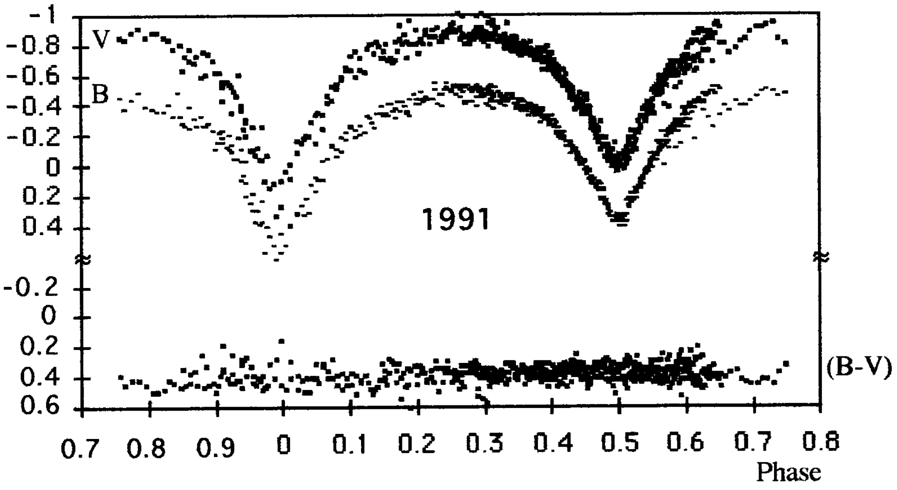

Figure 1

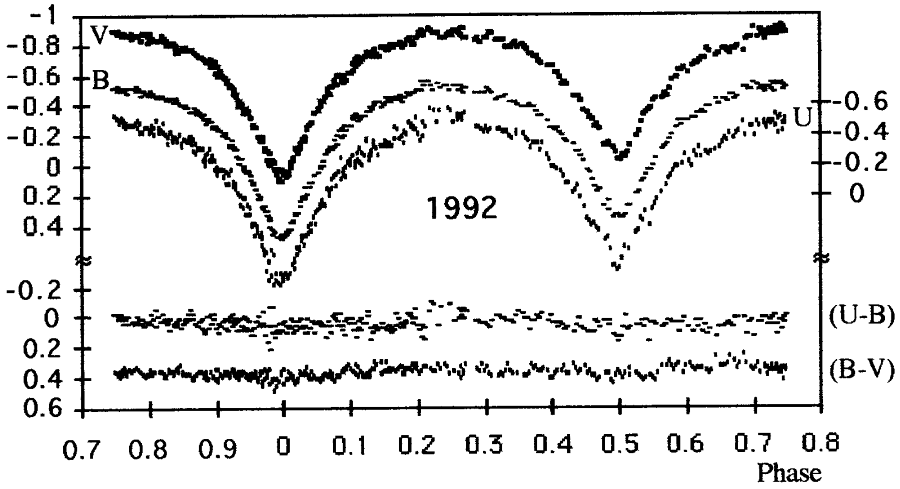

Figure 2

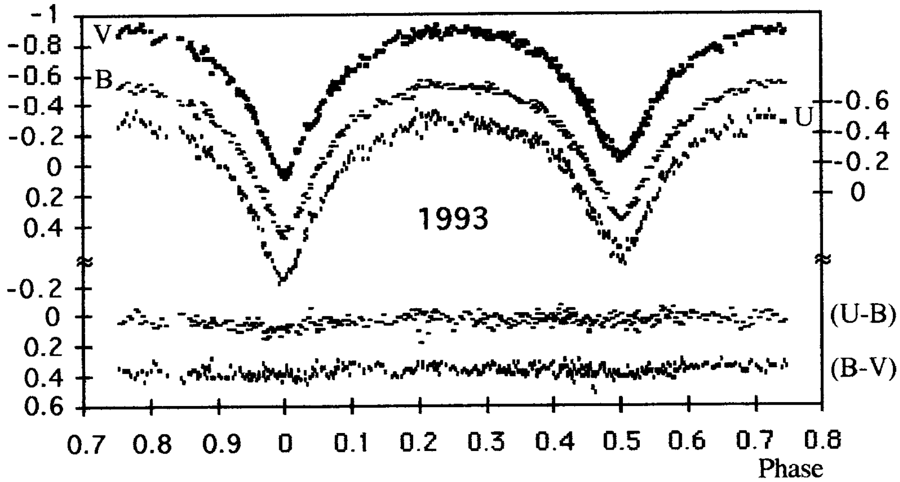

Figure 3

Table I

Min. Type	HJD min. +2400000	Mean err. (I)	Filters	HJD min. (mean)	Mean err. (II)
I	48475.3217	±0.00093	B	48475.3217	±0.00093
I	48477.34759	±0.00047	V	48477.34765	±0.00042
I	48477.34794	±0.00101	B		
II	48530.30831	±0.00036	B	48530.30876	±0.00030
II	48530.30987	±0.00056	V		
II	48531.32242	±0.00029	B	48531.32242	±0.00029
II	48532.3357	±0.00036	V	48532.33591	±0.00022
II	48532.33604	±0.00028	B		
II	48838.43569	±0.00046	U	48838.43601	±0.00017
II	48838.436	±0.00019	B		
II	48838.43679	±0.00068	V		
I	48853.3862	±0.00029	U	48853.38634	±0.00014
I	48853.38632	±0.00019	B		
I	48853.38651	±0.00028	V		
I	48854.39871	±0.00041	U	48854.39936	±0.00016
I	48854.39935	±0.00026	B		
I	48854.39957	±0.00023	V		
II	49179.5057	±0.00026	B	49179.50586	±0.00021
II	49179.50602	±0.00039	V		
II	49179.50681	±0.00088	U		
I	49186.34666	±0.00063	U	49186.34731	±0.00017
I	49186.3471	±0.00028	V		
I	49186.34752	±0.00022	B		
I	49193.44171	±0.00033	V	49193.44196	±0.00019
I	49193.4419	±0.00031	U		
I	49193.44227	±0.00033	B		
II	49238.29217	±0.00025	U	49238.29249	±0.00016
II	49248.29257	±0.00025	V		
II	49238.29301	±0.00038	B		

Birol GÜROL
Ankara University Observatory
06100 Tandoğan-Ankara
Türkiye

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NEW PHOTOELECTRIC LIGHT CURVES OF BL ERIDANI

Photoelectric observations of BL Eri (=BD−12°0818) were carried out in December 1991 with the 1-m telescope at Yunnan Observatory in China. Differential measurements made on two nights in B and V resulted in 254 individual observations in each bandpass. The two stars BD−12°0814 and BD−12°0821 were chosen as the comparison star and the check star, respectively. The observational accuracy throughout the observing period as derived from the magnitude differences between the two comparison stars is $\pm0\overset{m}{.}012$ (V) and $\pm0\overset{m}{.}016$ (B).

The times of minimum light for BL Eri shown in Table I were determined by a least squares analysis. The O−C values in Table I were computed from the following ephemeris:

$$\text{Min.I (Hel. J.D.)} = 2444606.5884 + 0\overset{d}{.}41691591 \times E$$
$$\pm3 \qquad \pm12\text{(p.e.)}$$

which was derived by a least squares analysis utilizing all the photoelectric times of minimum light.

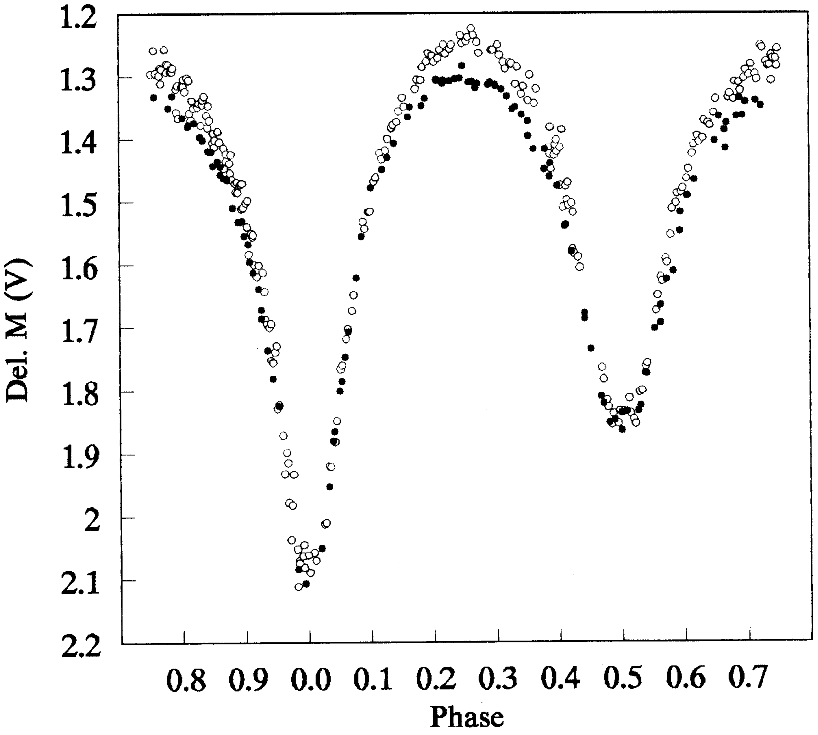

Figure 1. Light curves of BL Eri in V. The open circles show the present observations and the filled circles indicate Yamasaki et al.'s observations in 1982 and 1986.

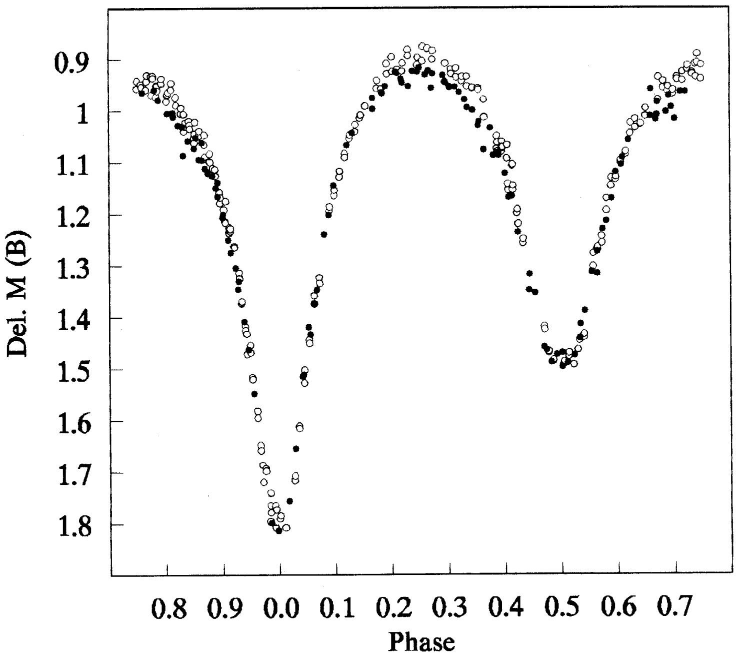

Figure 2. As Figure 1, but in B.

Table I. Times of minimum light for BL Eri

Hel. J.D.	Min.	Epoch	O−C
2448602.1026	II	9583.5	0.0006
2448603.1452	I	9586	0.0009

The light variations of BL Eri relative to BD−12°0814, magnitudes differences in the sense variable − comparison, are shown in Figure 1 (ΔV) and Figure 2 (ΔB) as open circles (the present observations) and filled circles (Yamasaki et al.'s observations in 1982 and 1986 (Yamasaki et al., 1988). The light curves indicate that significant stellar activity probably occurs in this binary.

LIU QUINGYAO
GU SHENGHONG
YANG YULAN
WANG BI
Yunnan Observatory
Chinese Academy of Sciences
Kunming
P. R. of China

Reference:
Yamasaki, A., Jugaku, J. and Seki, M., 1988, *Astron. J.*, **95**, 894

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ECLIPSING BINARY V530 Cyg=S 4539, FORMER Ins(a)-TYPE VARIABLE

The eclipsing binary V530 Cyg=S 4539 was discovered in the course of Sonneberg survey program (Ahnert et al., 1949). The following light elements were determined:

$$\mathrm{Min}=2429112.56+50^{\mathrm{d}}_{.}8611\times E$$

Ahnert et al. (1949) determined the initial epoch and the period close to reality, but later on these elements were disregarded. Kukarkin et al. (1958) included V530 Cyg in the Second Edition of the General Catalog of Variable Stars (GCVS) as an RW Aur type variable. In the Third and Fourth Editions of the Star was marked as an Ins(a)-type variable of B5: spectral type. Kholopov (1959) supposed V530 Cyg to be a member of the Cyg T2 association. Filipiev (1980) did not find any light variability of the star. Pugach (1988) observed three minima of V530 Cyg and proposed a new formal period of P=$35^{\mathrm{d}}_{.}519958$. Though, those moments of minima are well described with the above-mentioned ephemeris. Moreover, Pugach (1988) noted the presence of a shallow H absorption line profile.

In 1990 V530 Cyg was included in Mt. Maidanak ROTOR observational program (Shevchenko, 1989) to investigate its variability.

Our observations of V530 Cyg were made using the 0.5-m reflector equipped with UBVR pulse counting photometer. 300 UBVR magnitudes were obtaine during 4 observational seasons.

We have recorded 9 times of the primary minimum and calculated the improved elements using all data of other authors:

$$\begin{array}{l}\mathrm{MinI}=\mathrm{JD.Hel.}\,2448072.594+50^{\mathrm{d}}_{.}83141\times E\\ \qquad\qquad\qquad\qquad\pm0.005\pm 0.00005\end{array}$$

Julian Dates of the minima with phases and UBVR-data are listed in Table I. The folded V-curve and its primary minimum are shown in detail in Figures 1 and 2, respectively.

We have not enough data in the minimum to make an orbital solution. Nevertheless, we made a preliminary analysis of the light curve.

We suppose the following:

1. There is a partial eclipse at the minimum.
2. The secondary (fainter) star is passing in front of the small B5 primary in the primary minimum (see Figure 2.).

Table I

JD.Hel 2400000+	Phase	V	U−B	B−V	V−R
8072.3946	.996	12.33	0.05	0.63	0.68
8123.3514	.997	12.41		0.63	0.63
8174.1931	.999	12.38		0.66	0.63
8428.4361	.000	12.40		0.65	0.61
8479.3323	.001	12.42	0.04	0.65	0.66
8835.3494	.004	12.36	0.01	0.65	0.59
8886.1710	.004	12.34	−0.02	0.65	0.61
9190.3641	0.989	12.10	0.04	0.61	0.62
9191.3547	0.008	12.18	0.00	0.64	0.63
9241.2487	0.990	12.15	0.03	0.62	0.62
mean light in maximum		11.82	−0.01	0.62	0.61

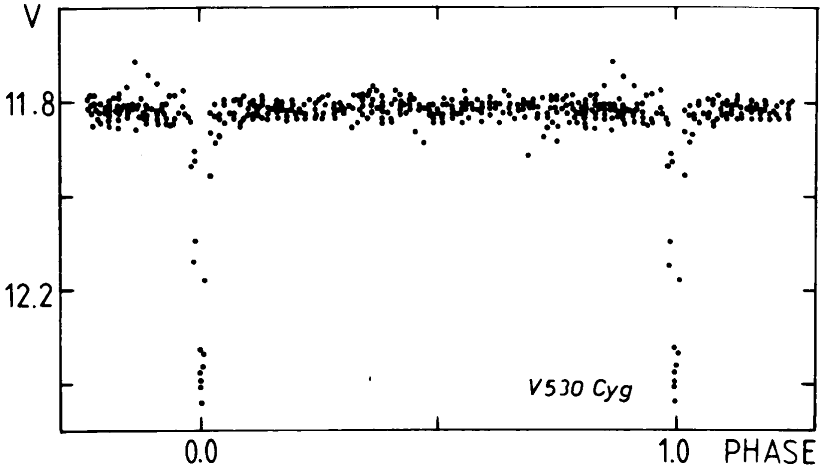

Figure 1. The V curve of V530 Cyg.

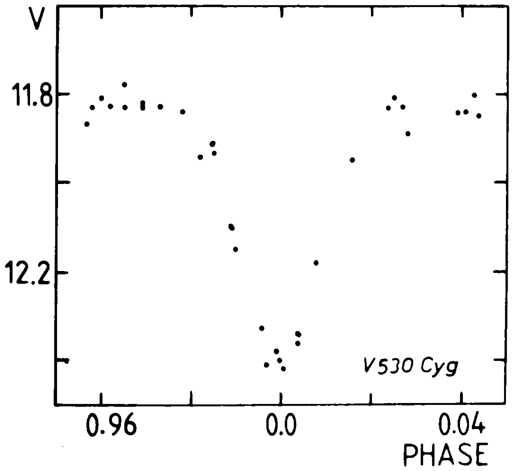

Figure 2. The minimum of V530 Cyg.

Taking into account the B5 spectral type of V530 Cyg we consider the total mass of the binary system not to be less than $8M_{\odot}$.

Then $R_1>5R_{\odot}$, $R_2>8R_{\odot}$, $M_v<-1.5$, $A_v\approx2.4$, $M-m>10.9$, $r>1.5$ kpc.

It takes about two more observational seasons to obtain the primary minimum in detail.

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S. Yu. MELNIKOV
V.S. SHEVCHENKO
K. N. GRANKIN
Astronomical Institute of Ac. Sci.
Uzbekistan, Astronomical st. 33,
Tashkent 700052, Uzbekistan

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IS PRAESEPE KW284 ACTUALLY A DELTA SCUTI STAR?

The δ Scuti stars are nearly a hundred radial and non-radial pulsators located, close to the Main Sequence, at the Cepheid instability strip (Rodríguez et al., 1994), being objects of extreme interest for asteroseismic investigations (Brown and Gilliland 1994).

These variables show short periods (typically shorter than 5 hours and longer than half an hour) and luminosity amplitudes ranging from several tenths of a magnitude to a lowest level which is continuously decreasing from one day to another (frequency peaks with amplitudes of the order of 0.4 mmag have been found in recent campaigns).

In the last few years, extremely good observational results have been obtained on δ Scuti stars, especially on their multi-periodic character, which seems to be more the rule than the exception (Breger, 1994). On the other hand, pure theoretical work is also currently undertaken on the subject (see e.g. Dziembowski, 1994).

A connection between high quality frequency spectra, which are being obtained, and theoretical work, carried out in order to interpret them, is being produced (Goupil et al. 1993, Pérez Hernández et al. 1994).

On the fourth photometry campaign of the STEPHI network, the δ Scuti-like stars BN Cnc (HD73576) and BUC nc (HD73576) were simultaneously monitored during a three-week, three-continental run, in February 1992 (Belmonte et al., 1994). Both stars are members of the Praesepe cluster. The "constant" star HD 73712 (KW284) was chosen as comparison star since, at that moment, no variability about it had been reported.

However, we were really surprised when we realized that KW284 had been discovered as a possible Delta Scuti star by Rolland et al (1991), with observations performed in February 1991, a year before our campaign.

Rolland et al. (1991) obtained observations over two distant nights (five hours on JD 2 448 303 and five hours on JD 2 448 311). The resolution in frequency associated to such a window is very close to the one obtained for one single night of 5 hours (50μHz). We thus have considered that the error bar on the frequency determined by Rolland et al. was of order $\pm 20\mu$Hz.

We have looked for this $80\pm 20\mu$Hz oscillation frequency in our data. In principle, we noticed that some frequency peaks, that we had identified as possible noise signals in previous analyses, were found at the correct frequency and with significant amplitudes (Figure 1).

On the other hand, during the STEPHI IV analysis, we had produced and analysed three different differential light-curves: BU Cnc/HD 73712, BN Cnc/HD 73712 and BU Cnc/BN Cnc. The comparison of these three light curves was used to ascertain which oscillation frequency corresponds to which star.

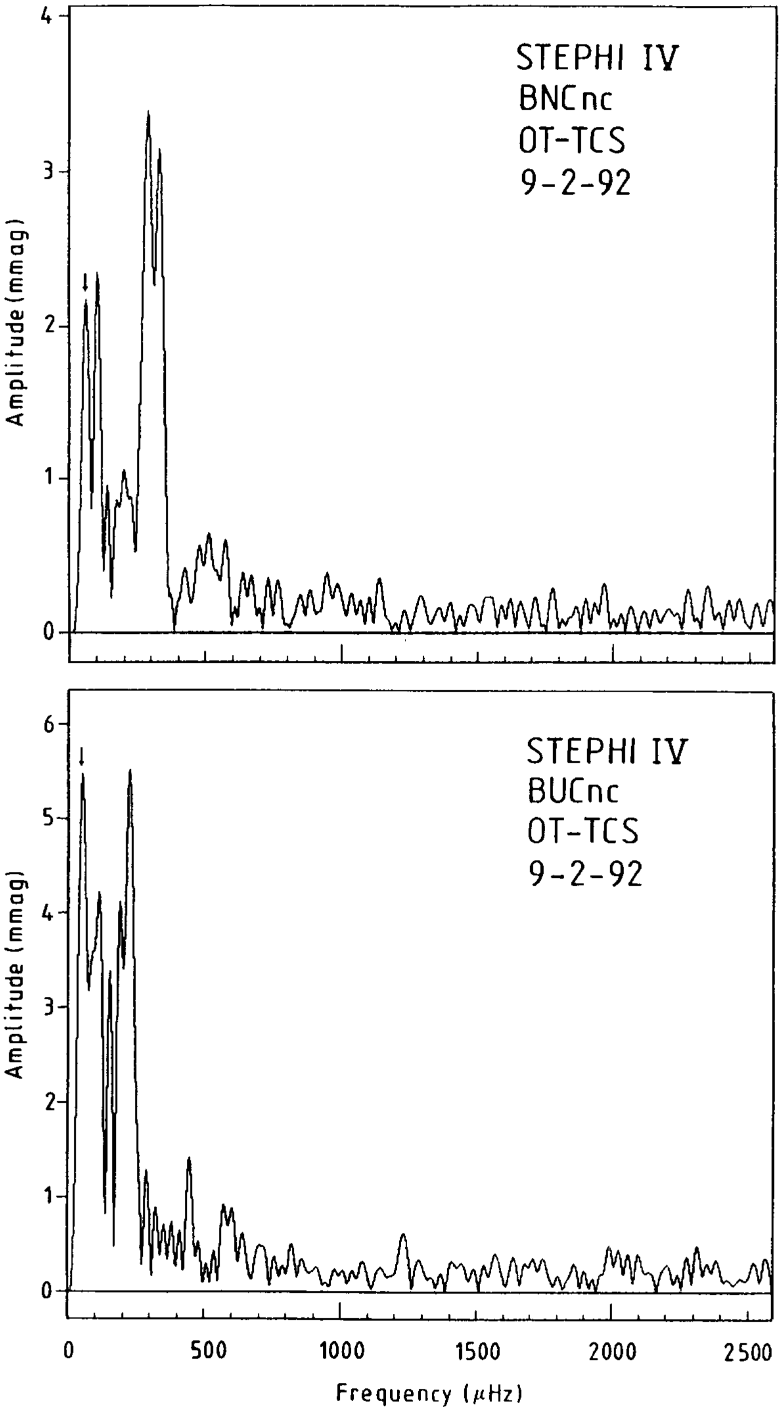

Figure 1: Frequency spectra of the time series BN/Comp. and BU/Comp., for February 9, 1992, at Observatorio del Teide. A common peak, at 70±30 μHz, was initially believed to be caused by noise. However, we now consider that it could be related to an oscillation frequency of the "constant" comparison star KW284.

Besides the results produced in Belmonte et al. (1994), the presence of a peak at $69.5\pm0.5\mu$Hz was noticed in the two light-curves, involving the comparison star HD73712 and not in the third light curve. The detection confidence level was around 20% and, in the absence of further information, this peak was attributed to noise in the comparison light-curve. However, the discovery of a $80\pm20\mu$Hz oscillation frequency in this star obliged to revise this detection.

We will not go into the details of the statistical test used in the analysis of the STEPHI campaigns. This test is derived from the Fisher's test (Fisher 1929, Koen 1990, Michel 1992). The point is that the confidence level attributed, according to this test, depends on the width of the frequency range in which one expects to detect oscillation frequencies. For a given peak, this dependence goes like the power of the frequency range ratio: $CL1 = CL2^{(FR1/FR2)}$, where $CL1$ is the confidence level associated with the frequency range $FR1$, and $CL2$, with the frequency range $FR2$. This simply reflects the fact that the probability to find, in a Fourier spectrum, a noise peak higher than a given amplitude increases with the number of events considered, i.e. with the number of independent frequency samples investigated.

In the STEPHI IV analysis, we were looking for oscillation frequency in the complete range of oscillation frequencies expected for Delta Scuti stars: $\sim46\mu$Hz to $\sim1500\mu$Hz, corresponding to periods from 6 hours to 10 minutes. However, if we now consider the detection, by Rolland et al. (1991), of an oscillation frequency in the range [60μHz, 100μHz] as completely secure (confidence level 100%), and if we investigate this restricted frequency range in the STEPHI data, the confidence level of the peak we see at 69.5μHz becomes: $0.2^{(40/1450)} \geq 95\%$.

We thus conclude that the oscillation frequency detected by Rolland et al. is very probably the $69.5\pm0.5\mu$Hz detected in the STEPHI IV data. The difference in amplitude between the two analyses (~4 mmag for Rolland et al. and 1.7 mmag and 3.0 mmag, for the two light curves considered in the STEPHI analysis) is not related to an amplitude change of the mode, but rather it can perfectly be attributed to the noise, which we found to be rather high at low frequency. Consequently, KW284 is probably a long period Delta Scuti star, located in the upper part of the Main Sequence –almost evolving to subgiant– where it is crossed by the instability strip.

Further data will be needed to establish its frequency spectrum with high accuracy. Hopefully, further campaigns of STEPHI or the Delta Scuti Network will provide such high quality data in the future.

J.A. BELMONTE[1],
E. MICHEL[2],
M. ALVAREZ[3] and
JIANG, S.Y. [4]

(1): *Instituto de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Spain*
(2): *Observatoire de Meudon, DASGAL, URA 335, F-92195 Meudon, France*
(3): *Instituto de Astronomía de la UNAM, Ap.P. 877, Ensenada, BC, Mexico*
(4): *Beijing Observatory, Chinese Academy of Sciences, Beijing, China*

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WATER MASERS IN L1251

We report the results of a water maser search carried out with the Effelsberg-100m telescope on 1993 Oct. 3 in the direction of 11 IRAS sources in the L1251 (Lynds, 1962) dark cloud. A 2.0Jy emission was detected in the direction of IRAS 22343+7501.

We observed the $6_{16} \rightarrow 5_{23}$ (22.23508 GHz) transition of H_2O with a beamwidth of 40 arc sec on 1993 Oct. 3 from UTC=12:00 to UTC=19:00. A liquid He cooled maser receiver was used with system temperature in the zenith of about 90K. We used the standard 1024 channel autocorrelator with bandwidths of 12.5 MHz and 6.25 MHz. This corresponds to 0.16 and 0.08 km/s resolution and 165 and 82 km/s velocity coverage respectively. We observed in the position switching mode with 3 minutes integration time on both the OFF and ON positions. NGC 7027 was used for flux calibration (see Baars et al. 1977).

The positions of the far infrared (FIR) sources in Kun & Prusti (1993) (K&P) with serial numbers: 1, 3, 4, 5, 7, 8, 13, 14, 15, 16, 17 were observed.

H_2O maser emission was detected towards IRAS 22343+7501 (#8 of K&P). The spectrum (obtained with 6.25 MHZ bandwidth, 25 min. integration time, RMS noise 0.12 Jy.) is shown in Figure 1.

There is a clear detection of a line at a velocity of 2.6 km/s which is redshifted by about 7 km/s relative to the rest velocity of the cloud ($v_{\rm LSR} \approx -4$km/s, see e.g. Sato and Fukui, 1989), and there is no indication for other lines (i.e. $S > 3\sigma$ peaks) in the velocity range [-40 km/s, +40 km/s]. The detected line has one gaussian component with a FWHM of 0.46 ± 0.02 km/s ($\delta v = 0.45$ km/s after correction for instrumental broadening), a peak flux of 2.0 Jy (rms=0.11 Jy), and line area of 0.97 ± 0.04 Jy km/s. The corresponding luminosity (assumed to be isotropic) at a distance of 350 pc (Balázs, 1994) is $L_{H_2O} = 2.7 \times 10^{-9} L_{\odot}$.

The FIR colour indices of IRAS 22343+7501 are $\log(F_{25}/F_{12})$=0.72; $\log(F_{60}/F_{25})$=0.40 and $\log(F_{100}/F_{60})$=0.08 similar to other maser sources found in Cepheus by Wouterloot and Walmsley (1986) (W&W). Its total FIR flux is $F_{\rm IRAS} = \int S_{\nu} d\nu = 2.55 \times 10^{-12}{\rm Wm}^{-2}$ which corresponds to $\approx 22.5 L_{\odot}$ FIR luminosity at a distance of 350 pc, assuming isotropic FIR radiation.

Near-infrared and mm continuum observations of IRAS 22343+7501 by Rosvick & Davidge (1994) indicate that the source is possibly just past the protostellar phase. There is an optical jet (Balázs et al., 1992) and a CO outflow (Sato & Fukui, 1989) associated with this source. The H_2O maser emission in the direction of this source has also been detected by Wilking et al. (1994) and found by them to be variable in time.

The maser emission may originate in the shocked clumps near the driving source of the jet. Interferometric observations of this source with the aim of determining a precise position would help further interpretation.

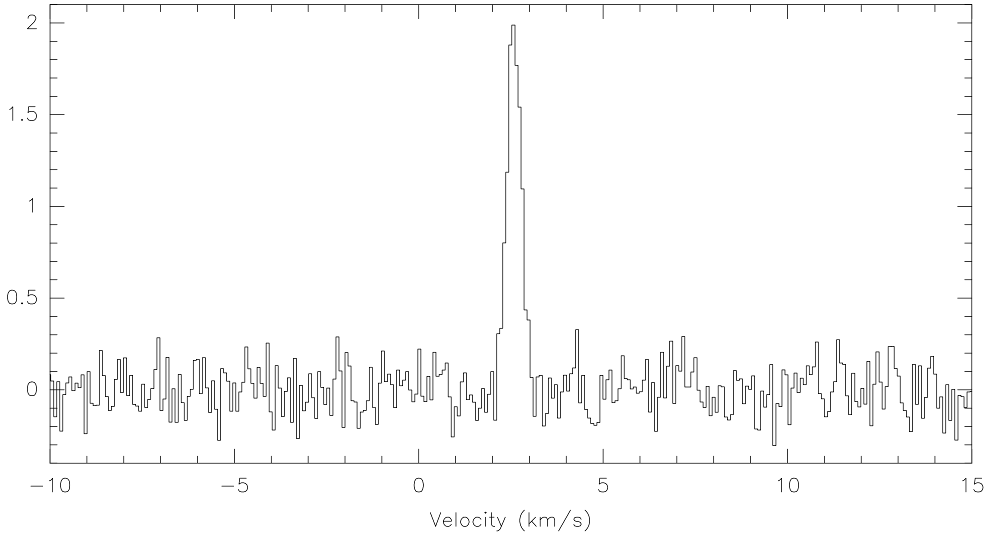

Figure 1. The H_2O $6_{16} \rightarrow 5_{23}$ spectrum of IRAS 22343+7501, (measured on 1993 Oct. 3 in the time interval UTC=16:15 - UTC=18:05).

Viktor L. TÓTH
Loránd Eötvös University,
Budapest, Ludovika tér 2.,
H-1083, Hungary

Charles M. WALMSLEY
Max-Planck-Institute für
Radioastronomie,
Auf dem Hügel,
53000 Bonn 1, Germany

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TIMES OF MINIMUM LIGHT FOR FOUR ECLIPSES OF FOUR BINARY SYSTEMS

We report on a continuing program to observe systems suggested by Hegedüs (1988) that show apsidal motion, or that are likely candidates to show apsidal motion, but have not been observed extensively enough to confirm such motion.

The observations were made with the 0.61 m B&C reflector and Photometrics PM512 CCD at the Whitin Observatory. The UBVRI filter set used was described by Bessell (1990). The data were acquired via a Macintosh IIci running IPLab. Data were taken in only one filter for a given eclipse, in order to minimize the time between points. This technique, along with the greater sensitivity of CCD's over PMT's, and the use of comparison stars in the same field as the variable, allows much fainter systems to be observed or much faster sampling on brighter systems.

The data were bias, dark, and flat corrected using standard scripts in IRAF. The data were then shifted to a common coordinate reference frame and photometered using custom scripts in IRAF developed by the authors (Downey and Hawkins, 1994). V/C intensity ratio and photometric errors were then calculated with the SC spreadsheet.

Once V/C intensity ratios had been calculated, the times of minimum light and standard errors in Table 1 were calculated via the method of Kwee and van Woerden (1956), using a program written by Ghedini (1982). This algorithm has been shown to give the most accurate estimation of conjunction for asymmetric or distorted light curves (Caton 1989). The comparisons used are listed by their coordinates from version 1.1 of the GSC CD-ROM (Epoch J2000). All comparisons were compared to two check stars, and found to be stable within the photometric errors over the time scale of the observations. Since the data were only intended for timing analysis, they were not transformed to Johnson standard magnitudes.

Table 1

System	Type of Eclipse	HJD (−2400000)	Standard Error	Comparison Coordinates	Filter
AP Tau	Secondary	48687.5562	0.0002	$04^h54^m36^s$+26°54'07"	I
XX Cas	Primary	49308.5557	0.0001	01 29 49 +60 58 00	R
XZ And	Primary	49313.5336	0.0001	01 56 53 +42 08 39	I
V 456 Cyg	Secondary	49589.6918	0.0002	20 28 35 +39 14 43	R

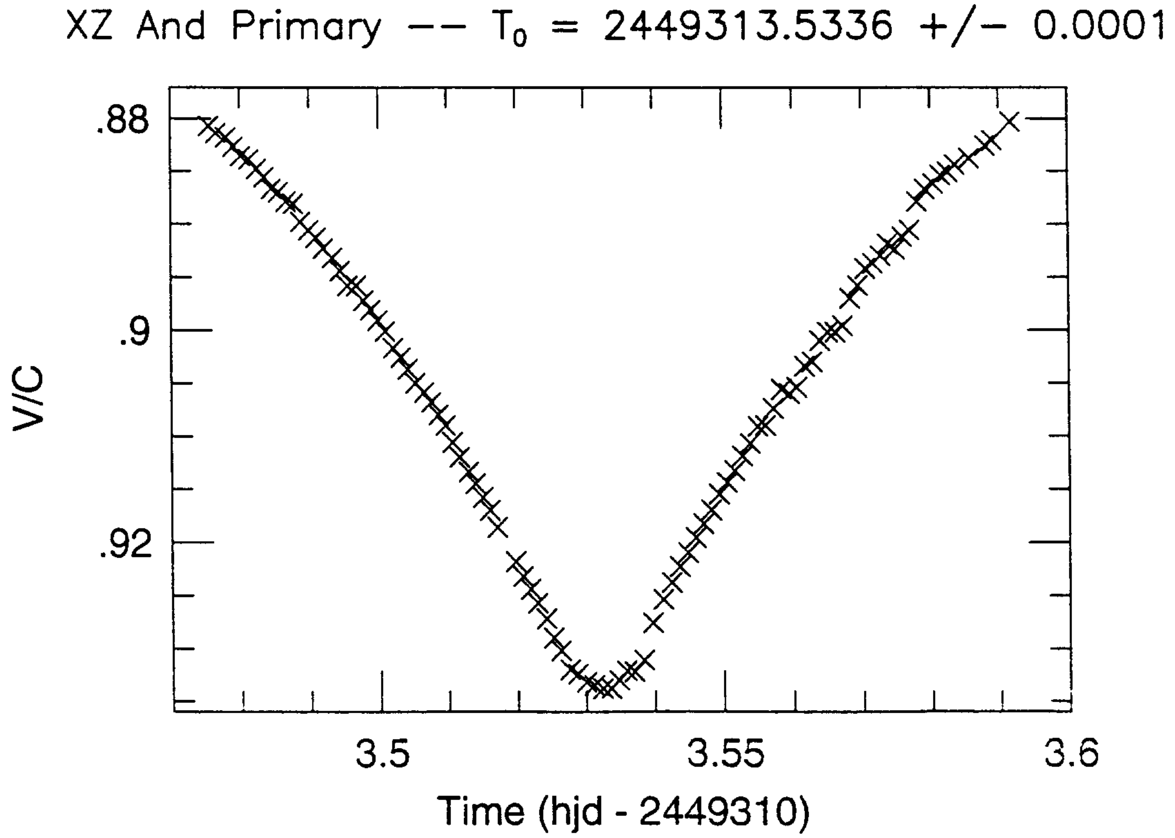

Figure 1

Figure 1 is a light curve of XZ And near the time of minimum light, showing the low scatter and large number of points attainable with a CCD system.

We would like to thank Priscilla Benson, Kristin Laudadio, Molli Moss, Catherine Sinnott, and Sarah Weisman for their kind assistance in the observations of XX Cas and XZ And. This research was supported in part by a grant from the W.M. Keck Foundation to the Keck Northeast Astronomy Consortium.

R. Lee HAWKINS
Department of Astronomy
Whitin Observatory
Wellesley College
Wellesley, MA 02181
USA

Kyle F. DOWNEY
Department of Astronomy
Thompson Physics & Astronomy Lab
Williams College
Williamstown, MA 01267
USA

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PHOTOELECTRIC PHOTOMETRY OF THE SHORT-PERIOD ECLIPSING BINARY HW VIRGINIS

During a UBV survey of UV-bright objects HW Vir (BD−07°3477) was discovered to be an eclipsing binary ($P_{orb}\sim0.1167$ days) by Menzies and Marang (1986). As a part of this survey Berger and Fringant (1980) obtained spectroscopy of HW Vir and classified it as an sdB star. Menzies (1986) obtained UBVRI light curves of this system and then Menzies and Marang (1986) analysed these light curves by WD-code. They also measured the radial velocity of the primary star and calculated the absolute dimensions of the components. Wood et al. (1993) also made UBVR photometry of the system and analysed the light curves using WD-code. In the recent annual report of SAAO Marang and Kilkenny (1994) announced that HW Vir shows a definite period decrease.

We included HW Vir in our observing program in 1992 and observed the system on one night in 1992, one night in 1993 and seven nights in 1994. Differential observations with respect to the comparison star BD−08°3411 were obtained with the 30cm Maksutov telescope of Ankara University Observatory. We used an OPTEC SSP-5A photometer head which contains a side on R-1414 Hamamatsu photomultiplier. We used BD−07°3467 as a check star and the magnitude differences between the check star and comparison star were constant within probable errors of ±0.022, ±0.013 and ±0.016 in U, B and V bands respectively. The light curves formed by these differential observations (in the sense variable minus comparison) are shown in Figure 1 for different filters with their respective B−V color curve (U observations are shifted vertically by +0.5 mag). Differential atmospheric extinction and heliocentric corrections were made. The phases of the light curves were calculated with the light elements

$$\mathrm{HJD(Min\ I)}=2448294.886472+0\overset{d}{.}11671953\times E$$

We derived ten mean times of minima from the new observations (six primary, four secondary) by using the well-known method of Kwee–Van Woerden (1956). The new estimates in different filters and their mean values are listed in Table I. Mean times of minima and their mean errors were generated with the formula

$$t_{min(mean)} = \frac{\sum_i (t_i/\sigma_i^2)}{\sum_i (1/\sigma_i^2)}$$

$$\text{and } \sigma^2_{mean} = \frac{1}{\sum_i (1/\sigma_i^2)}$$

Light curves in all filters exhibit a large reflection effect as mentioned before by several authors. In all wavelength bands, there is a shoulder of extra light in 0.06-0.12 phase interval which may be interpreted as a mass transfer effect.

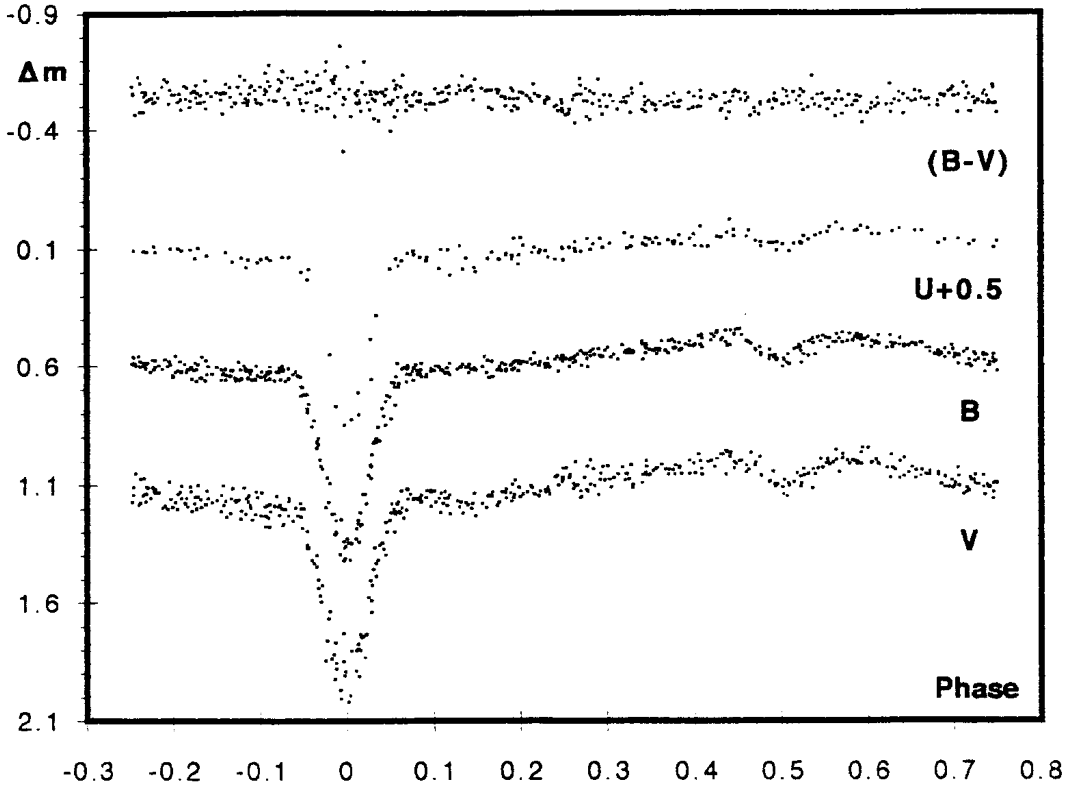

Figure 1

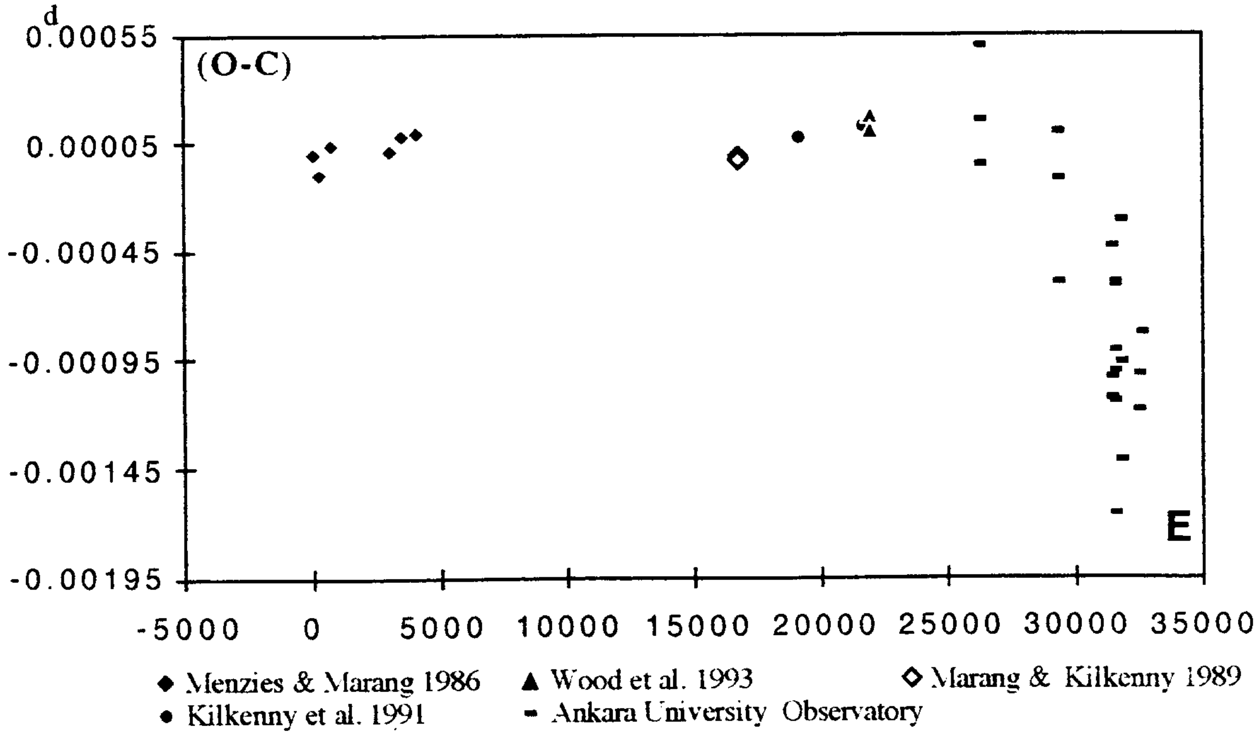

Figure 2

Table 1

Min. Type	HJD min +2400000	Mean err.	Filter	HJD Min(mean) +2400000	Std err.	Obs
I	48776.3548	±0.00046	V	48776.3552	±0.00013	SS
I	48776.3550	±0.00021	B			
I	48776.3553	±0.00018	U			
II	49149.3318	±0.00021	U	49149.3323	±0.00011	ZM
II	49149.3323	±0.00026	B			
II	49149.3325	±0.00015	V			
II	49393.5095	±0.00032	B	49393.5095	±0.00032	BA
I	49393.5671	±0.00017	V	49393.5672	±0.00005	BA
I	49393.5672	±0.00006	B			
II	49400.5114	±0.00050	B	49400.5121	±0.00013	SÖ
II	49400.5119	±0.00017	V			
II	49400.5125	±0.00023	U			
I	49400.5704	±0.00007	U	49400.5705	±0.00005	SÖ
I	49400.5705	±0.00008	B			
I	49400.5708	±0.00021	V			
II	49427.4739	±0.00010	B	49427.4742	±0.00009	BG
II	49427.4750	±0.00017	V			
I	49427.5327	±0.00010	V	49427.5327	±0.00005	BG
I	49427.5327	±0.00005	B			
I	49511.3372	±0.00016	V	49511.3373	±0.00008	BG
I	49511.3373	±0.00009	B			
I	49518.3407	±0.00008	B	49518.3407	±0.00008	BG

Observers: SS: S. Selam, ZM: Z. Müyesseroğlu, BA: B. Albayrak, SÖ: S. Özdemir, BG: B. Gürol.

We collected all available times of minima from the literature and constructed the O−C diagram which is shown in Figure 2. The E epochs were calculated with the light elements given by Menzies and Marang (1986) as,

$$\text{HJD (Min I)}=2445730.556074+0\overset{d}{.}1167196311\times \text{E}$$

Both primary and secondary times of minima follow the same trend of O−C variation which indicates zero eccentricity for the binary orbit. The O−C diagram shows a clear rapid period decrease which can be interpreted as active mass change between component stars. But, Wlodarczyk (1994) pointed out from his analysis of their own light curves, both components are well located inside its Roche lobe, and he suggests that period changes most likely are resulting from are extended common envelope, remaining after the giant phase. Only the future accurate observations will help to settle the true nature of this period variation.

We give our special thanks to the observers and to Z. Müyesseroğlu for making his observing computer code available to us.

Birol GÜROL
Selim SELAN
Ankara University Observatory
Science Faculty, 06100, Tandoğan
Ankara, Turkey

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THE SPOTTED YOUNG SUN – HD 129333 (= EK Dra)

HD 129333 (= EK Dra) is a young, single, solar-type star with a rotational period of approximately $2^{\mathrm{d}}.7$. Its U, V, W space velocity components (+3, −29, −17) (km/s) are very close to those of the Pleiades cluster (+9, −27 −12), making it a probable member of the Pleiades moving group of young stars with an age of $\approx$ 70 Myr (Soderblom & Clements, 1987). This star is part of a program being carried out at Villanova University called *The Sun in Time*. The program involves multiwavelength observations of single G0-G5 V stars with ages ranging from $\approx$ 70 Myr to $\approx$ 9 Gyr. These stars are suitable proxies for the sun at several stages of its life history from the zero age main sequence (ZAMS) to the very late (terminal) main-sequence (TAMS) phase (Dorren & Guinan, 1994a).

HD 129333 (dG0, B−V = +0.61, T_{eff} = 5930 K, age $\approx$ 70 Myr) provides a look at the sun shortly after it arrived on the main-sequence (Dorren & Guinan, 1994b). It has a very active chromosphere and transition region, which are consistent with its youth and rapid rotation. Furthermore, in 1991, HD 129333 was detected as an X-ray source during ROSAT pointed observations, with an X-ray luminosity of L_x (0.2-2.4 keV)$\sim 9\times10^{29}$ erg/s, or about 300 times stronger than the Sun (Dorren & Guinan, 1992). The X-ray emission probably originates from the stellar corona, while the UV emission features are associated with the chromosphere-corona transition region of the star (Dorren & Guinan, 1994b). The best fit to the X-ray energy distribution indicates a two-temperature component corona with $T_1 = 1.3 \times 10^6$ K and $T_2 = 9.6 \times 10^6$ K (Dorren, Güdel & Guinan 1994).

In 1983 this star was discovered to have low amplitude (Amp(V) $\approx$ 0.05) light variations with a period of $\sim 2^{\mathrm{d}}.7$ (Dorren & Guinan, 1994b). These periodic $2^{\mathrm{d}}.7$ variations increase in amplitude with a decrease in wavelength and are assumed to be rotational modulation due to the presence of cool starspots. In that case, the photometric period ($\sim 2^{\mathrm{d}}.7$) represents the stellar rotational period. HD 129333 now has a variable star designation of EK Draconis (Kazarovets, Samus & Goranskij, 1993).

Photoelectric photometry was obtained from 1990/91 to the present for HD 129333 in *UBV*, *ubvy* and Hα *wide* and *narrow* bandpasses with Automatic Photoelectric Telescopes (APTs) located at Mt.Hopkins, Arizona. The data presented in this report has come from the Four College Consortium (FCC) 0.8m APT. The photoelectric observations were carried out relative to the nearby comparison star HD 129390 (V = +7.5; B−V = +0.4; F2) and check star HD 127821 (V = +6.09; B−V = +0.41; F4 IV) and followed the usual pattern of *sky-comparison-check-variable-comparison-sky*, with each measure lasting 10 seconds. 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. Typically, each normal consists of 4-5 individual 10 sec measurements.

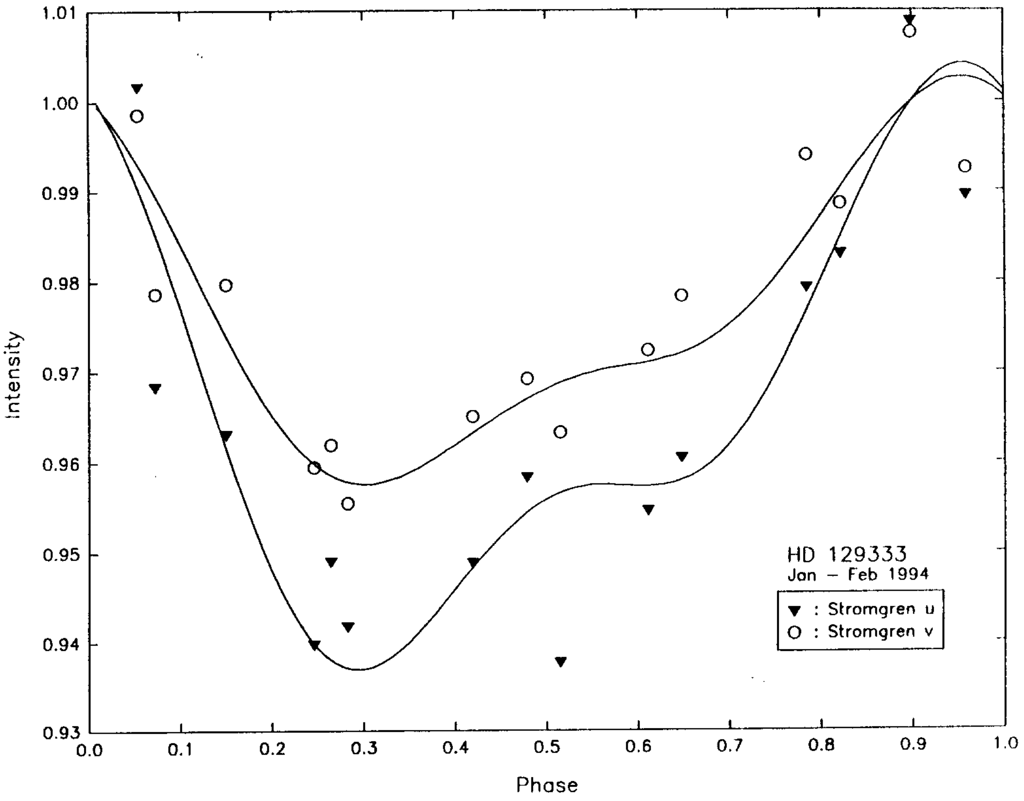

Figure 1: Photometric variations of HD 129333 versus phase. Each filter was fit with a model (solid lines on figure) using Binary Maker 2.0.

Table 1. Spot Parameters for HD 129333

Assumed Quantities

Inclination $i = 60°$

$\mathrm{P}_{rotation} = 2.74\mathrm{d}$

$\mathrm{T}_{photosphere} = 5930\ \mathrm{K}^{a}$

Limb-Darkening Coefficients[b]

$\mathrm{x}(\lambda 3700) = 0.76$

$\mathrm{x}(\lambda 5500) = 0.62$

Determined Quantities

	Temperature (K)	Radius	Longitude	Latitude
Spot 1	5470 ± 40	$20.5° \pm 1.5°$	$240° \pm 5°$	$+40° \pm 5°$
Spot 2	5470 ± 40	$24.5° \pm 1.5°$	$100° \pm 5°$	$+38° \pm 5°$

Total Spotted Area[c] $= 7.4\% \pm 0.5\%$

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[a] From dG0 spectral type.

[b] Al-Naimiy (1978).

[c] In terms of the total surface area of the star.

The data discussed here represents 15 nights over the period 1994 January 24 UT through 1994 February 26 UT. Nightly means were calculated and phases were computed using an arbitrary starting heliocentric Julian Date and a period of $2\overset{\mathrm{d}}{.}74$. The data were then normalized to intensity units and plotted in intensity versus phase.

Figure 1 shows the nightly mean differential magnitudes for the y-band (5500 Å) and the u-band (3600 Å). The differential yellow light curve has a broad primary minimum extending from ≈ 0.10P to ≈ 0.60P. The light amplitude of the yellow curve is $\simeq 0.040$ mag. For the u-filter ($\lambda 3600$), the shape is very similar to the yellow curve but the light amplitude is greater ($\simeq 0.062$ mag). The intermediate filters (violet 4100 Å and blue 4400 Å) have similar shapes and amplitudes which fall between the yellow and ultra-violet curves.

The fits for HD 129333 were done using Binary Maker 2.0, a synthetic modeler for binary star systems (Bradstreet, 1993), with the second component essentially *turned off* (given a very low mass and temperature) in order to model a single rotating star. The model consists of two large, mid-latitude spots separated by 140° in longitude. The total area spotted is about 7.4% of the stellar surface area. The spots were assumed to be circular and to have the same temperature. Table 1 gives a summary of the spot parameters used in the model.

The temperature difference between the spots and the photosphere was determined to be 460 (±40) K. The model was fit for several different starspot temperatures and radii in the y-band (5500 Å) and then compared with the u-band (3600 Å) to cover the full range of wavelength dependence in the data. The models that best fit to both colors were in the range 420-500 K. This solution was found to fit the other light curves at the intermediate wavelengths. The uncertainty in the value results from the scatter in the data and ambiguities in the model.

Maureen P. SCHEIBLE
Edward F. GUINAN
Dept. of Astronomy and
Astrophysics
Villanova University
Villanova, PA 19085 U.S.A.

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PHOTOELECTRIC OBSERVATIONS OF AB DORADUS

AB Doradus is a chromospherically active rapidly rotating single star that has been extensively observed for over 16 years. Photoelectric measurements were made at Mt Molehill in November 1993 (13 & 22) and in January 1994 (5, 19, 27, 28 & 30). A 200mm f10 Schmidt-Cassegrain Telescope, an RCA 931b P.M.T., standard Johnson B & V filters and DC electronics were used to make the observations. AB Doradus was monitored continuously in two colours,using differential photometry. Measurements of the comparison star and check were made regularly at about 15 minute intervals.

Reductions to the UBV standard system were carried out in accordance with the methods described by Henden and Kaitchuck (1982).

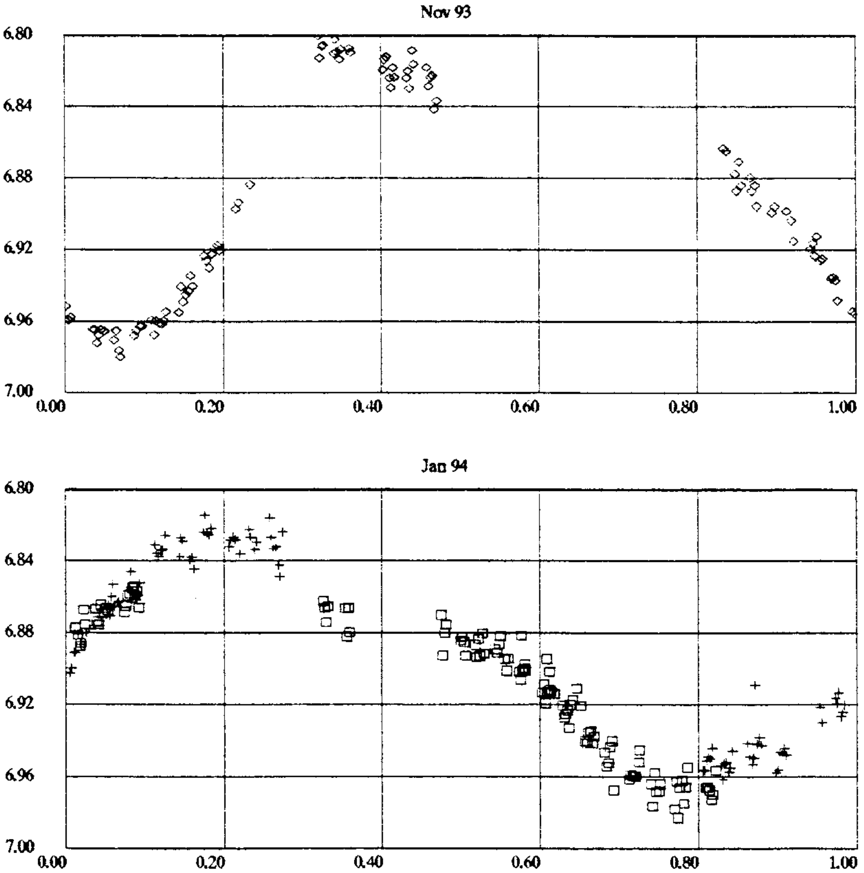
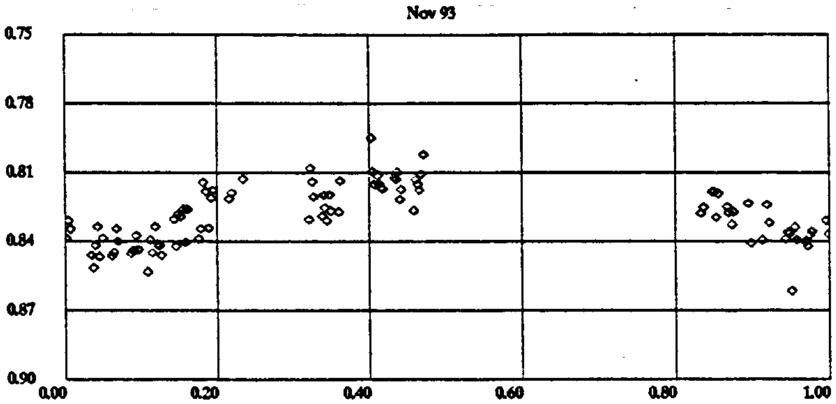


Figure 1. The two light curves collected in November 1993 (top) and in January 1994 (bottom). The square symbols are January 27, 28 &30



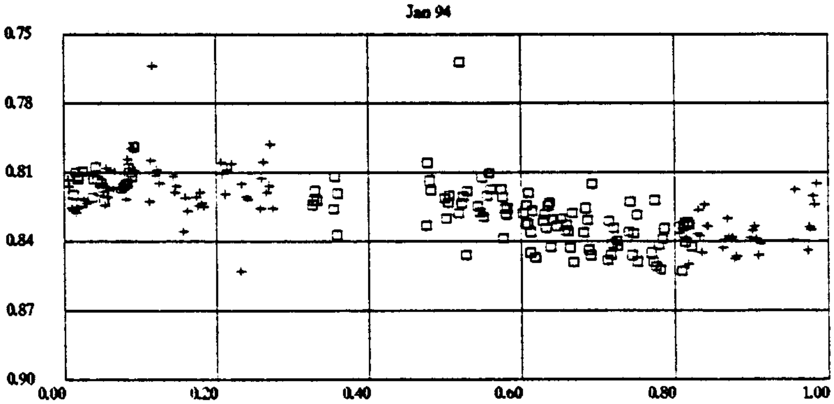


Figure 2. The B−V plotted against phase, November 1993 (top) and Januar 1994 (bottom). The square symbols are January 27, 28 & 30

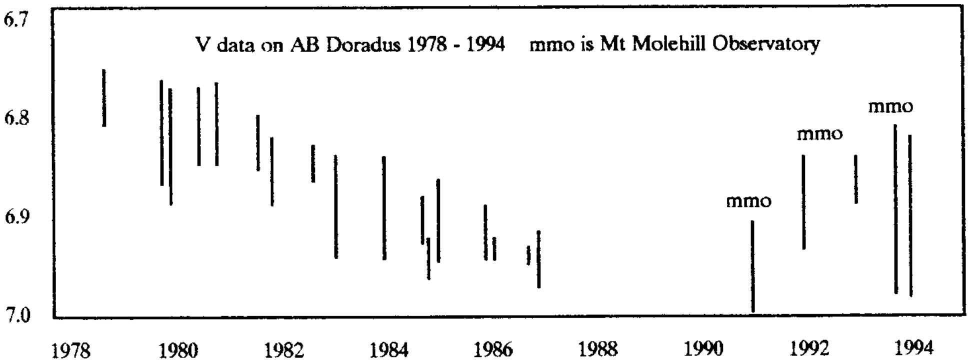


Figure 3. Overall light level and range of V light plotted against year. Each bar gives the range and light level at the observed epochs.

Table 1. Check Star HD 37279

Date	n	V mag	S.D.	B−V	S.D.
individual nights					
J.D. 2449304	9	7.425	.009	0.263	.009
J.D. 2449313	7	7.425	.005	0.275	.008
J.D. 2449357	9	7.433	.011	0.261	.011
J.D. 2449371	6	7.438	.004	0.254	.008
J.D. 2449380	11	7.429	.005	0.260	.010

S.D. = standard deviation

The observing sequence was sky-comp-var-comp-sky-var-check-comp-sky etc. Check star measurements (Table 1) had a standard deviation of 0.011 or less. Each data point on the light curve is the sum of three 10 sec integrations. Both the November and January light curves have amplitudes of approximately 0.14 magnitudes (Figure 1). The more complete light curve for January 1994 (Figure 1b) shows what appears to be a second spot at phase 0.37. Figure 1 shows the amplitude of the light curves and the phase angle of the spots in relation to each other. There is a three hour phase shift between the November 1993 and January 1994 light curves. This corresponds to a linear phase shift of $1\overset{\circ}{.}7$ per day when using the period of 0.51479 days derived by Innis et al. (1988). By changing the period to 0.5138 days the two data sets can be brought back into phase. The January 1994 (Figure 1b) light curve is a composite of five nights. The rise was observed on January 5 and the fall on January 28, thirteen days apart, and the resulting light curve is distorted. The rise and the fall on November 13, 1993 (Figure 1a) were observed during one observing session, and therefore would be more accurate. The B−V (Figures 2a & 2b) shows an apparent drop from 0.82 to 0.84 coinciding with the minimum of the V light curves. (Figure 3) is a plot of the overall brightness and amplitude of AB Doradus since 1978. Each bar gives the range and light level at the observed epochs.

Since observations started at Mt Molehill in December of 1990 AB Doradus has been steadily increasing in brightness, the light curves for November 1993 and January 1994 are in agreement with this.

Marc BOS
Mt Molehill Observatory
83a Hutton Street, Otahuhu
Auckland, New Zealand

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A NEW V/R CYCLIC CHANGE OF Hα in ζ Tau

Since the late 1970s, we have monitored the object. The observations reported in this paper were made with the grating spectograph of the 2.16 m telescope at the Xinglong Station of Beijing Astronomical Observatory during 1990 December - 1994 April. The detector was a CCD with 512×512 (or 576×384) pixels. The reciprocal linear dispersion of the spectra was 50Å mm^{-1} at Hα. One pixel corresponds to 1.35Å (or 1.15Å). The S/N-ratio at the continuum was >150. The observational and data reduction techniques have already been described by Guo and Guo (1992). Our results showed that the Hα profiles underwent a cyclic change (c.f. Figure 1). The 1990 December 25 Hα profile appeared as a single emission peak of asymmetric top and no visible central reversal. The profiles become distinct double emission peaks during 1991-1993. It is of interest to note that the 1994 April 28 profile become again a single emission peak, such as on 1990 December 25. In addition, the V/R ratio of Hα was larger (in 1990), equal to (around the beginning of 1992) and less (during 1992 November and 1993 October) than 1. Table 1 lists the results of the Hα measurements in the different observing periods. Throughout our observations no appreciable change in the Hα profiles obtained within each night has been detected. Hence we show only the mean profile measurements for each given night. It can be seen from the table that the equivalent width (Wα) and the full-width-at-half-maximum (FWHM) reached the maximum when the violet emission component is equal to the red one, and that the intensities (I_v) of the violet emission component declined gradually, while the intensities (I_r) of the red one rose slowly during our observing period.

Table 1

Date UT	No. of profiles	Wα (Å)	FWHM (Å)	I_v	I_a	I_r
1990 Dec 25.727	5	−19.7	10.69		(2.40)*	
1991 Oct 09.876	20	−20.1	10.69	2.96	1.60	2.17
1991 Dec 16.674	15	−22.5	10.69	2.85	2.02	2.30
1991 Dec 27.717	4	−22.3	10.69	2.78	2.02	2.24
1992 Feb 26.620	4	−24.4	11.08	2.78	2.02	2.66
1992 Feb 27.644	6	−23.8	11.04	2.78	2.03	2.65
1992 Nov 14.804	3	−23.8	10.50	2.52	2.04	3.25
1992 Nov 15.809	6	−24.0	10.32	2.52	2.06	3.33
1993 Oct 28.659	2	−21.8	10.52	2.09	1.95	2.84
1994 Apr 28.495	6	−22.3	10.50		(2.69)*	

$\star$ values in paranthesis are central intensity of the emission line

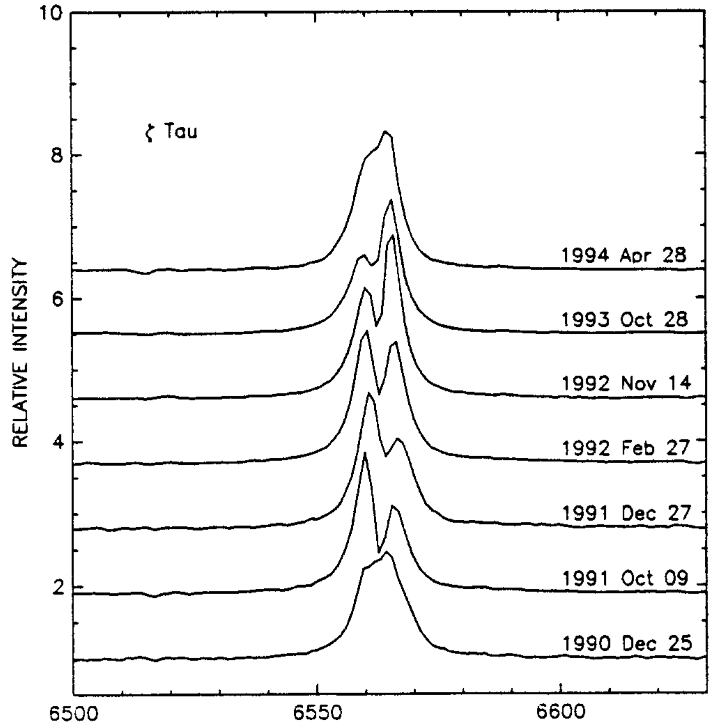

Figure 1

Since the beginning of 1960s, the cyclic variations of the radial velocity of the Balmer absorption lines and the V/R ratio of the Balmer emission lines have been observed successively in the star on numerous occasions (Hubert-Deplace et al., 1982). Mon et al. (1992) showed the cyclic variations had terminated and the star seemed to have entered a new quiet phase around 1982. Our spectroscopic observations also indicate that the V/R cyclic variations of Hα had vanished since 1982 (Yulian Guo et al., 1994). Our results show that after their disappearance for several years, a new V/R cyclic variation of Hα emerged once again at the end of 1990 and lasted for about 3.5 years. It seems that the cyclic variations of the star were very complicated, not only the duration and the amplitude of each cycle are different but the cyclic variation is sometimes disappearance and at other times reappearance. Therefore, it is necessary to make further observations and discussions.

YULIAN GUO
Beijing Astronomical Observatory
Chinese Academy of Sciences
Beijing, China

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A DETECTION OF MOVING BUMPS IN THE EMISSION PROFILES OF THE Be STAR FX Lib

This star has a long history of spectroscopic observations. Since 1932-35, its shell become active. Long-term variations of the radial velocity of the shell absorption lines and of V/R ratio of Balmer emission lines are cyclic (Faraggiana, 1971; Delplace and Chambon, 1976; Aydin and Faraggiana, 1978, Hubert-Delplace et al., 1983). Its Hα profile also underwent rapid changes on a time scale of days as well as long-term changes on a time scales of years (Aydin and Faraggiana, 1978; Slettebak and Reynolds, 1978).

A series of CCD Hα spectra of the star were taken using the grating spectograph of the 2.16 m telescope at the Xinglong Station of Beijing Astronomical Observatory during 1994 April-June. The detector was a CCD with 512×512 pixels. The reciprocal linear dispersion of the spectra was 50Å mm^{-1} at Hα. One pixel corresponds to 1.35Å. The observational and data reduction techniques have already been described by Guo and Guo (1992). The following changes can be found from these data:

1. Night-to-night changes occur in the Hα emission profile. Figure 1 shows three Hα profiles which represent the mean profile obtained on 1994 April 27, 28 and June 25 respectively. It can be seen from the figures that 1994 April 27 Hα profile appears as a double emission, but one day later, the Hα profile had three emission peaks. While in the Hα profiles of η UMa and κ Dra which were observed in same two nights, were not found any changes. This demonstrates that the Hα profile changes of 48 Lib are reliable. It is worth noting that the 1994 June 25 Hα profile become again a double emission peak but the violet emission component obviously weaker than red one. The remarkable change in the Hα profile observed on 1994 April 27-28 implies the possible occurrence of rapid violent activity in the stellar emission envelope.

2. Hα emission profiles of the star exhibit ultrarapid and as if cyclic changes. 16 spectra of the star were taken on 1994 April 28 (see Figure 2a). The Hα displayed change with time. It is seen at a glance that, there were two red emission components varying in intensity. The bottom profile in Figure 2b represents the mean profile of these spectra, and the other which are formed by subtracting the mean profile from each spectrum, are the line profile residuals. It is obvious that its Hα emission undergoes the ultrarapid changes on a time scale of minutes.

It can be seen from Figure 2b that the ultrarapid variations of the Hα profiles resemble the moving bumps which have been observed at high-resolution and high-signal-to-noise-ratio in the absorption lines of some Be stars (Walker et al., 1979; Yang et al., 1990; Floquet et al., 1992, Bossi et al., 1993). At present, there were two interpretations for these line-profile variations in Be stars: photospheric non-radial pulsations (Vogt and Penrod, 1983), or corotating structures in the matter above the stellar photosphere (Harmanec, 1989; Gies, 1994). Our observations showed that the Hα profiles had dramatic moving features but the phenomenon was not found in HeI λ6678. Therefore, we may infer that

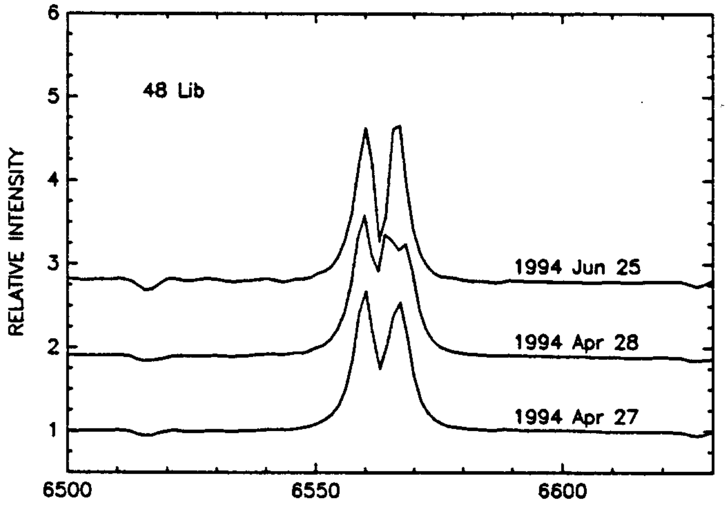

Figure 1

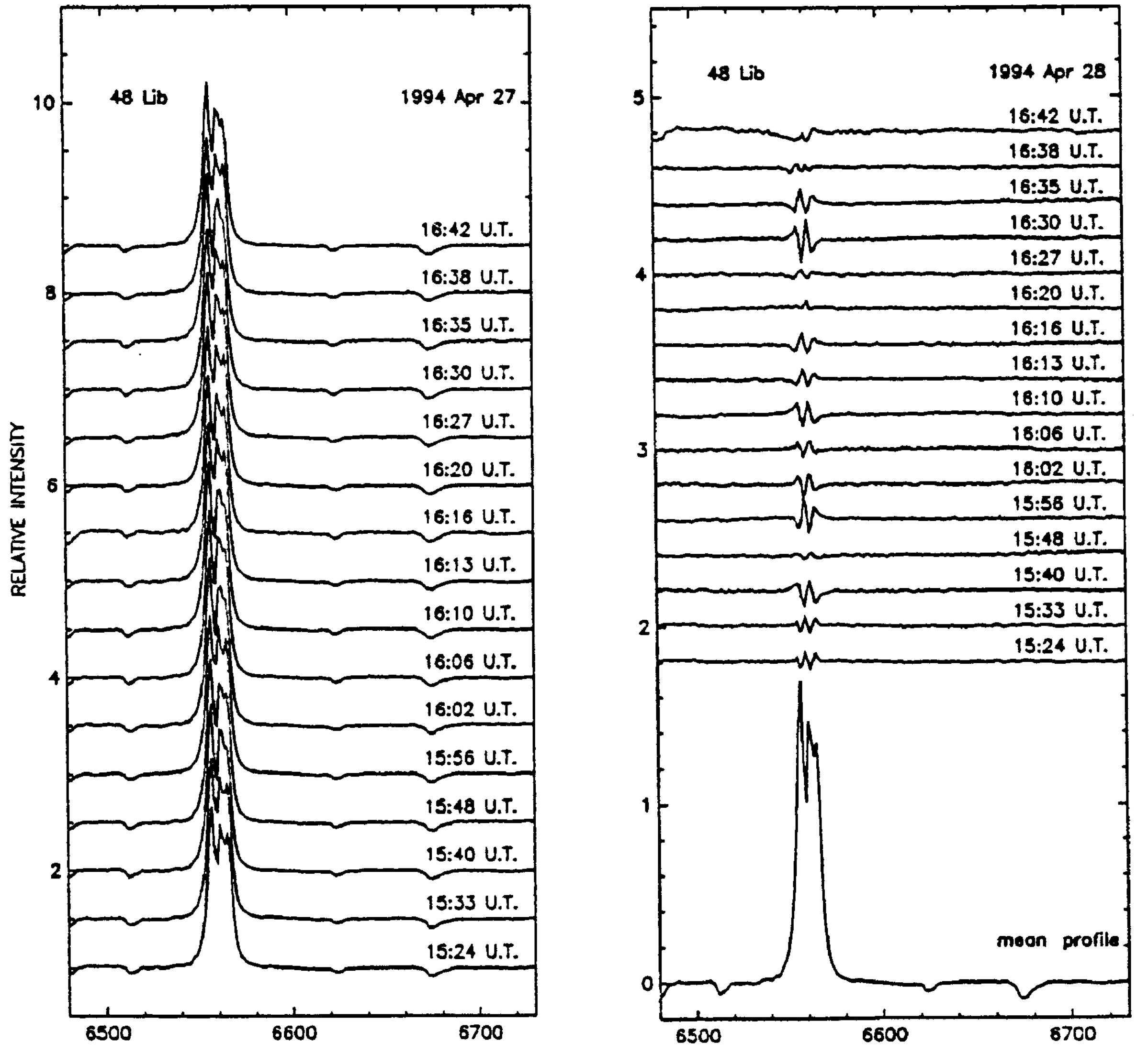

Figure 2

the Hα line-profile variations could be due to the nonuniform distribution of the circumstellar matter. The nonuniform distribution of the circumstellar envelope is possibly related to the violent activity of the emission envelope in the star during 1994 April 27-28. Unfortunately, our resolution is considerably lower and observations are limited only to Hα and HeI λ6678. In order to better understand the details of the variations and throughly investigate the nature of the variations, it is necessary to make high-resolution and high-signal-to-noise-ratio observations of different lines of interest at widely different wavelengths.

YULIAN GUO
Beijing Astronomical Observatory
Chinese Academy of Sciences
Beijing, China

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APT OBSERVATIONS OF SMALL-AMPLITUDE RED VARIABLES

Small-amplitude red variables (SARVs) are M giants which are pulsating with small amplitudes (<2.5 mag) and with periods of 20 to 200 days. SARVs are believed to be part of a sequence of red variables extending from the so-called σ Librae stars (periods 10 - 20 days, V amplitudes typically 0.1 mag) to the Mira stars. Along this sequence of red variables, the incidence of variability, and the period and amplitude of variability, tend to increase with later spectral type, but the correlation is not an exact one.

There are 164 known and 136 suspected variables among the approximately 500 M giants in the Yale Catalogue of Bright Stars. In order to clarify the variability status of these 500 M giants, one of us (JRP) has been conducting a search for SARVs using the 0.4 m "teaching telescope" of the University of Toronto (Percy and Fleming 1992; Percy and Shepherd 1992), and using the American Association of Variable Star Observers (AAVSO) network of photoelectric photometrists (Percy et al. 1994). Several SARVs which had not been assigned to a student observer or to the AAVSO observers were monitored for one season with an automatic photoelectric telescope (APT).

The seven SARVs listed in Table 1 were monitored automatically with the Phoenix 10 0.25 m reflector through the APT Service of the Fairborn Observatory, exactly as described by Percy (1993). Table 1 lists the program (P), comparison (C) and check (K) stars, their properties, the standard deviations of the differential U, B and V magnitudes of the program and check stars relative to the comparison stars, and the assessment of the variability of each star. A few observations were omitted for a priori reasons, e.g. if there was a large internal standard error, if the APT quality control information indicated that the night was a poor one, and/or if the observation was incomplete. The standard deviations of the constant stars (0.005 to 0.01 in B and V, 0.01 to 0.02 in U) are typical for observations of cool stars with this telescope.

In addition to the results given in Table 1, there are the following notes on individual stars; sample light curves are given for three stars:

HR 5123. VAR? (YCBS). The variability is marginal, at best.

HR 5150. VAR? (YCBS). The star varies on time scales of ~20 and >100 days (Figure 1); there is also a distinct peak in the power spectrum at ~6 days.

HR 5154. NSV 06389; V = 4.63 - 4.73 (NSV). We find a similar range. The variability is irregular, with a characteristic time scale of 20 days (Figure 2). The highest peak in the power spectrum is at 18 days.

HR 5215. VAR? (YCBS). The most obvious variability is on a time scale of ~100 days, but there is some evidence for more rapid variability as well (Figure 3).

HR 5226. CV Dra; V = 4.46 - 4.94 (YCBS). Our observations show a much smaller range (but over a limited time interval). The power spectrum shows no dominant peak.

HR 5299. BY Boo; Lb? V = 5.1 - 5.28 (YCBS). The dominant peak in the power spectrum is at 30 days.

Table 1. APT Observations of Small-Amplitude Red Variables.

Star (HR)	SpT	V	σ(U)	σ(B)	σ(V)	Result	ΔV	Period (days)
P 5123	M2 III	5.74	0.0204	0.0096	0.0093	constant?	0.04	
C 5102	G8 III	6.11	–	–	–	constant		
K 5149	G9 III	5.62	0.0091	0.0057	0.0047	constant		
P 5150	M2 III	5.01	0.0546	0.0321	0.0262	variable	0.09	6+longer
C 5111	G6 III	5.73	–	–	–	constant?		
K 5178	K5 III	6.05	0.0373	0.0091	0.0108	constant?		
P 5154	M2 III	4.66	0.0155	0.0170	0.0204	variable	0.08	18?
C 5177	F7 IV-V	6.50	–	–	–	constant		
K 5142	A3 Vn	5.46	0.0075	0.0068	0.0061	constant		
P 5215	M2 III	5.87	0.0307	0.0198	0.0207	variable	0.07	~100?+shorter
C 5195	K0 III	5.62	–	–	–	constant		
K 5161	G5 III	5.98	0.0117	0.0048	0.0085	constant		
P 5226	M3.5 III	4.65	0.0248	0.0352	0.0317	variable	0.10	
C 5256	K3 V	6.37	–	–	–	constant		
K 5213	G3 V	5.96	0.0080	0.0058	0.0045	constant		
P 5299	M4 III	5.27	0.0329	0.0510	0.0547	variable	0.17	30
C 5335	gK3	6.24	–	–	–	constant		
K 5271	K2 III	6.27	0.0232	0.0120	0.0063	constant		
P 5300	M1.5 III	5.25	0.0308	0.0228	0.0230	variable	0.10	19
C 5271	K2 III	6.27	–	–	–	constant?		
K 5280	A2 V	6.15	0.0199	0.0074	0.0136	constant?		

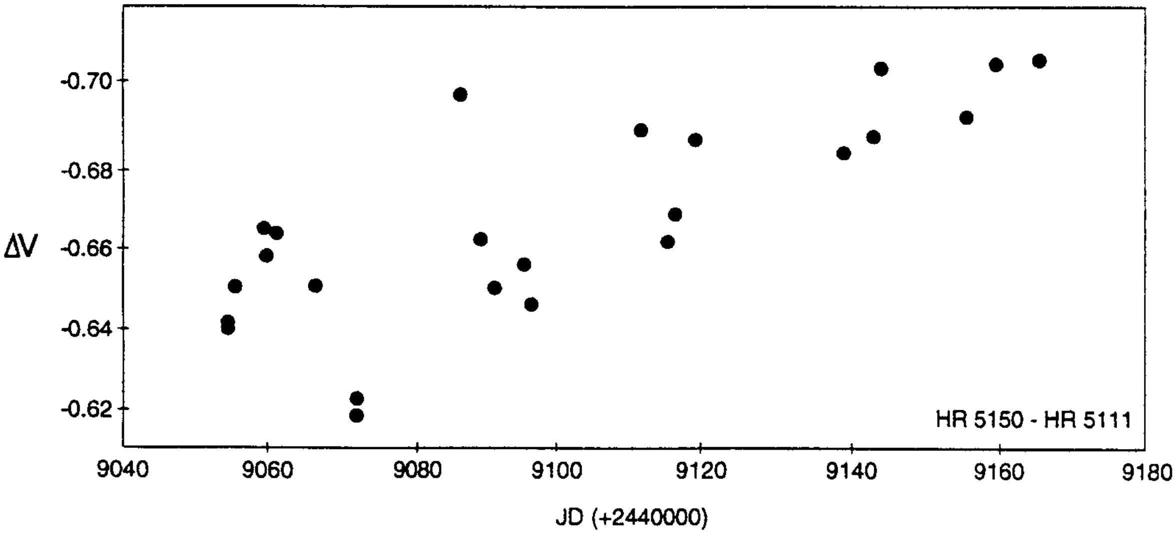

Figure 1. The V light curve HR 5150 relative to HR 5111.
The standard error of the measurements is 0.010.

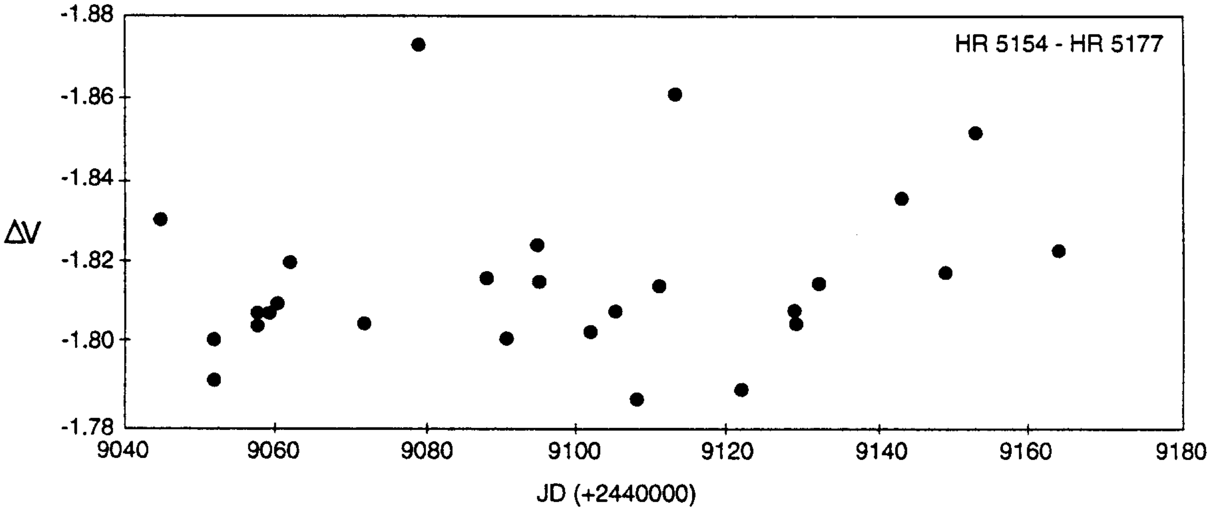

Figure 2. The V light curve of HR 5154 relative to HR 5177.
The standard error of the measurements it 0.006.

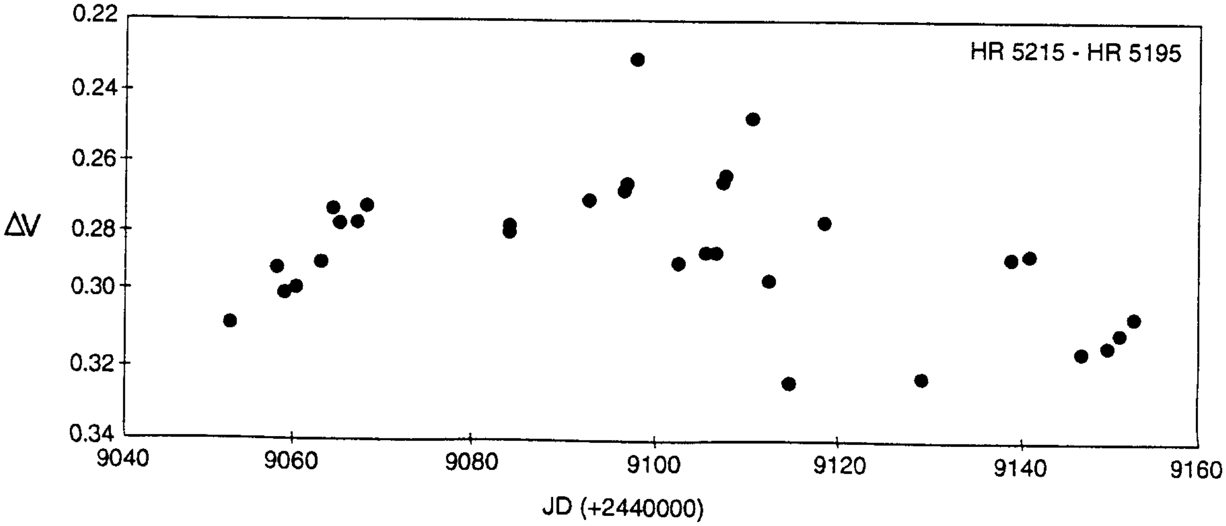

Figure 3. The V light curve of HR 5215 relative to HR 5195.
The standard error of the measurements is 0.008.

HR 5300. CF Boo; m_{pg} = 7.0 - 7.13 (YCBS). The dominant peak in the power spectrum is at 19 days.

Because of the limited span of the observations, it is not possible to derive precise information about the amplitude and time scales of the variability. The observations have, however, given estimates of the amplitude of short-term (days to months) variability which are useful for statistical purposes. Most of these stars are early M giants, and the amplitudes are relatively small, and the time scales short. HR 5150, for instance, shows some evidence of very short time scale variability. A few of the stars show conspicuous time scales of variability of order weeks. At least two show variability on a time scale $\geq$100 days. The origin of these long-term variations is not known. In general, the incidence, amplitude and time scales of variability, as a function of spectral type, are consistent with previous results.

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John R. PERCY
Winnie AU
Erindale Campus
University of Toronto
Mississauga, Ontario
Canada L5L 1C6

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V AND UV PHOTOMETRY OF HD 159176

HD 159176 is a bright ($< V > = +5\overset{m}{.}70$), early (O6 V + O6 V), non-eclipsing binary in the center of the open galactic cluster NGC 6383. Thomas (1975) reported an ellipsoidal variability in the V bandpass and in this contribution we communicate that photometry supplemented by optical and UV data derived from a number of spectral images secured by the International Ultraviolet Explorer (*IUE*).

Table I: V differential photometry of HD 159176

1975	UT	ΔV	s.d.	N	Phase
March	15.367	−1.568	0.004	11	0.244
	16.390	−1.543	0.003	16	0.548
	19.395	−1.539	0.003	11	0.441
	20.328	−1.558	0.003	15	0.718
	21.332	−1.534	0.004	8	0.016
	22.340	−1.563	0.004	7	0.315
	23.293	−1.556	0.003	19	0.590
	24.322	−1.541	0.004	8	0.904
	26.363	−1.547	0.002	15	0.510
	27.243	−1.562	0.004	20	0.772
	29.337	−1.551	0.002	18	0.394
	31.325	−1.534	0.003	16	0.984
April	01.293	−1.557	0.003	16	0.272
	02.297	−1.553	0.003	20	0.570

The Thomas (1975) differential photoelectric photometry, with HD 158859 ($V = +7\overset{m}{.}20$) used as a comparison star, is listed in Table I. *N* is the number of magnitude differences that were averaged to obtain each tabulated magnitude difference, and *s.d.* is their standard deviation. The photometry used the V filter of the UBV system and a 1P21 photomultiplier tube. The magnitudes were derived from capacitor charge integrations displayed on strip chart paper, acquired with the Lowell 0.6 meter telescope at the Cerro Tololo Inter-American Observatory. A second comparison star provided a check on the possible variability on HD 159176. Each tabulated magnitude difference in Table I (HD 159176 minus HD 158859) represents an observing time interval of about 20 minutes. Corrections for extinction did not enter into the calculations. Offset by $+20\overset{m}{.}68$ in the ordinate in order to bring it on scale, this photometry appears as triangles in Figure 1, revealing an ellipsoidal variation with an amplitude of about $0\overset{m}{.}05$.

Table II: V magnitudes and UV data from *IUE* images

Image *SWP*	Phase	1270Å–1350Å ($\times 10^{-10}$)	1420Å–1480Å ($\times 10^{-10}$)	1650Å–1850Å ($\times 10^{-10}$)	FES m_V
45704	0.0467	3.366	2.591	1.801	+5.76
45705	0.0539	3.388	2.608	1.811	+5.77
45708	0.0796	3.379	2.609	1.810	+5.76
45709	0.0880	3.403	2.628	1.810	+5.72
45711	0.1205	3.357	2.599	1.795	+5.77
45712	0.1288	3.423	2.623	1.812	+5.71
45715	0.1535	3.415	2.621	1.809	+5.75
45716	0.1616	3.315	2.558	1.794	+5.77
45719	0.1859	3.421	2.639	1.823	+5.74
45720	0.1937	3.451	2.665	1.857	+5.75
45723	0.2190	3.463	2.672	1.849	+5.73
45724	0.2268	3.478	2.701	1.866	+5.73
45727	0.2521	3.444	2.674	1.848	+5.73
45729	0.2757	3.486	2.693	1.855	+5.75
45731	0.2947	3.489	2.678	1.857	+5.78
45733	0.3203	3.476	2.695	1.849	+5.77
45735	0.3378	3.463	2.656	1.841	+5.78
45794	0.4220	3.233	2.522	1.750	+5.75
45795	0.4294	3.293	2.542	1.768	+5.78
45746	0.6247	3.402	2.591	1.802	+5.76
45748	0.6429	3.423	2.638	1.827	+5.74
45680	0.6826	3.400	2.639	1.817	+5.72
45683	0.7173	3.481	2.675	1.846	+5.73
45686	0.7503	3.512	2.684	1.856	+5.73
45687	0.7574	3.519	2.696	1.861	+5.75
45693	0.9003	3.340	2.570	1.761	+5.76
45694	0.9086	3.383	2.600	1.802	+5.76
45697	0.9333	3.422	2.612	1.811	+5.75
45698	0.9410	3.408	2.610	1.815	+5.72
45701	0.9639	3.376	2.609	1.806	+5.77

Column 1 of Table II lists the image numbers of 30 *IUE* spectra that were secured during three consecutive periods of the binary. These high resolution images were obtained by the *SWP* (Short Wavelength Primary) camera aboard the spacecraft through the large aperture. Phases for the photometry data in the present paper were calculated from the following constant–period ephemeris kindly provided by R. H. Koch:

$$\text{Pri.Min.} = \text{HJD}\,2,448,886.263 + 3\overset{\text{d}}{.}366764 \times \text{E},$$

which is consistent with the optical photometry of Thomas and the accurate radial velocity solution of Stickland et al. (1992) based on the IUE material.

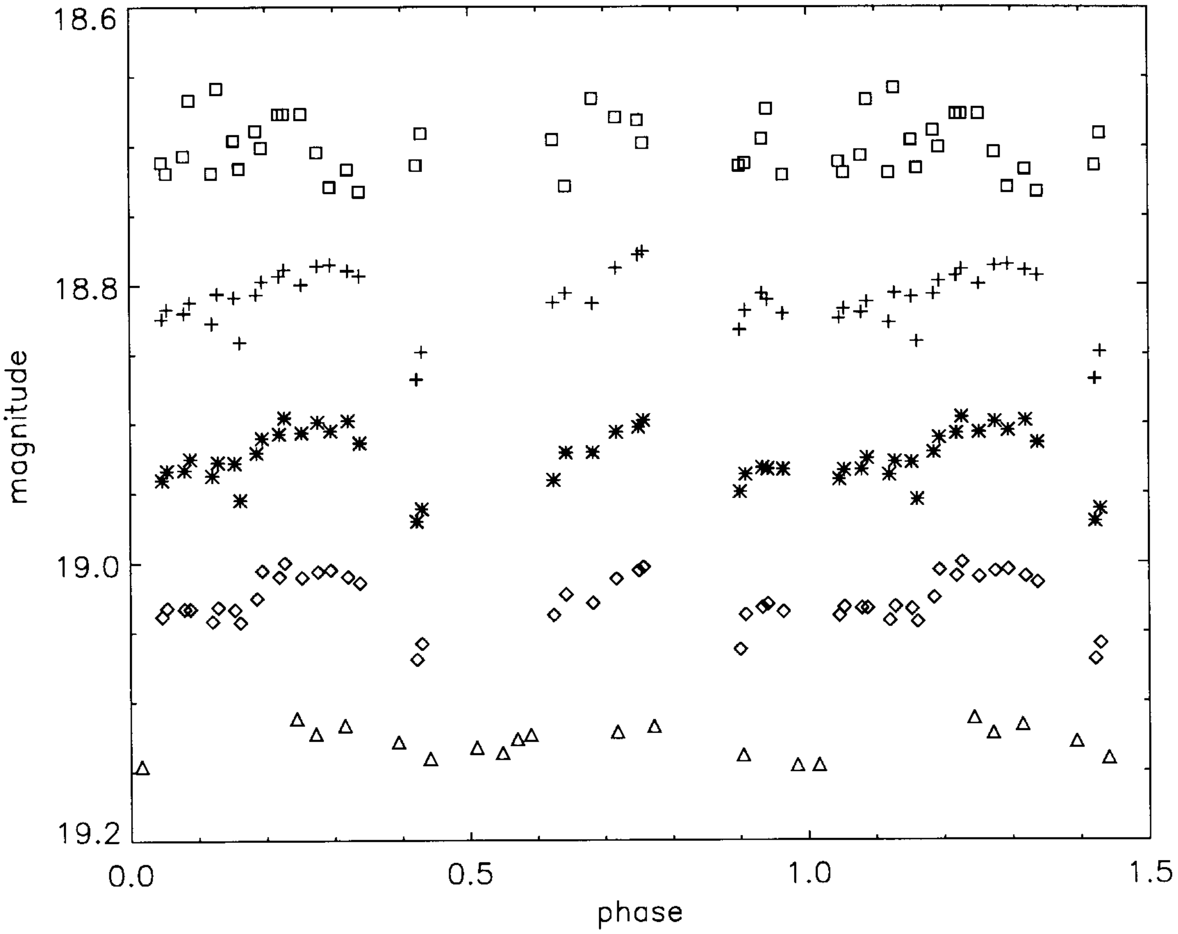

Figure 1

UV light curves were derived from the *IUE* spectral images in the following way. A square filter [1270Å–1350Å] applied on a given spectral image integrated all flux between 1270Å and 1350Å *ie*, filter transmittance is 100% within the bandpass and zero outside). This integrated flux was then divided by the bandwidth (in this case 80Å) to yield average monochromatic flux (in units of MFU) over that bandpass. These measures are listed in column 3, Table II. Two additional data sets, derived in the [1420Å–1480Å] and [1650Å–1850Å] bandpasses, are also listed in Table II. This UV photometry was restricted to the 30 most recent large-aperture, high-dispersion SWP spectral images, since the other archival images were obtained through the small aperture, or span a different (LWP) spectral region, or are of low resolution.

UV magnitudes in each bandpass were computed from the listed fluxes by first multiplying by the bandwidth (yielding fluxes in FU), and then calculating $m_{UV} = -2.5 \cdot log(flux)$. The light curves so computed are displayed in Figure 1, displaced in the ordinate scale by the following quantities to bring them on scale:

crosses: [1270Å–1350Å], by $-0\overset{m}{.}10$
stars: [1420Å–1480Å], by $-0\overset{m}{.}58$
diamonds: [1650Å–1850Å], by $+0\overset{m}{.}43$.

None of the three bandpasses is contaminated by wind lines and the estimated accuracy of the measures is better than ± $0\overset{m}{.}01$.

All three UV light curves are remarkably similar, even though they span almost 600Å. The ellipsoidal variability evidenced in the optical light curve is also present in all three UV data sets at a level of $0^{\mathrm{m}}.05$ to $0^{\mathrm{m}}.08$, depending on the significance attributed to the two fainter measures near phase 0.42 and to the one near phase 0.9.

The Fine Error Sensor (*FES*) is an optical sensor aboard the *IUE* spacecraft intended for target acquisition rather than photometry. Nevertheless, each *IUE* image is supplemented with "*FES* counts" from the source which were converted to the *V* magnitudes listed in Table II, column 6, using *IUE* Data Analysis Center (*IUEDAC*) software. This *FES*-derived photometry, displaced by $+12^{\mathrm{m}}.95$ in the ordinate scale, is displayed in Figure 1 by squares. The errors, commonly claimed to be $\pm\ 0^{\mathrm{m}}.10$, clearly hide the ellipsoidal variability revealed in the Thomas data and in the UV light curves.

J. C. THOMAS
2290 Montezuma Dr.
Campbell, CA 95008
U.S.A.

I. PACHOULAKIS
Department of Physics
and Astronomy
University of Pennsylvania
209 S. 33rd Str.
Philadelphia, PA 19104
U.S.A.

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CF Cas = NSV 14787

During my work on *PICA project* (Precise Identification and Coordinate Adjustment of about 7000 variables) I have found that *CF Cas* is identical with *NSV 14787*.

CF Cas = 347.1931 = SVS 256 is a well known classical cepheid located in the open cluster NGC 7790. It was discovered by Beljawsky (1931) and soon received its final designation (Guthnick, Prager, 1934). From the time of its discovery the star was included in many photometric and spectroscopic researches.

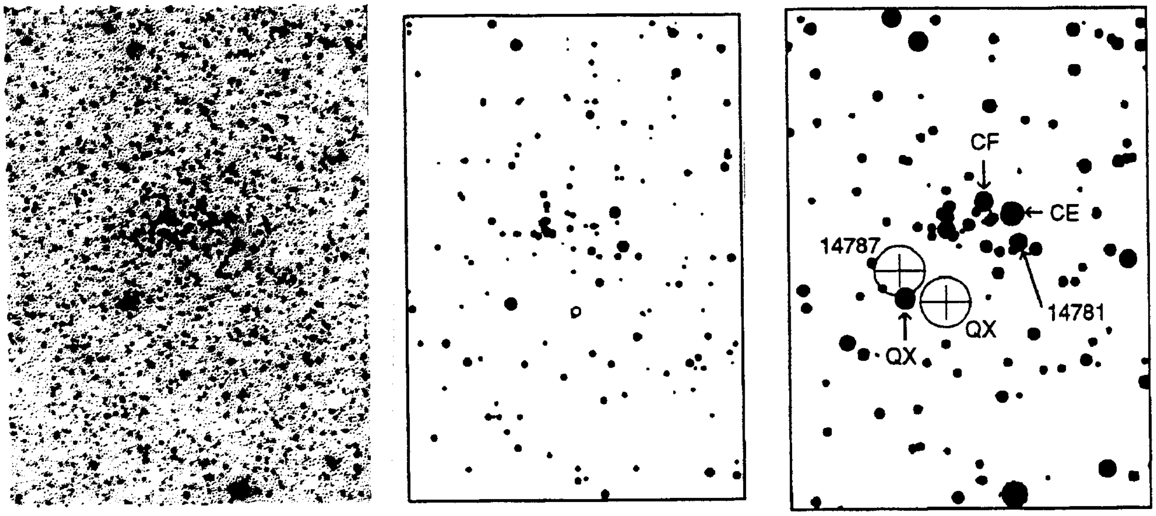
NSV 14787 is listed as star No. 750 in a catalogue of proper motions of stars in the region of open clusters NGC 7788 and NGC 7790 (Ishmukhamedov, 1966). Neither chart nor equatorial coordinates were published for this star in his paper. Later it was included in the New Catalogue of Suspected Variable Stars (Kholopov et al., 1982).

While working on field variable stars around *QX Cas* I have noticed that coordinates reported in NSV for *NSV 14787* are about 1' north of the star I have earlier identified as *QX Cas*. To find additional information, usable for correct identification, I have checked Ishmukhamedov's paper (the only one found for *NSV 14787* at all). He gives there the used procedures and also a catalogue, listing star sequence number, photographic magnitude, approximate *xy* coordinates in mm, proper motion components and a short remark. From the *xy* coordinates and magnitudes I have plotted a chart, covering field around star No. 750 (see Figure 1, in the middle). Comparison of this plot with scanned paper copy of POSS plate O-1233 (Figure 1, left) gave following results :

— star No. 692 without *var* remark was identified as *NSV 14781*.
— star No. 705 without *var* remark was identified as *CEab Cas*.
— star No. 840 with *var* remark was identified as *QX Cas*.
— star No. 750 = *NSV 14787* with *var* remark has no suitable optical counterpart at the plotted position.

From this it is clear that *NSV 14787* cannot be identical with *QX Cas*. From the comparison one can also see that the coordinates given in NSV for *NSV 14787* are erroneous. So where is this star ?

Another comparison of plot and scanned POSS shows that while star No. 750 is superfluous in it's location, one bright star (by chance variable *CF Cas*) is missing on the plot. Close look shows that plotted stars do NOT exactly match their counterparts on the sky. This can explained partly by the fact that catalogue *xy* coordinates are only approximate, having the precision stated to be 0.1 mm, but in fact a bit worse. But such errors can't help us. Therefore I have checked the whole catalogue for evident misprints – and found 13 of these (stars Nos. 87, 113, 161-165, 282, 609, 793, 847, 1055 and 1072), out of 1088 listed stars. I have found also some other misprints in the text part so I have checked the possibility there is a misprint in *xy* coordinates of stars No. 750 and I have found a solution. The printed y coordinate is -6.0, while at -2.0 (and same x coordinate) is the



Left: Scanned POSS plate O-1233. The picture was processed after scanning to eliminate the faintest stars. Middle: Plot from catalogue of Ishmukhamedov (1966). The open circle marks the position of star No. 750 on its original place. Right: Plot from GSC. Arrowed stars are CEab Cas, CF Cas, QX Cas and NSV 14781, while crossed circles mark the (bad) GCVS and NSV positions for QX Cas and NSV 14787. The area covered by all the charts is the same – about 15'×20' with north up.

Table 1. Comparative table of *original* data for NSV 14787, GSC 4281.1902, GSC 4281.1230, CF Cas and QX And. CF Cas and QX And. Data concerning NSV 14787 are from NSV, data for CF Cas and QX Cas are from GCVS, data for CF Cas (Plaut) are by Plaut (1977) and data for GSC 4281.1902 for GSC 4281.1902 and GSC 4281.1230 are from GSC. Photometric system code 1 for GSC represents the Kodak IIa-D plate with W12 filter. Coordinates printed in italics were computed from the above stated data sources.

Name	Position (B1950)		Position (J2000)		Type	Max	Min	Phot.
	h m s	° '	h m s	° ' "		mag	mag	system
NSV 14787	23 56 12	+60 54.0	*23 58 44*	*+61 10.7*	–	12.0		p
CF Cas	23 55 46	+60 56.6	*23 58 18*	*+61 13.3*	δ Cep	10.80	11.47	V
CF Cas (Plaut)	23 55 45.88	+60 56 34.2	*23 58 18.09*	*+61 13 15.9*				
GSC 4281.1902	*23 55 45.79*	*+60 56 34.4*	23 58 18.00	+61 13 16.1		11.00		1
QX Cas	23 55 58	+60 52.8	*23 58 30*	*+61 09.5*	EA/DM	10.19	10.70	V
GSC 4281.1230	*23 56 10.76*	*+60 52 58.3*	23 58 43.20	+61 09 40.0		10.00		1

bright star, having up to this moment no counterpart in catalogue. I suppose these stars are identical for these reasons :

- after correction the match with real star is quite good.
- misprints are often in the paper of Ishmukhamedov.
- star No. 750 has a *var* remark and *CF Cas* is variable.
- the photographic magnitude of star No. 750 does not contradict B magnitudes of *CF Cas*.

Summary information can be found in Table 1. Following cross-identifications are valid:

CF Cas = 347.1931 = SVS 256 = NSV 14787 = Vat ph $23^{h}52^{m}+61^{\circ}$No. 39660 =
GSC 4281.1902

QX Cas = SVS 969 = CSV 5816 = GSC 4281.1230

Jan MÁNEK
Štefánik Observatory
Petřín 205
118 46 Praha Czech Republic
Internet : `observ@earn.cvut.cz`

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PHOTOELECTRIC OBSERVATIONS OF THE CLOSE ECLIPSING BINARY VW CEPHEI

Differential photoelectric photometry of the close eclipsing binary VW Cephei (SAO 9828, M_v=7.45±0.12, B−V=+0.73±0.20) was carried out during the summer 1993 at the station of Capanne di Cosola (AL, Italy). A total of 473 data points were collected in the instrumental V color.

The comparison star was HIC 103219 (SAO 9911, M_v= 6.047±0.031, B−V= +0.934 ±0.015) and the check one was HIC 101824 (SAO 9836, M_v= 7.076±0.031, B−V= +0.934 ±0.015).

Photometry of VW Cephei was carried out with a 200mm Schmidt–Cassegrain f15 telescope equipped with a solid state photoelectric photometer Optec SSP3 operating in the Johnson–Morgan B and V bands.

Five heliocentric times of minimum were computed using the available observations. The heliocentric times of minimum obtained with the Minimum Entropy SOP method (MEMSOP, Gaspani 1993a) are listed in Table 1. The O−C residuals computed with respect to the ephemeris (Navratil, 1994):

$$T_{min}\ (\mathrm{HJD}) = 2448862.5255 + 0\overset{d}{.}27831460\times E \tag{1}$$

are listed in the same table. It is interesting to remark that all the residuals are systematically negative. This means that the ephemeris (1) must be updated in order to satisfy our data.

On the other hand the moments of minima observed by Abbott et al. (1994) as well as Vinkó et al. (1993) give as yet negative residuals of comparable magnitude with respect to the ephemeris (1).

Therefore we computed an updated ephemeris making use of our data as well as the recent data of Navratil (1994), Abbott et al. (1994) and Vinkó et al. (1993) in order to increase the accuracy of the least squares fit.

On the basis of the available times we obtained the following least squares fit:

$$\begin{array}{l} \mathrm{Min.I\ (HJD)} = 2448862.5220 + 0\overset{d}{.}2783076\times E \\ \qquad\qquad\qquad\quad \pm\ 0.0026\ \pm\ 0.0000024 \end{array} \tag{2}$$

Table 2 shows the residuals computed with respect to the ephemeris (2).

VW Cephei is an active close binary whose light curve shows temporal changes. This variability has been interpreted as arising from the presence of dark starspots located mainly on the photosphere of the more massive star of the system (Bradstreet and Guinan, 1990).

After these premises, it seems to be useful to try to recover the true light curve from the noisy data in order to show changes in the height of the maxima, depth of the minima and photometric perturbations.

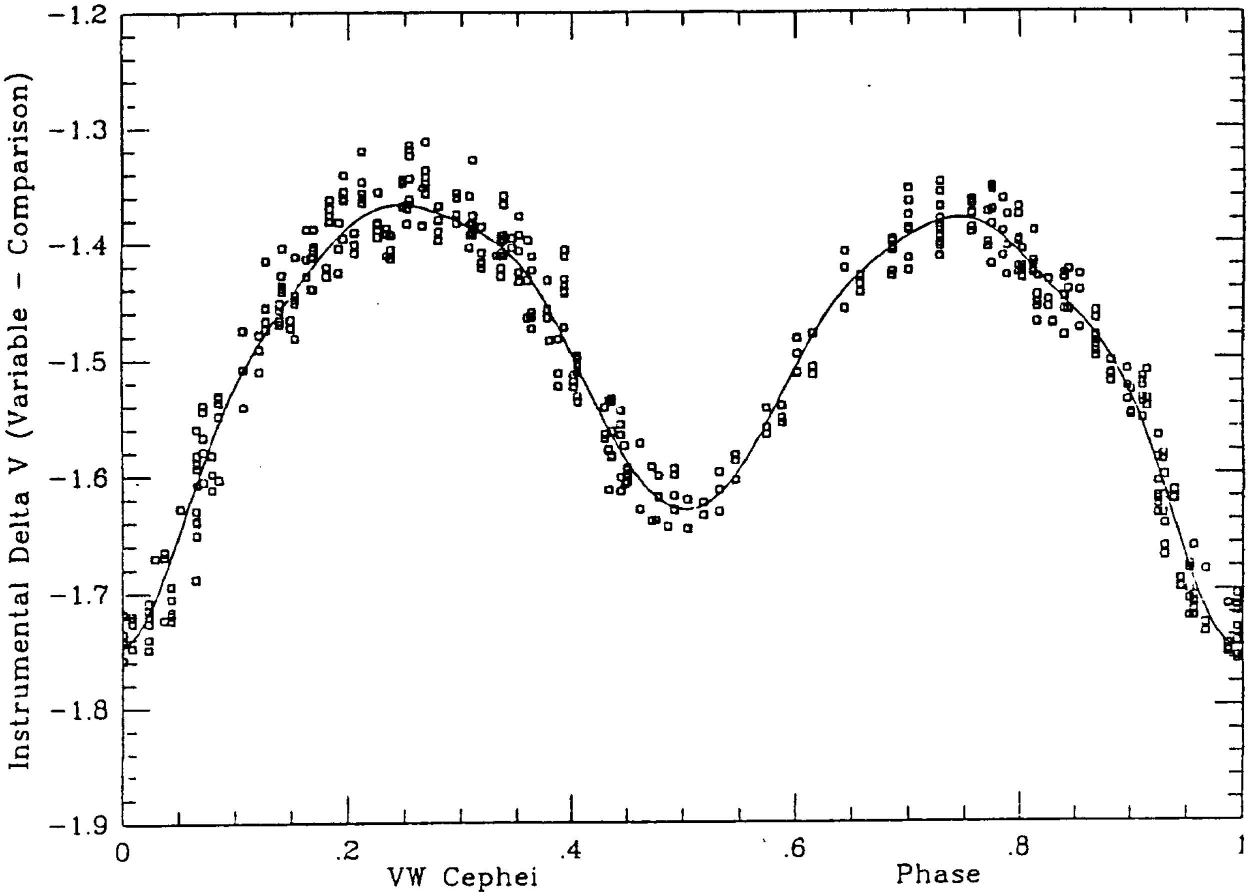

Figure 1. Light curve of VW Cephei. The solid line is the signal restored with the optimum Wiener filter and the squares are the individual data points.

Table 1. Heliocentric times of minimum

Observed Minima	E	O−C	
2449186.479 ±0.003	1164	−0.005	(Min.I)
2449191.479 ±0.008	1182	−0.014	(Min.I)
2449192.457 ±0.006	1185.5	−0.010	(Min.II)
2449192.604 ±0.005	1186	−0.003	(Min.I)
2449193.42 ±0.02	1189	−0.022	(Min.I)

In order to recover a convenient estimate of the true signal from the noisy data we processed the noisy phased data with a signal restoration technique based on the Optimum Wiener Filter Theory (Gaspani, 1993b).

Figure 1 shows the restored light curve, graphed as a solid line across the original data points and Table 3 shows the results obtained.

Table 2. Residuals from the ephemeris (2).

Epoch E	Observed time of minimum JD 2440000+	Residual (O−C)	Source
−7.5	8860.438	0.002	(a)
−0.5	8862.386	0.002	(a)
0.0	8862.525	0.003	(a)
1161.0	9185.637	−0.001	(b)
1164.0	9186.479	0.006	(c)
1164.5	9186.614	0.003	(b)
1165.0	9186.750	−0.001	(b)
1182.0	9191.479	−0.003	(c)
1185.5	9192.457	0.001	(c)
1186.0	9192.604	0.008	(c)
1189.0	9193.420	−0.011	(c)
1261.0	9213.465	−0.004	(d)
1401.0	9252.431	−0.001	(d)
1404.5	9253.405	0.000	(d)

(a) Navratil (1994), (b) Abbott et al. (1994), (c) Aluigi et al. (present paper), (d) Vinkó et al. (1993)

Table 3

	Delta V (VW Cep−HIC 103219)
Primary Minimum	−1.748
Maximum I	−1.367
Secondary Minimum	−1.630
Maximum II	−1.380

Marco ALUIGI
GEOS - 3, Promenade Venezia,
F-78000 Versailles (France)

Gianni GALLI
GEOS - 3, Promenade Venezia,
F-78000 Versailles (France)

Adriano GASPANI
Osservatorio Astronomico di Brera
Via Brera 28, Milano (Italy), and
GEOS - 3, Promenade Venezia,
F-78000 Versailles (France)

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35 NEW BRIGHT MEDIUM- AND HIGH- AMPLITUDE VARIABLES DISCOVERED BY THE TYCHO INSTRUMENT OF THE HIPPARCOS SATELLITE[1]

The HIPPARCOS project will discover a large number of hitherto unknown variable stars, as a side result of a primarily astrometric satellite (for a description see Perryman, 1989, and references therein). The HIPPARCOS main instrument is expected to detect low-amplitude variability in several 10 000 stars, while the TYCHO instrument will scan 1 million stars down to about B=12 for medium- to high-amplitude variations. The four-year lifetime of the satellite ended in August 1993. The reduced data, including the individual photometric measurements of all observed stars, will become available to the general astronomical community in 1997.

Here we present a small list of new bright medium- to high-amplitude variables that became obvious during routine astrometric processing of the TYCHO data. All were checked for known counterparts in the General Catalogue of Variable Stars (GCVS), in the New Catalogue of Suspected Variables (NSV), and in the five name lists of newly designated variable stars issued since 1985 (IBVS 2681, 3058, 3323, 3530, 3840). Ground-based follow-up observations are encouraged to clarify the nature of the stars and to assess the quality of these preliminary TYCHO results. The amplitudes (as observed by TYCHO) are mostly above 0.5 magnitude, with 6 of them exceeding 1 magnitude.

The 35 new variables are listed in Table 1. The columns of the table contain, in turn: the designation of the star in the Space Telescope Guide Star Catalogue, the J2000 position, the observed range of variability in the T magnitude (defined below) and remarks. For each of the stars there are of the order of 100 TYCHO observations in two wavelength bands (close to B and V, respectively). Nevertheless light curve classification from these data is very difficult because the observations are extremely unevenly distributed in time. Table 1 therefore gives only rough indications on the character of the variability.

Among the 35 stars in Table 1 there are six NSV stars (indicated in the remarks column). The TYCHO measurements thus confirm the suspected variability of these objects.

Figures 1 and 2 show the observed light curves for two of the NSV objects as an illustration of the TYCHO data. The T magnitude is a broad-band optical magnitude derived from the sum of the photon counts in the TYCHO B and TYCHO V photometric channels, under the condition that T=B=V if B-V=0. See Halbwachs et al., 1992, for more details.

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[1] Based on observations made with the ESA Hipparcos satellite

Table 1. Results on the 35 new variables

GSC/TIC Id	R.A. 2000	Dec. 2000	T(max)	T(min)	Remarks
8468 104	$0^{h}20^{m}20^{s}\!.2$	$-57°9'48"$	9.37	10.66	
2345 1896	3 19 01.5	32 41 16	7.90	8.33	
8503 158	3 37 44.6	−55 23 47	8.67	10.13	NSV 1214
7572 1544	3 44 18.7	−41 53 52	8.22	8.99	350 days period?
3347 1499	4 48 15.4	47 16 29	9.24	9.77	
3738 234	5 06 31.7	55 21 13	7.73	8.51	periodic, 90 days
2910 447	5 31 26.8	38 19 11	7.54	8.23	
709 46	5 32 54.5	13 03 07	9.04	9.69	NSV 2106
3378 458	6 10 21.3	47 44 22	8.16	8.67	
6513 1712	6 16 01.9	−27 30 34	8.29	9.44	
7102 1296	7 05 13.9	−35 56 23	7.42	8.31	NSV 3379
8143 1629	7 56 20.9	−49 58 55	8.38	9.69	
7132 590	8 01 32.9	−37 11 50	8.06	8.60	400 days period?
8155 343	8 38 01.0	−46 54 16	7.89	9.35	NSV 4166
8585 1054	9 36 14.7	−52 32 41	8.13	8.98	360 days period?
7729 173	11 02 13.9	−41 06 51	7.14	7.55	
8212 1230	11 04 31.4	−51 13 19	8.43	10.00	SRb type?
5511 693	11 15 23.6	−11 35 17	7.62	7.96	periodic?
8653 1082	13 14 08.3	−54 41 35	8.59	9.15	
1466 869	13 43 59.2	21 49 05	8.81	9.73	
2549 677	14 15 58.3	34 26 15	8.91	9.53	
6199 618	15 56 40.1	−22 01 40	8.85	9.83	NSV 7344, R CrB type?
7850 1060	15 57 59.7	−43 57 49	8.94	10.07	NSV 7357
353 301	15 59 05.8	0 35 45	7.51	8.2	eclipsing?
8710 1370	16 01 36.3	−54 08 36	8.67	9.28	slowly variable
7362 894	17 15 15.5	−30 32 14	8.77	9.38	
8353 620	17 21 04.6	−51 07 14	9.47	10.73	
6306 417	19 30 09.6	−19 23 08	8.74	9.28	
5153 387	19 41 07.6	−03 55 10	8.38	9.05	
8782 316	19 43 13.7	−56 15 36	8.25	8.65	
1089 751	20 46 49.3	7 33 11	8.64	9.12	eclipsing?
7987 835	21 25 28.4	−41 42 07	8.26	8.98	periodic?
7990 374	21 54 22.3	−41 15 58	8.59	9.36	
8827 195	22 57 05.8	−57 24 04	7.68	8.71	
8833 1050	23 44 19.2	−54 26 10	8.12	8.74	

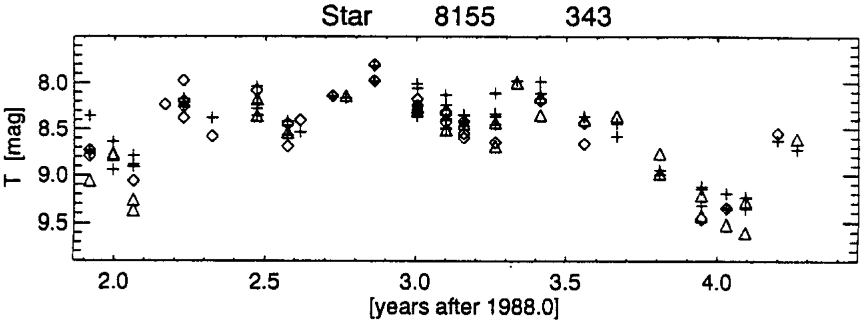

Figure 1: TYCHO light curve of GSC 8155 343 = NSV 4166. All raw observations of the star by TYCHO are shown. The different symbols denote different apertures of the instrument. The T magnitude is defined in the text. The strong clumping of the points is an unavoidable consequence of the (primarily astrometric) measuring schedule of the HIPPARCOS satellite. The scatter of the points within each clump is due to the random measurement errors. They will be somewhat smaller after the final photometric reduction of the TYCHO data. The variability of this suspected variable is confirmed by the data shown here.

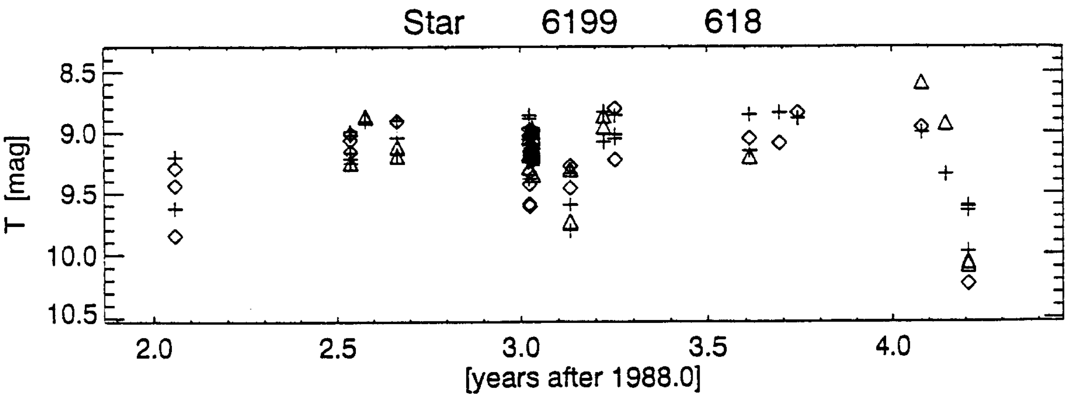

Figure 2: TYCHO light curve of GSC 6199 618 = NSV 7344. Same remarks as for Figure 1

Valeri MAKAROV (1),
Ulrich BASTIAN (2),
Erik HOEG (1),
Volkmar GROSSMANN (3),
Andreas WICENEC (3)

(1) Copenhagen University Observatory, Copenhagen, Denmark
(2) Astronomisches Rechen-Institut, Heidelberg, Germany
(3) Astronomisches Institut der Universitaet, Tuebingen, Germany

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FIVE NEW DHK VARIABLES

My continuing photographic patrol has resulted in the discovery of four more variable stars that are not listed in the General Catalogue of Variable Stars (Kholopov et al., 1985) or the subsequent Name Lists of the Variable Stars (Kholopov et al., 1985, 1987, 1989; Kazarovets and Samus 1990; Kazarovets et al., 1993). Nor are they listed in the New Catalogue of Suspected Variable Stars (Kholopov et al., 1982). In addition, a fifth new variable star, DHK 38, was discovered photoelectrically during observations of Nova Aql 1993 (Green, 1993). Positions and preliminary magnitude ranges, types, and periods are given in Table 1, which continues the list in Kaiser (1992).

I have confirmed photoelectrically the variability of DHK 37, 38, 40 and 41. David B. Williams has examined DHK 37 and 39-41 on the Harvard patrol plates, confirmed their variability, and provided the photographic magnitude ranges cited in the Table. Marvin E. Baldwin has visually monitored the new eclipsing binaries, detected additional minima, and helped to determine the periods. The observations of each star will be published when analysis is completed.

DHK 39-41 were discovered using photographs taken with the newly completed Automatic Photographic Patrol (APP). The APP is an automated camera in equatorial mount controlled by computer. It will be described in detail elsewhere.

Table 1

Var. Designation	RA (1950)	Dec (1950)	Range	Type	P (days)
DHK 37= GSC 2457:0279	$07^h35^m11^s$	32°39' 41"	10.4-11.8 pg	SR:	?
DHK 38=SAO 124400 HD 179624 PPM 167402	19 10 43	01 29 29	9.31-9.69 V	Lb:	–
DHK 39= GSC 2661:1058	19 10 21	35 18 13	10.9-11.6 pg	SR:	?
DHK 40=SAO 46698 BD+49°2630 PPM 56164	17 23 09	49 41 16	9.38-9.87 V	EB	0.530
DHK 41=SAO 76494 HD 284195	04 09 06	21 49 11	8.98-9.4: V	EA	3.176

The APP is supported by a grant from NASA administered by the American Astronomical Society, for which I am most grateful. I would also like to thank David B. Williams and Marvin E. Baldwin for helping to confirm the variability and determine the periods of these stars. The variables were detected using a projection blink comparator (PROBLICOM) as described by Mayer (1977).

Daniel H. KAISER
2631 Washington Street
Colombus, IN 47201
USA

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A FLARE EVENT ON HR 2517[1]

HR 2517 = SAO 114465 (spectral type B II-III, $V = 6.15$) was not known as a variable. It is even listed as "a photoelectric standard with confirmed long-term stability" in the Hipparcos Input Catalogue (Turon et al. 1992). The star was used for more than ten years as comparison star to the Be star V 505 Mon (Vogt & Sterken 1993) in the framework of the "Long-term Photometry of Variables" (LTPV) project (Sterken 1983). HR 2517 also figured as a standard star for the LTPV project, until 1992, when it suddenly brightened by about $0\overset{m}{.}10$ in the y, b and v bands, and by $0\overset{m}{.}15$ in u. As shown in Fig. 1, this flash-like activity is modulated with a period slightly longer than one month, suggesting rotation of a hot spot.

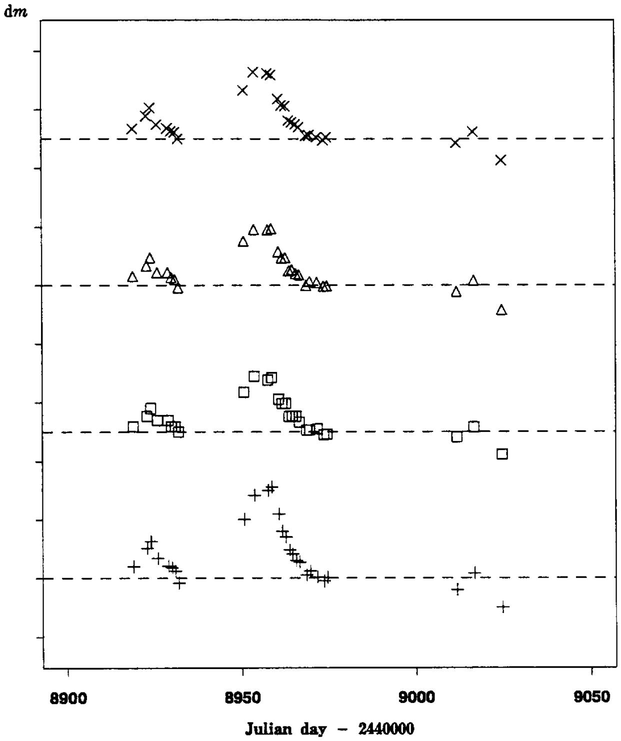

Figure 1

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[1] BASED ON OBSERVATIONS CARRIED OUT AT THE ESO LA SILLA OBSERVATORY

Unfortunately, this increased activity approximately coincided with the end of the observations of the star, so that only two cycles have been monitored. Only a few points have been obtained in 1993, but they show that the star was still active.

Detailed analysis of this flare and of the previous microvariability of HR 2517 is being carried out. We plan to secure more photometric and spectroscopic observations of this object in the following months. Photometric monitoring of HR 2517 by other observers, with special emphasis towards the determination of the duration of the active state, is strongly encouraged.

All data used here will become available in the course of 1995 through the CDS Data Center in Strasbourg.

C. STERKEN[1]
University of Brussels (VUB)
Pleinlaan 2
B-1050 Brussels, Belgium

J. MANFROID[2]
Institut d'Astrophysique
Avenue de Cointe 5
B-4000 Liège, Belgium

[1] Belgian Fund for Scientific Research (NFWO)
[2] Belgian Fund for Scientific Research (FNRS)

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THE LONG TERM PHOTOMETRIC BEHAVIOUR OF THE CATACLYSMIC BINARY HX PEGASI

The photometric history of HX Pegasi has been unclear until now. Green and Kristian (1975) believed (from three scattered observations) the star to have had "remained bright" near V=$13^{\rm m}$ from July 1973 to October 1974 at least. Eachus and Liller (1976) found it "irregularly varying" between B=$13\overset{\rm m}{.}2$ and $16\overset{\rm m}{.}5$ with "no evidence of nova-like activity" on 162 Harvard plates of 70 years. I. Meinunger (1976) was not able to detect the star above threshold of Sonneberg Sky Patrol exposures; this was, however, because she searched at a wrong position (that has nothing to do with the misprint in the heading of her article. Greenstein et al. (1977) called the star "erratically variable". Ringwald (1993) in the course of a thorough spectroscopic investigation caught the object during a rapid ascent of its brightness in one night, followed by a decline in the next one.

Moreover, the star has been included erroneously in the listings of nearby stars of Gliese and Jahreiss (1979) and of Petit (1980), because McCook and Sion (1977) and others took the object for a white dwarf of 13th apparent magnitude.

As this binary deserves special interest because of its probable sdK secondary, I have determined its brightness on a sample of almost 500 Sonneberg Sky Patrol plates taken since 1962 mainly by H. Huth and B. Fuhrmann, and I came to the following results: the long-term light curve is characterized by numerous dwarf-nova-like eruptions up to $12\overset{\rm m}{.}4$ pg (Figure 1). The Mt. Wilson magnitude system of Selected Area 91 served as a standard. From this light curve and from statistical considerations (after Wenzel and Richter, 1986) a mean cycle length C of about 30 days can be derived. Strong secondary fluctuations (range: 0.5 mag, time scale: hours to days) are observed during several high states.

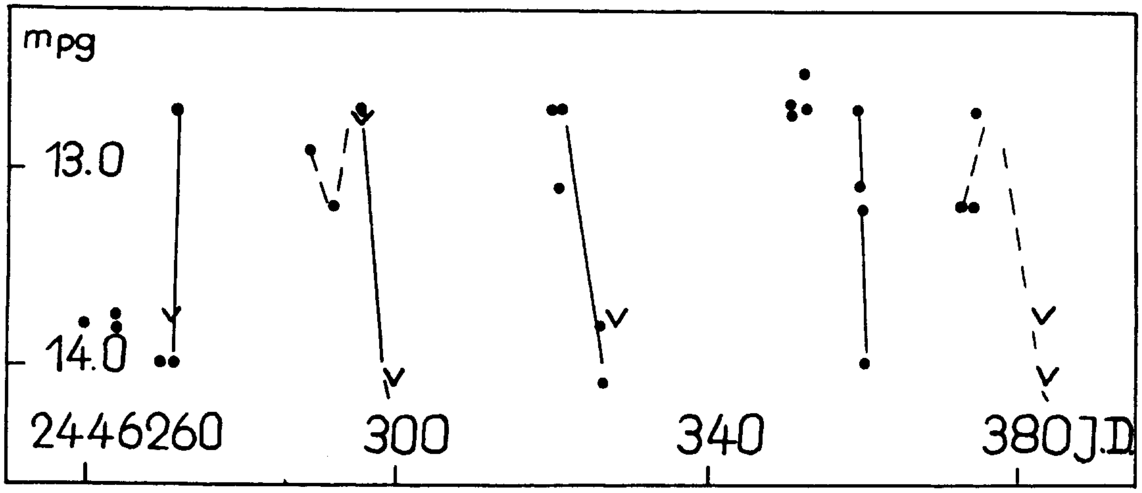

Figure 1

We did not find any short full range eruptions of a length of the order of one day. But, as this might be attributed to the rather limited length of our sample, the nature of the rapid decline observed by Ringwald (1993) is still undecided. If we take into account the faint observations of Greenstein (1986) ($B=17\overset{m}{.}2$) and the minimum data of Eachus and Liller (1976) ($m_{pg}=16\overset{m}{.}5$), an amplitude of about $4\overset{m}{.}5$ pg can be deduced. This is rather large a value as compared with an average taken from the Kukarkin–Parenago relationship for dwarf novae (e.g. Richter and Bräuer, 1989) at C=30 days. Far reaching plates are not at our disposal. We hope that CCD observations which we have been performing at one of the Sonneberg 60 cm mirrors since October 1994 will clear up the low state behaviour and whether there are eclipses.

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W. WENZEL
Sternwarte
D 96515 Sonneberg
Germany

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ECLIPSE CURVES OF UX UMa IN 1992

UX UMa is considered as an example of relative orbital stability for an interacting binary although the shape of its light curve is quite variable. Besides eclipses and flickering Mandel (1965) proposed that the orbital period itself of this eclipsing binary varies with a period of 10600 days.

The presented photoelectric data of UX UMa were obtained during 8 nights at the end of December 1992 and at the beginning of January 1993. The observations were carried out with a 0.6 m telescope of Mt. Suhora Observatory (Poland), equipped with a double beam photometer and an autoguider (Kreiner et al., 1992). In order to satisfy the requirement of the two-channel photometer (that the distance between a variable and a comparison star to be between 10 and 20 arcmin), we used the star marked "B" in Figure 1 as a comparison and BD+52°1720 (marked "N") and BD+52°1722 (marked "C") as check stars. Figure 2 shows that the star "B" is constant.

The data were phased according to the ephemeris of Mandel (1965)

$$\mathrm{MIN} = \mathrm{J.D.(Hel)}2427341.22392 + 0.196671299 \times \mathrm{E} \qquad (1)$$

Some of our eclipse curves are presented in Figure 3. On the right side on every curve is the cycle number introduced in Table 1 (down). The magnitude difference in the sense comparison−variable on the vertical axis is relative to the central curve in every colour. The other curves are moved up or down to get a good visibility. (The U curves are omitted from Figure 3 because their quality is too poor.)

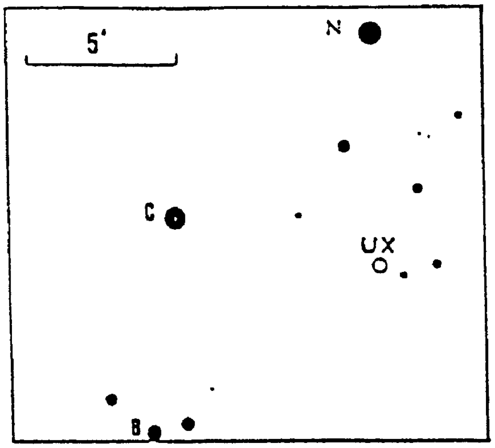

Figure 1

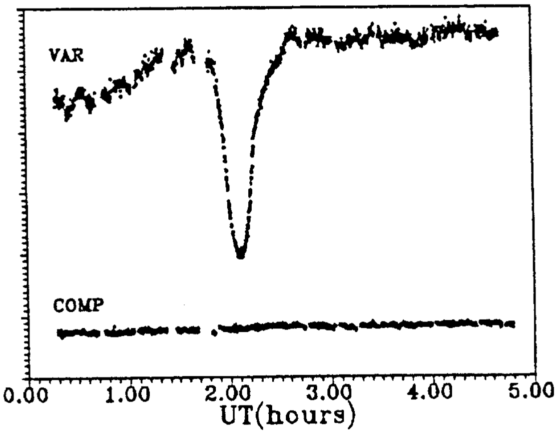

Figure 2

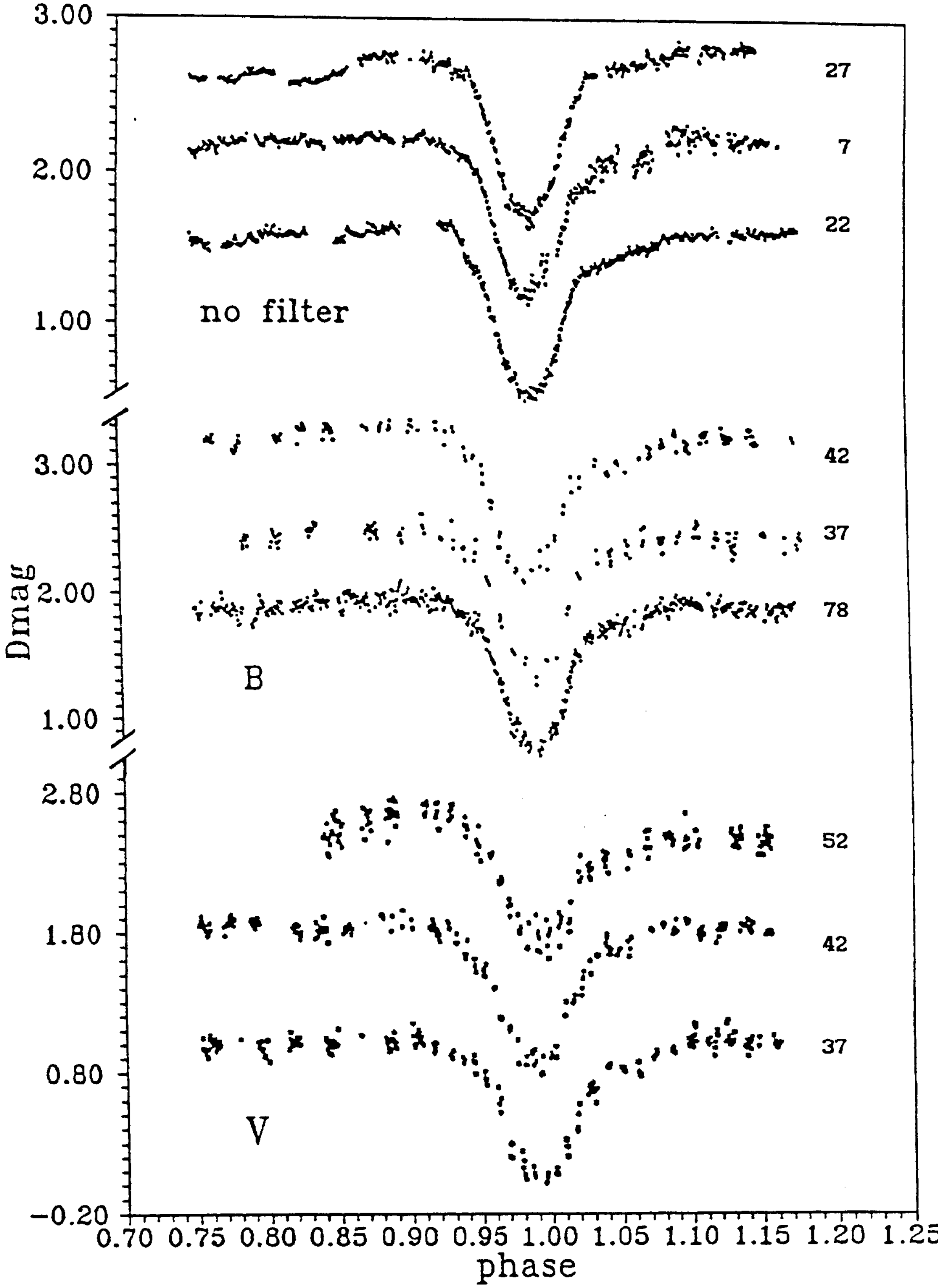

Figure 3

Table 1 includes the observed times of minima with the errors of their determination and respective O−C values according to the ephemeris (1).

Table 1

Cycle number E 110000 +	Filter	Minima J.D.(Hel.) 2448900.+	O−C
7	no	76.63824±0.00015	−0.00194
22	no	79.58831±0.00002	−0.00194
27	no	80.57149±0.00002	−0.00212
31	no	81.35816±0.00003	−0.00213
32	no	81.55583±0.00010	−0.00114
37	U	82.53816±0.00033	−0.00206
37	B	82.53831±0.00042	−0.00191
37	V	82.53844±0.00060	−0.00181
42	B	83.52089±0.00025	−0.00279
42	V	83.52137±0.00022	−0.00231
43	B	83.71715±0.00054	−0.00320
43	V	83.71796±0.00038	−0.00139
52	B	85.48882±0.00014	−0.00157
52	V	85.48858±0.00010	−0.00181
53	U	85.68473±0.00079	−0.00233
53	B	85.68531±0.00030	−0.00175
53	V	85.68539±0.00035	−0.00167
78	B	90.60191±0.00005	−0.00194

Analysis of our eclipse curves allows us to draw the following conclusions:

(1) The times of minima in different colours in the same cycle coincide within the errors of their determination. The small differences between the times of the minima in different colors, when observed simultaneously, show that the minima occur in a sequence U, B and V (except for cycle 52).

(2) The mean phase of our observations relative to the Mandel's 29.02 yr cycle (Nather & Robinson, 1974) is

$$\psi = (\mathrm{J.D.Hel.}-2435000)\times 0.0000934 = 0.32 \qquad (2)$$

Then it turns out that our mean O−C residual value $-0\overset{d}{.}00199$ (marked as a diamond in Figure 4) falls just on the periodic curve adapted from Quigley & Africano (1978), i.e. our observational data support 29.02 yr cycle of UX UMa.

(3) In this observational season we obtain the mean orbital period of $0\overset{d}{.}1966714$. This value is very near to that of Mandel (1965) and Kukarkin (1977).

(4) The shape of the eclipse curves in the same colours changes from cycle to cycle. Usually the bottom of the eclipse is almost symmetric with respect to the light minimum, but in some cases its rising branch is deformed. Similar peculiarities were seen by Warner & Nather (1972);

(5) The mean duration of the whole minima in different colours is about 42 minutes and the mean duration of the stillstand on the ascending branch of the eclipse is about 17 minutes;

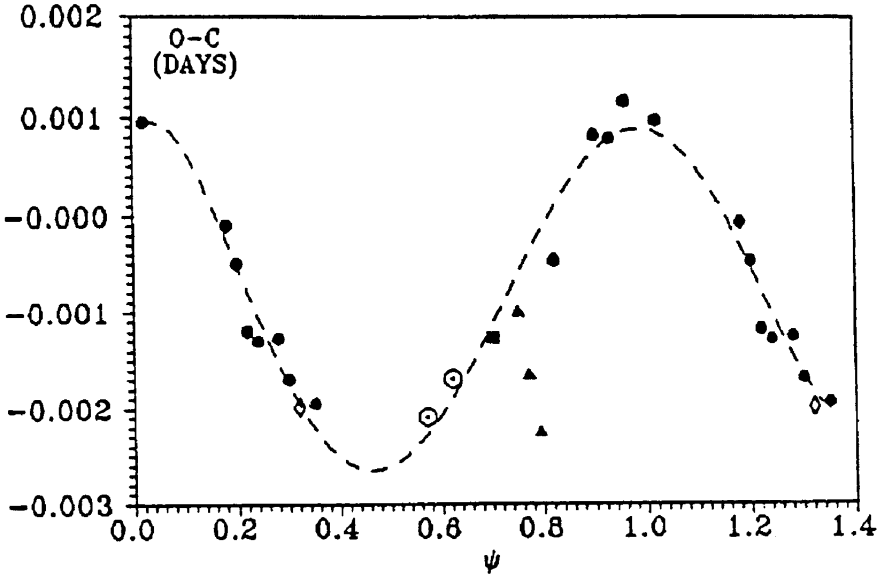

Figure 4. O–C residuals according to Mandel's 29.02 yr cycle

(6) The mean depth of minima in different colours is respectively ΔV=1^{m}; ΔB=$1\overset{m}{.}25$; ΔU=$1\overset{m}{.}5$.

(7) A small stillstand is visible on the descending branch of the eclipse nearly symmetrically to the one on the ascending branch. It is most apparent in the cycles 22 and 42. This feature is more clearly visible in B than in V.

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Diana P. KJURKCHIEVA
Dragomir V. MARCHEV
Shoumen University,
9700 Shoumen,
Bulgaria

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KY Ara IS MISIDENTIFIED

KY Ara was discovered by E. Boyce (Shapley et al., 1939) and was classified as a possible dwarf nova. Finder charts appear in Tsesevitch & Kazanasmas (1971), Wyckoff and Wehinger (1978), and Duerbeck (1987), with the later two being based on the 1971 paper. This 1971 finder chart is based on examination of the original Harvard plates (Tsesevits & Kazanasmas, 1971).

Only one outburst has been seen, in early July 1937 (JD 2428715-721), and this was on four unidentified plates in the Harvard archival plate collection (Shapley et al., 1939). This single eruption was selected from a search through the GCVS as a candidate for being an event similar to those expected from gravitational lensing by a foreground MACHO star. Such events must be color-neutral, time symmetric, and unique. We looked into the case of KY Ara to see if the eruption could be a MACHO event.

Photometry of the star identified by Duerbeck (1987) was performed at the Cerro Tololo Inter-American Observatory on 25 July 1994. The brightness of this star was measured with various standard filters as U=16.88, B=16.82, V=16.21, R=15.82, and I=15.45 with uncertainties of roughly 0.02 magnitudes. These are the normal colors of a G0 main sequence star, not those of a dwarf nova.

Table 1

Plate	JD	Comments on brightness of KY Ara
A 19438	2428692	KY Ara invisible, G0 star visible
A 19446	2428694	KY Ara invisible, G0 star visible, poor plate
A 19456	2428696	KY Ara invisible, G0 star visible
MF 23368	2428699	KY Ara invisible, G0 star visible
MF 23383	2428701	KY Ara invisible, G0 star visible
MF 23387	2428703	KY Ara invisible, G0 star visible
A 19530	2428715	Discovery plate, B$\sim$15.8, KY Ara is to east of G0 star
B 62154	2428716	Poor plate limit, consistent with plate A 19530
A 19538	2428716	KY Ara slightly brighter than G0 star, B$\sim$16.5
MF 23447	2428719	Neither KY Ara nor G0 star visible
A 19546	2428719	KY Ara roughly equal to G0 star in brightness
A 19553	2428721	KY Ara roughly equal to G0 star in brightness
MF 23469	2428721	Neither KY Ara nor G0 visible, poor plate limit
MF 23481	2428722	KY Ara invisible, G0 star visible
A 19568	2428727	Neither KY Ara nor G0 star visible
A 19594	2428741	KY Ara invisible, G0 star visible
MF 23642	2428755	KY Ara invisible, G0 star visible

We then examined the original records and plates at Harvard. Table 1 summarizes the relevant plates. The discovery plate was A 19530, wich displayed a well-formed significant image of KY Ara. The other three plates with images of KY Ara are A 19538, A 19546, and A 19553, although the variable is close to the plate limit in all three cases. The existence of four good images at the same location over a six day period convinces us that KY Ara is indeed a true variable star.

KY Ara is identified in the original notes of E. Boyce as the following star of a double. Examination of plate A 19530 shows this to be true, with the preceding star being the G0 star mistakenly identified in later finder charts. The origin of this mistake arises from the chart of Tsesevich & Kazanasmas (1971) which correctly depicts the discovery plate, yet has the circle centered on the preceding star. Subsequent finder charts merely followed this first chart.

Terry Girard (Yale University) made PDS astrometric scans of plates A 19530, A 19538, and the ESO sky survey plate. These confirm that the preceding star is the G0 star. KY Ara is found to be roughly 1 magnitude brighter than the G0 star, or B$\sim$15.8, on the discovery plate. The position of KY Ara is $9\overset{''}{.}5$ east and $4\overset{''}{.}2$ south of the G0 star. With the position of the G0 star reported by Wyckoff and Wehinger, the 1950.0 coordinates for KY Ara are $18^{\rm h}4^{\rm m}9\overset{\rm s}{.}5$ $-54°56'$ $50\overset{''}{.}3$. Examination of the sky survey plates shows this position to be empty to below B magnitude 20. Examination of our CCD images from Cerro Tololo show the position to be empty to below B magnitude 21. Thus, the amplitude of KY Ara is greater than approximately 5 magnitudes.

The true nature of KY Ara is unclear. The amplitude, duration, and singularity of the 1937 event are consistent with the Boyce's suggestion of a dwarf nova (with a large amplitude and rare outbursts). Alternatively, since there is only one observed maximum, KY Ara could be a fast nova or even a large amplitude MACHO event.

Bradley E. SCHAEFER
Dorrit HOFFLEIT
Departments of Physics and
Astronomy
Yale University
New Haven, Connecticut 06520-8101
USA

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GENEVA PHOTOMETRY OF THE ECLIPSING BINARY TV Nor

The eclipsing binary HD 143654 = TV Nor has been brought to the attention of spectroscopists by Renson (1990) because it has been classified Ap EuCrSr by Houk (1978). Indeed, there is as yet no clear-cut case of an Ap star of the Si or SrCrEu type belonging to an eclipsing system. This is probably because of the lack of short period binaries among this kind of peculiar stars (see e.g. Gerbaldi et al. 1985). However, such a system would be most interesting, because it is known that the abundance anomalies are not evenly distributed on the surface of the star, but are concentrated into patches following the large-scale magnetic structure. Many Ap stars are therefore spectrum variables simply because their rotation brings these patches into view and away from it; the art of "Doppler imaging" exploits the resulting line variations to map the abundance anomalies on the surface of the star. Such maps, however, present ambiguities, especially regarding the latitudes of the patches. Observing an Ap star undergoing an eclipse by a normal, constant companion would help to remove the ambiguities, and even to build an independant map of the eclipsed hemisphere for the corresponding rotational phase (Piskunov & Rice, 1993; Vincent et al., 1993).

In the hope that HD 143654 could be such a rare system, we monitored it with Geneva photometry in order to obtain a good quality lightcurve. All measurements have been made from the European Southern Observatory, La Silla, Chile, with the double-beam "P7" photometer attached to the 0.7m Swiss telescope. The first three, routine measurements were made as early as 1982, 1983 and 1984 respectively, and 5 additional measurements were made in April 1989 by the late Dr. Zdenek Kviz. Systematic monitoring began essentially in June 1990, stimulated by Renson's IBVS note, and continued each following season until July 1994.

We expected that this well-detached system would present periodic variations outside the eclipses, due to the intrinsic variations of the Ap component. The result is, however, disappointing from this point of view, as shown in Figure 1 which displays the [U-B], [B-V] and V curves. Outside the eclipses, the r.m.s. standard deviations are respectively 0.0090, 0.0049 and 0.0047, which can be entirely attributed to measurement uncertainties. Thus, neither the primary nor the secondary is photometrically variable in a significant way, making any spectral variation rather improbable.

It is interesting to notice that the minima have different depths in V and vary in opposite ways in [B-V], while [U-B] remains constant. This means that the components have significantly different effective temperatures and spectral types. The primary is probably an early or mid- A dwarf while the secondary may be an A8 or F0 giant. This fact is probably significant regarding the Ap classification: the spectrum appears composite, and was very likely misinterpreted as that of a single Ap EuCrSr star.

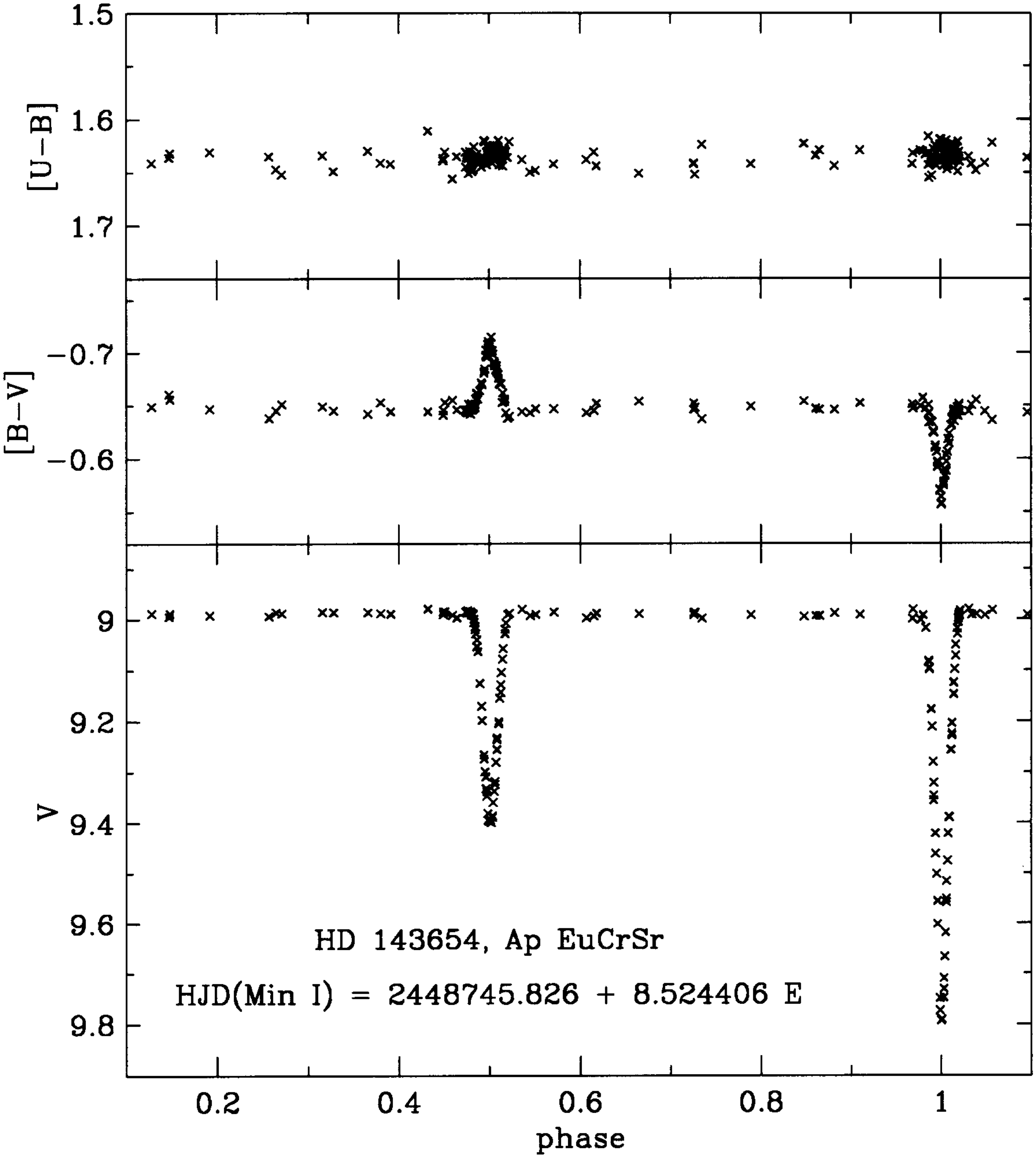

Figure 1. Geneva [U-B], [B-V] and V lightcurves of the eclipsing binary TV Nor, folded according to the period of Hertzsprung (1937). Notice the lack of variability between the eclipses.

This is confirmed by the behaviour of the peculiarity parameter $\Delta(V1-G)$ as a function of phase: while this parameter is generally positive for Ap stars (see e.g. Hauck & North 1982), it remains here at the constant value

$$\Delta(V1 - G) = -0.006$$

with an r.m.s. residual scatter of only 0.0055 magnitudes. There is no significant variation at all during the eclipses. Therefore, the $\Delta(V1 - G)$ value of not only the whole system, but also of each component of TV Nor is quite typical of normal stars.

Furthermore, one of us (PN) has taken a spectrum of this system with the 1.4m CAT telescope of the European Southern Observatory, equipped with the CES spectrograph, the Long Camera and the FA 2048 CCD detector (ESO CCD # 30). The resolving power was R = 60000. The spectrum was taken in the H_α region on the night of May 16-17, 1994 at HJD = 2449489.607, i.e. at phase $\phi = 0.2531$ according to the ephemeris given in Figure 1. This is practically at a quadrature and allows us to estimate the total mass of the system from the relative velocity at that phase and from the Kepler's third law. Fitting a gaussian to the core of the H_α line of each component, we obtain $\lambda_p = 6560.984$Å and $\lambda_s = 6564.447$Å, implying a relative velocity $\Delta V_r = 158.2$ km s^{-1}. If the orbit is circular, which is very probably the case since the eclipses have the same duration and are separated by exactly half a period, and if the inclination i of the orbital plane is close to 90° as the very existence of deep eclipses suggests, then we obtain for the semi-major axis

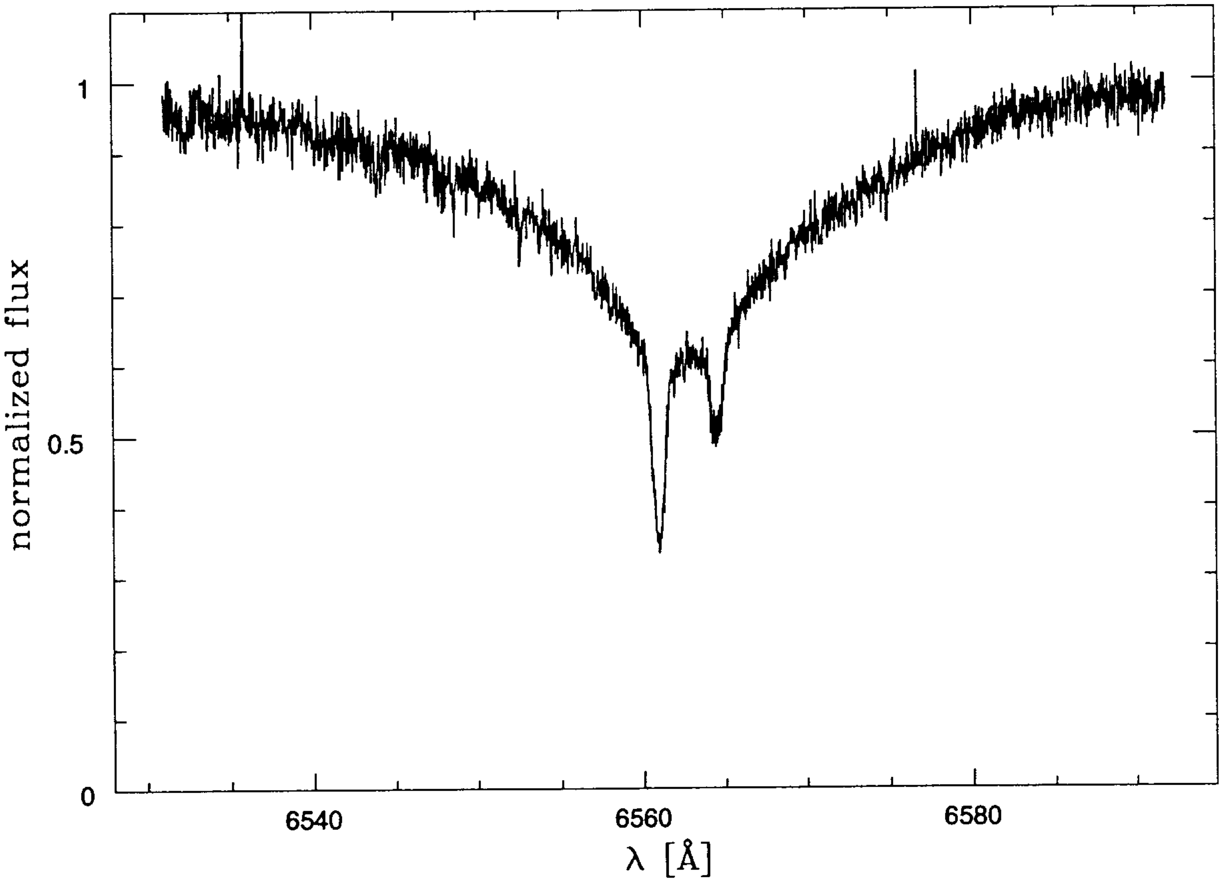

Figure 2. High-resolution spectrum of TV Nor taken at orbital phase 0.253, i.e. at quadrature, and showing the star as a double-lined system.

$$a = 0.124 \text{ AU}$$

and for the total mass

$$M_p + M_s = 3.50 M_\odot$$

which is quite consistent with the spectral types and luminosity classes proposed above for the two components.

This binary may well be spectroscopically normal, which would designate it as a very good candidate for precise mass and radius determination.

Acknowledgements: This work was supported in part by the Fonds National de la Recherche Scientifique. Drs. Z. Kviz, P. Lampens and Mrs. C. Nitschelm and F. Barblan contributed to the photometric observations, which were reduced by Mr. C. Richard.

P. NORTH
Institut d'Astronomie de l'Université
de Lausanne
CH-1290 Chavannes-des-Bois,
Switzerland

M. BURNET
Observatoire de Genève
CH-1290 Sauverny, Switzerland

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TEN NEW VARIABLE STARS IN HERCULES AND CORONA BOREALIS

Ten new variables were discovered using the positive-negative method in a field 10°×10° centered on η Her ($\alpha=16^{\rm h}40^{\rm m}$, $\delta=+39\overset{\circ}{.}$, 2000).

Our study was based on Moscow collection plates taken with the 40 cm astrograph in Crimea.

Table 1 contains coordinates and GSC identifications of new variables (for GSC stars, the coordinates are taken from GSC). Table 2 presents for each star: number of observations and time interval covered (n and JD); maximum and minimum brightness (B band); type of variability and light elements. Magnitudes of comparison stars, presented in Table 3, were obtained using a standard near M13 (Arp and Johnson, 1955) with improved photometry from Forbes and Dawson (1986). Finding charts and light curves of the periodic variables are presented in Figures 1 and 2, respectively.

Sincere thanks are due to S.Yu. Shugarov for the software used for period determinations. This study was partially supported by the Russian Foundation for Fundamental Research through grant No. 93-62-17108.

Table 1

Star	$\alpha_{(2000)}$	GSC	
Var 1	$16^{\rm h}49^{\rm m}44\overset{\rm s}{.}2$	39°38'57"	
Var 2	16 35 33.9	41 06 50	
Var 3	16 27 45.4	41 40 23	3066.0251
Var 4	16 25 16.3	40 53 49	3065.0704
Var 5	16 35 11.2	42 46 26	
Var 6	16 16 59.5	39 38 37	3062.0786
Var 7	16 19 14.1	39 39 98	3062.0052
Var 8	17 02 38.3	39 32 27	
Var 9	16 59 50.5	41 11 14	3075.0202
Var 10	16 59 36.7	41 57 25	3079.0534

Remarks for individual stars

Var 4. Period varies. The data from JD 2441750 to 45960 are used in Fig. 2 for Var 4. Seven latest observations (2447027–48778) are not represented with the elements. $l=64\overset{\circ}{.}79$, $b=+44\overset{\circ}{.}35$, confirming the suggested CWA classification.

Var 7. Blazhko effect.

Var 9. Red on Palomar charts. Fragments of the light curve are given in Fig. 3. A brightness decrease during JD=2441782–41813 resembles an eclipse.

Var 10. A secondary minimum exists. $D=0\overset{\rm P}{.}1$. Primary minima:

JD=2441565.28
41570.28
41840.42
41947.33
41952.36
42212.43
42217.43
42309.24
42365.16
42686.28
42869.47
42920.50
43017.38
43659.43
43807.20
43934.54
45524.36
45529.39
45580.30
45585.34
45911.39
47027.32
47679.44

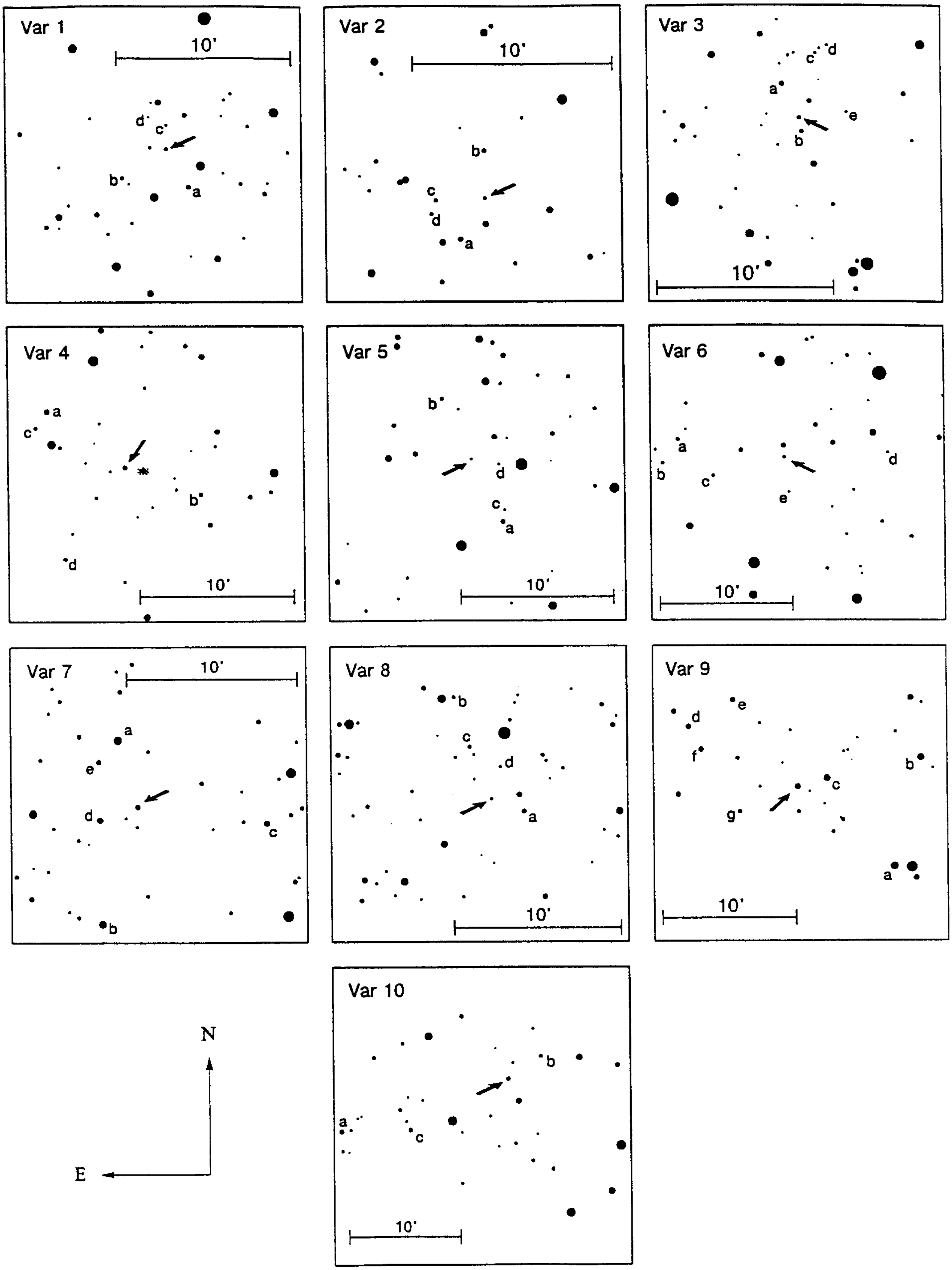
Var 1
10'
d
c
b
a
Var 2
10'
b
c
d
a
Var 3
c
d
a
e
b
10'
Var 4
a
c
b
d
10'
Var 5
b
d
c
a
10'
Var 6
a
d
b
c
e
10'
Var 7
10'
a
e
d
c
b
Var 8
b
c
d
a
10'
Var 9
e
d
f
b
c
g
a
10'
Var 10
b
a
c
10'
N
E

Figure 1

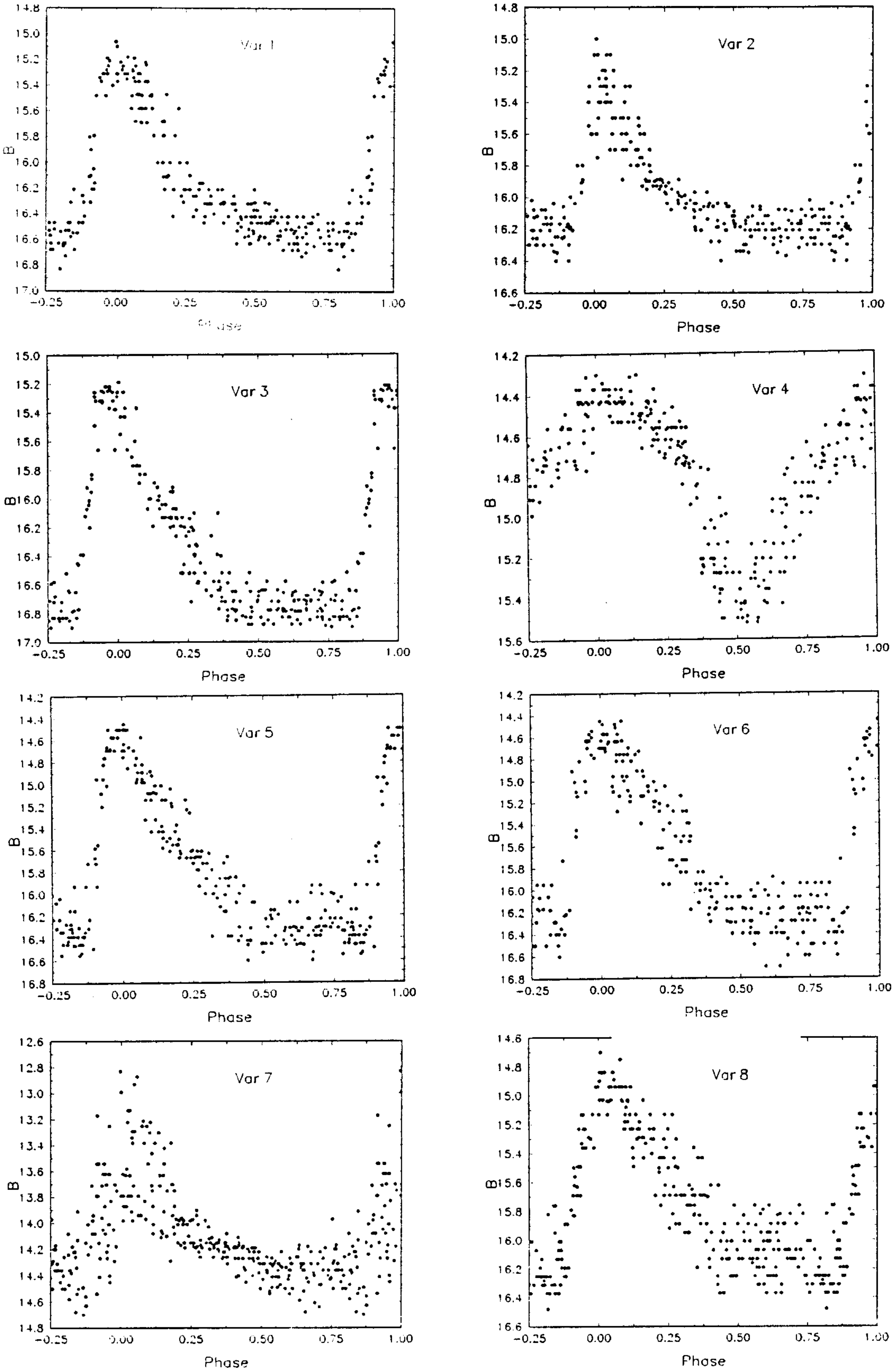
Var 1
B
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
16.8
17.0
−0.25
0.00
0.25
0.50
0.75
1.00
Phase
Var 2
B
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
Phase
Var 3
B
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
16.8
17.0
Phase
Var 4
B
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6
Phase
Var 5
B
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
16.8
Phase
Var 6
B
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
16.8
Phase
Var 7
B
12.6
12.8
13.0
13.2
13.4
13.6
13.8
14.0
14.2
14.4
14.6
14.8
Phase
Var 8
B
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
Phase

Figure 2

Table 2

Star	n	JD 24...	Type	B_{pgMAX}	B_{pgMIN}	Light elements
Var 1	240	41750–48778	RRab	$15^{\rm m}.1$	$16^{\rm m}.8$	JD_{MAX}=2447296.48±$0^{\rm d}.704545$×E
Var 2	238	41750–48778	RRab	15.1	16.4	JD_{MAX}=2441837.42±$0^{\rm d}.532464$×E
Var 3	239	41750–48778	RRab	15.2	16.9	JD_{MAX}=2442363.20±$0^{\rm d}.488907$×E
Var 4	254	41750–48778	CWA	14.3	15.5	JD_{MAX}=2445616.20±$15^{\rm d}.501$×E
Var 5	244	41750–48778	RRab	14.5	16.6	JD_{MAX}=2443969.49±$0^{\rm d}.502775$×E
Var 6	229	41750–48778	RRab	14.5	16.7	JD_{MAX}=2445588.35±$0^{\rm d}.578174$×E
Var 7	312	37080–48778	RRab	12.9	14.6	JD_{MAX}=2442633.43±$0^{\rm d}.480107$×E
Var 8	299	37087–48778	RRab	14.8	16.4	JD_{MAX}=2444849.30±$0^{\rm d}.568397$×E
Var 9	322	37087–48778	?	12.1	14.2	
Var 10	315	37087–48778	EA	12.95	14.1	JD_{MIN}=2442217.42±$5^{\rm d}.0952$×E

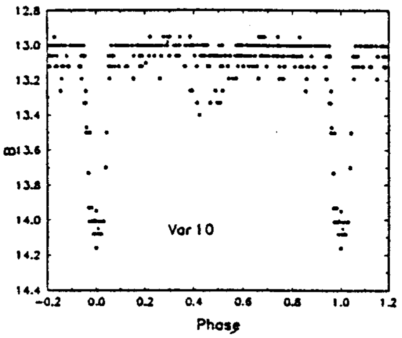

Figure 2 (cont.)

Table 3

Star	a	b	c	d	e	f	g
Var 1	14.75	15.37	16.42	16.94			
Var 2	14.90	15.89	16.08	16.52			
Var 3	14.88	15.26	15.83	16.13	16.78		
Var 4	14.00	14.62	14.77	15.50			
Var 5	14.57	15.20	15.78	16.53			
Var 6	14.20	14.82	15.28	16.40	17.50		
Var 7	12.43	12.05	13.87	14.22	14.68		
Var 8	14.26	15.23	15.89	16.48			
Var 9	11.80	12.21	12.32	12.84	13.34	13.49	14.42
Var 10	12.73	13.54	14.32				

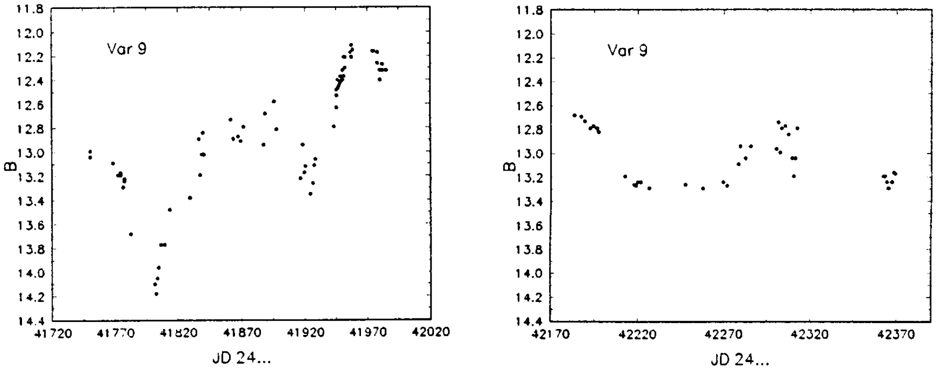

Figure 3

S. V. ANTIPIN
Sternberg Astronomical Institute
13, Universitetskij Prosp.
Moscow 119899, Russia

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PHOTOELECTRIC OBSERVATIONS AND MINIMA TIMES OF FOUR W UMa SYSTEMS: LS Del, SW Lac, V839 Oph AND AQ Psc[1]

During the Summer School of Young Astronomers held at Ankara University Observatory, between 22 Aug.-3 Sept. 1994, four W UMa systems: LS Del, SW Lac, V839 Oph and AQ Psc were observed in B and V filters using a single channel unrefrigerated SSP-5 photometer attached to the 30 cm Maksutov telescope. The observations were carried out by the 28 participant students (six groups in turn) and some colleagues of the Ankara University Observatory, as part of the Summer School program. The school was sponsored by The Ankara University Science Faculty, The Ankara University Graduate School of Natural and Applied Sciences, The Technical and Research Council and The Turkish Astronomical Society.

The identification and general properties of program stars are listed in Table 1, where Sp, No, T_0 and P stand for the spectral type of the system, number of observations obtained in each filter, epoch and orbital period used in phase calculation. Each observation comprises three five second integrations through B or V filter in sequence comparison-sky-variable-sky-variable-comparison-sky with occasional interruptions for background and check star measurements. Typical r.m.s. error of a single observation is around 0.01 mag. The control of the photometer head, data acquisition and data reduction for atmospheric extinction and heliocentric correction were carried out with a software prepared by Müyesseroğlu (1992). The light and color curves of the program stars by using the light elements from Table 1 are shown in Figures 1, 2 and 3. Part of the scatter in observations (see figures) is due to night to night light variations. The observations of AQ Psc cover only the phase interval 0.46-0.86 around secondary minimum.

Table 1. Identification and general properties of the program stars.

LS Del	SW Lac	V839 Oph	AQ Psc	
Var. Star	BD+19°4574	BD+37°4717	BD+09°3584	BD+06°0203
Comp. Star	BD+19°4568	BD+37°4715	BD+09°3578	BD+05°0177
Check Star	BD+19°4576	BD+37°4711	BD+09°3590	BD+06°0204
Sp	G5	G8V+G8V	F8V	F8V
No	132	335	379	133
T_0	47790.42696	49594.4684	49590.3794	44562.4691
P	0.363840	0.3207209	0.40899532	0.47564
Reference	Demircan et al. 1991	Pena et al. 1993	Niarchos 1989	Sarma and Radhakrishnan 1982

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[1] Paper dedicated to research assistant H. Dündar who died after ulcer operation on 25 of September 1994

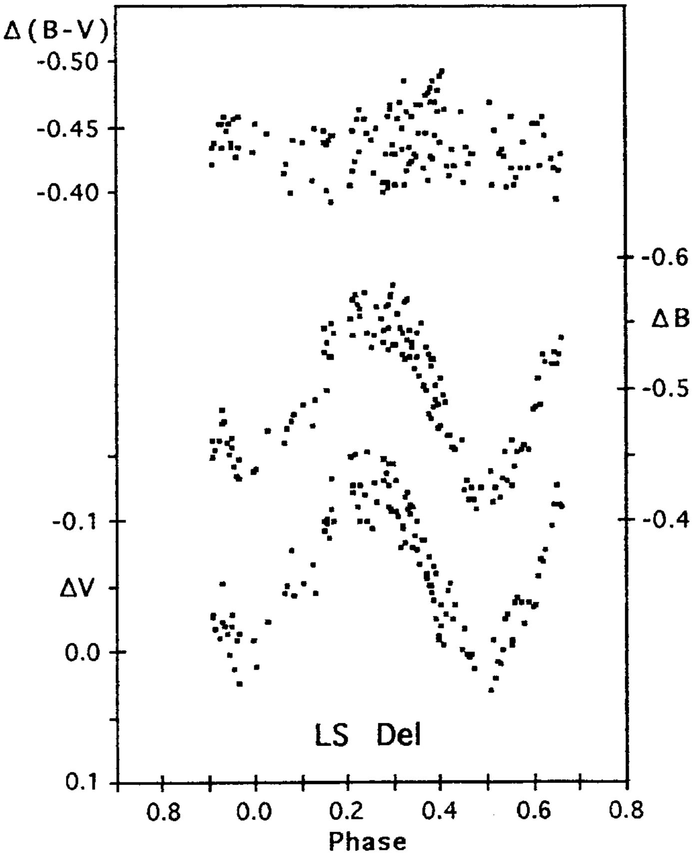

Figure 1

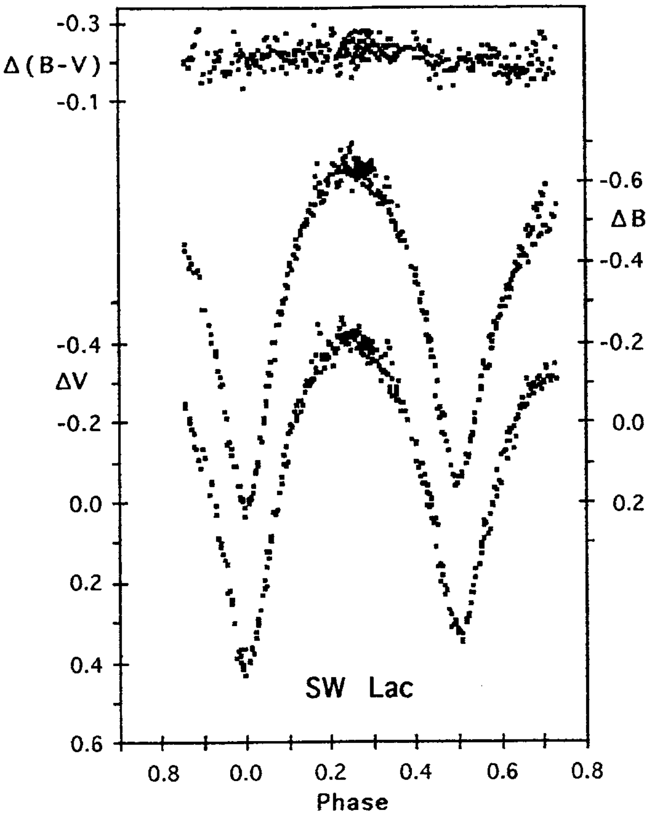

Figure 2

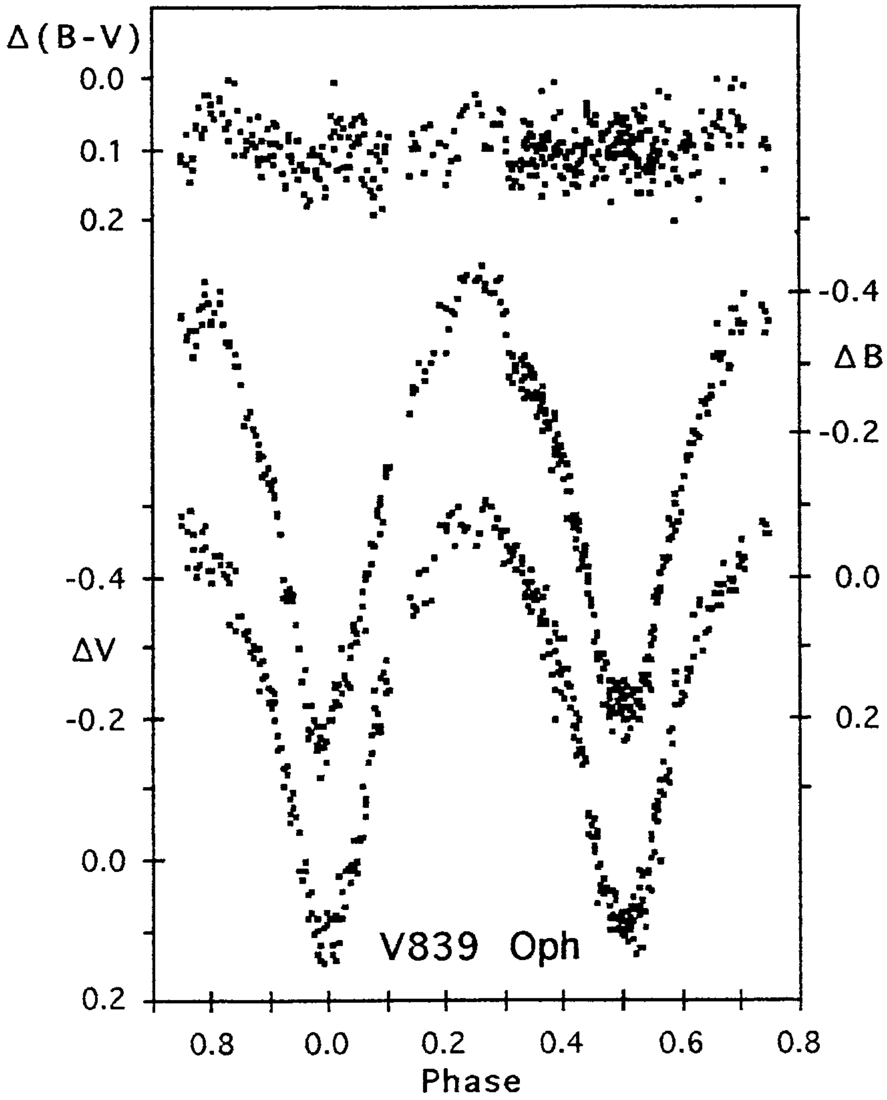

Figure 3

Table 2. Times of minima

LS Del	SW Lac	V839 Oph	AQ Psc
49588.3451 B II	49589.4973 B II	49590.3780 B I	49596.4629 B II
±0.0007	±0.0003	±0.0009	±0.0009
49588.3431 V II	49589.4989 V II	49590.3797 V I	49596.5183 V II
±0.0008	±0.0003	±0.0004	±0.0006
	49594.4696 B I	49596.3118 B II	
	±0.0003	±0.0002	
	49594.4674 V I	49596.3116 V II	
	±0.0003	±0.0003	
	49597.5156 B II	49598.3573 B II	
	±0.0003	±0.0003	
	49597.5159 V II	49598.3573 V II	
	±0.0003	±0.0003	

From these new observations 16 new times of minimum light were calculated by using the method of Kwee and Woerden (1956). The times of minimum light for the asymmetric eclipse curves of SW Lac were checked by using the well known graphical"chord" method. The resulting new times of minimum light together with their r.m.s. errors are listed in Table 2 for each system.

O. Demircan
M. Tanriver
A. Devlen
A. Bulut
A. Savranlar
Y. Yüksel
A. Aşçilar
Z. Aslan
H. Ak
A. Gökçe
E. Çınar
G. Şen
G. Taş
E. Açıkgöz
C. Ibanoğlu
H. Dündar
H. Çalışkan
H. Varlı
H. Özdemir
Y. Alemdar
B. Bektaşli
Z. Müyesseroğlu
B. Albayrak
A. Iskender
N. Çubukcu
Ö. Çakırlı
R. T. Yıldırım
F. Göksen
S.O. Selam
K. Yüce
Y. Kaya
K. Uluç
M. Dağcı
Y. Erdal
N. Köker

Ankara University Observatory
Faculty of Science
TR 06100 Tandogan, Ankara
Turkey

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1994 BVRI PHOTOMETRY OF CG CYGNI

CG Cygni (= BD+34°4217 = # 177 in the catalog of Strassmeier et al., 1993) is a member of the short period eclipsing RS CVn class of stars. Budding and Zeilik (1987) first modeled the spots on this star. Zeilik et al. (1994) model the spot structure for available data from 1922 to 1993 and review the literature on this star.

I observed CG Cyg on the nights of 13, 15, 16, 18, and 19 August 1994 using the San Diego State University 61-cm telescope on Mt. Laguna. The telescope is equipped with a photometer using a Hamamatsu R943-02 tube operated at −1450V and cooled to −15°. The BVRI filters are chosen to closely match the Johnson–Cousins system. I used BD+34°4216 (=SAO 70728) as a comparison star. The data, plotted in Figures 1 and 2, are differential magnitudes (star−comparison) in the standard Johnson–Cousins system. Zeilik et al. (1994) discuss small amplitude variations outside the eclipses that are seen by several different independent observers. These variations are apparent in the 1994 data, but their nature is still uncertain.

I modeled the data using the Information Limit Optimization Technique (ILOT) described in detail by Budding and Zeilik (1987). I extracted a distortion wave from the initial binary star fit, then fit the distortion wave for the longitude and radius of two 0K circular spots at a fixed 45° latitude. Figures 3 and 4 show these fits for the B band. The fits for each wavelength are performed independently. I get:

	B band	V band	R band	I band
Longitude	254.7±10.1	258.5±8.1	257.5±7.0	259.9±7.5
Latitude	45	45	45	45
Radius	8.2±1.0	9.1±0.9	10.1±0.8	9.6±0.9
Longitude	106.5±10.7	113.9±16.0	125.3±13.6	130.6±20.5
Latitude	45	45	45	45
Radius	6.9±1.2	5.3±1.6	6.1±1.4	5.5±1.5
χ^2	132.2	103.3	92.9	85.0

Note that the models in the different bands agree to within the errors. Zeilik et al. (1994) find that the spots for CG Cyg tend to cluster in Active Longitude Belts at 90°and 270°. These models show the same phenomenon.

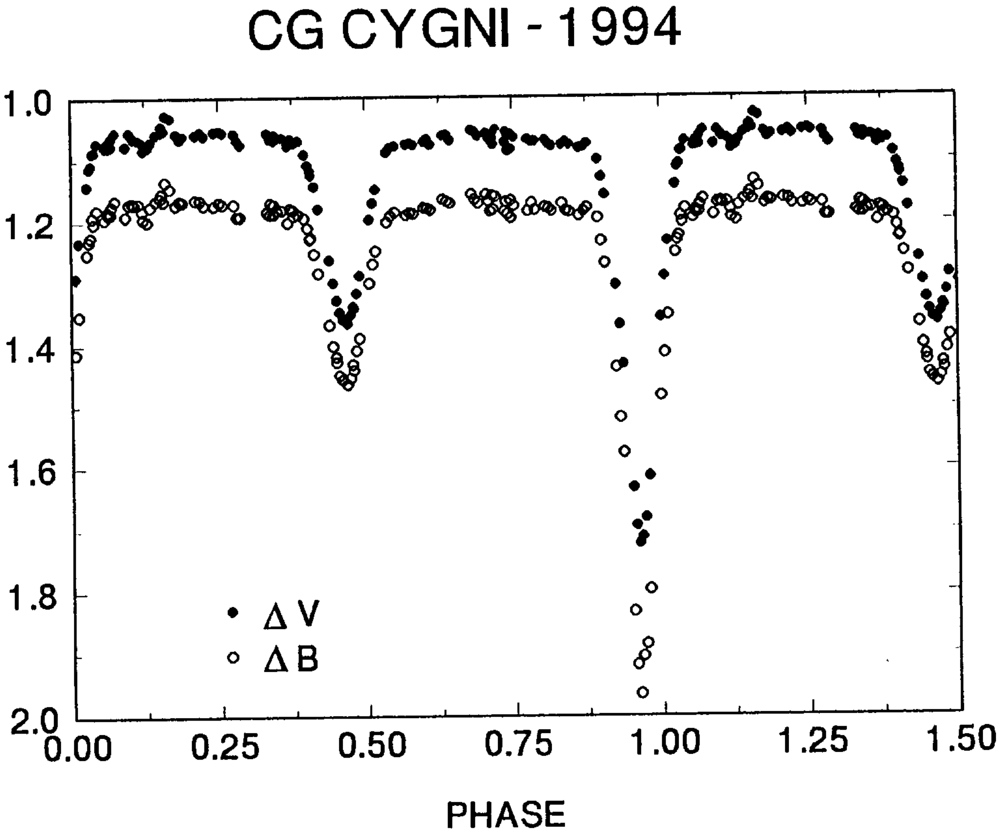

Figure 1

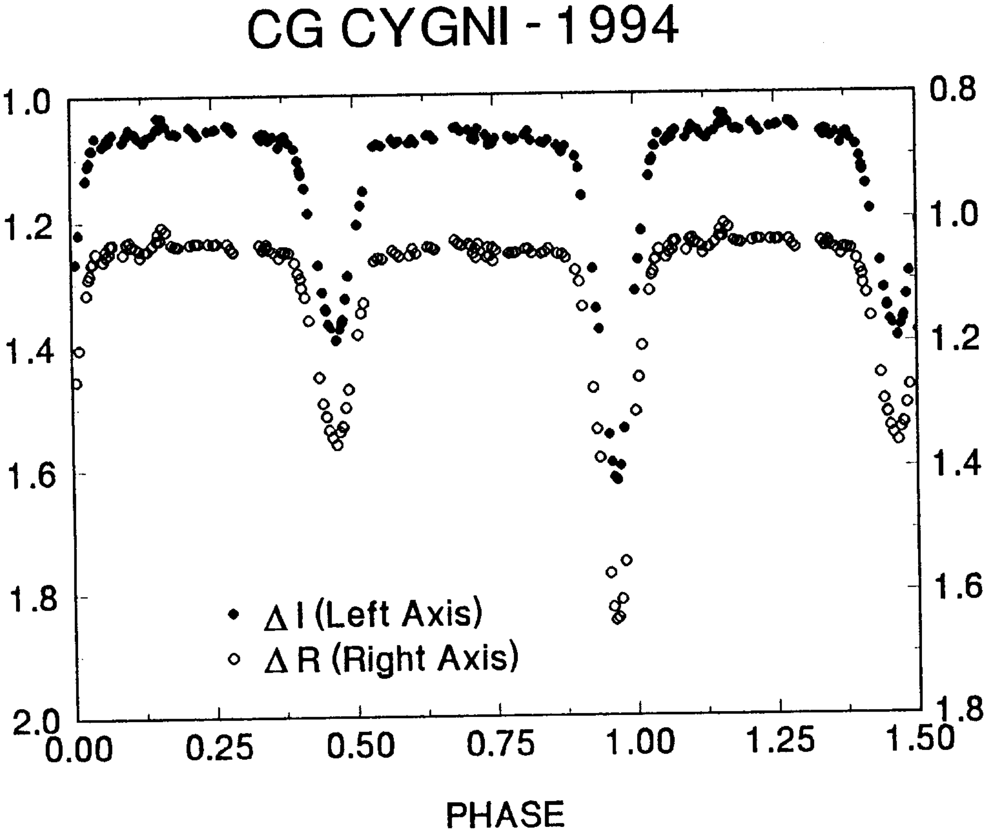

Figure 2

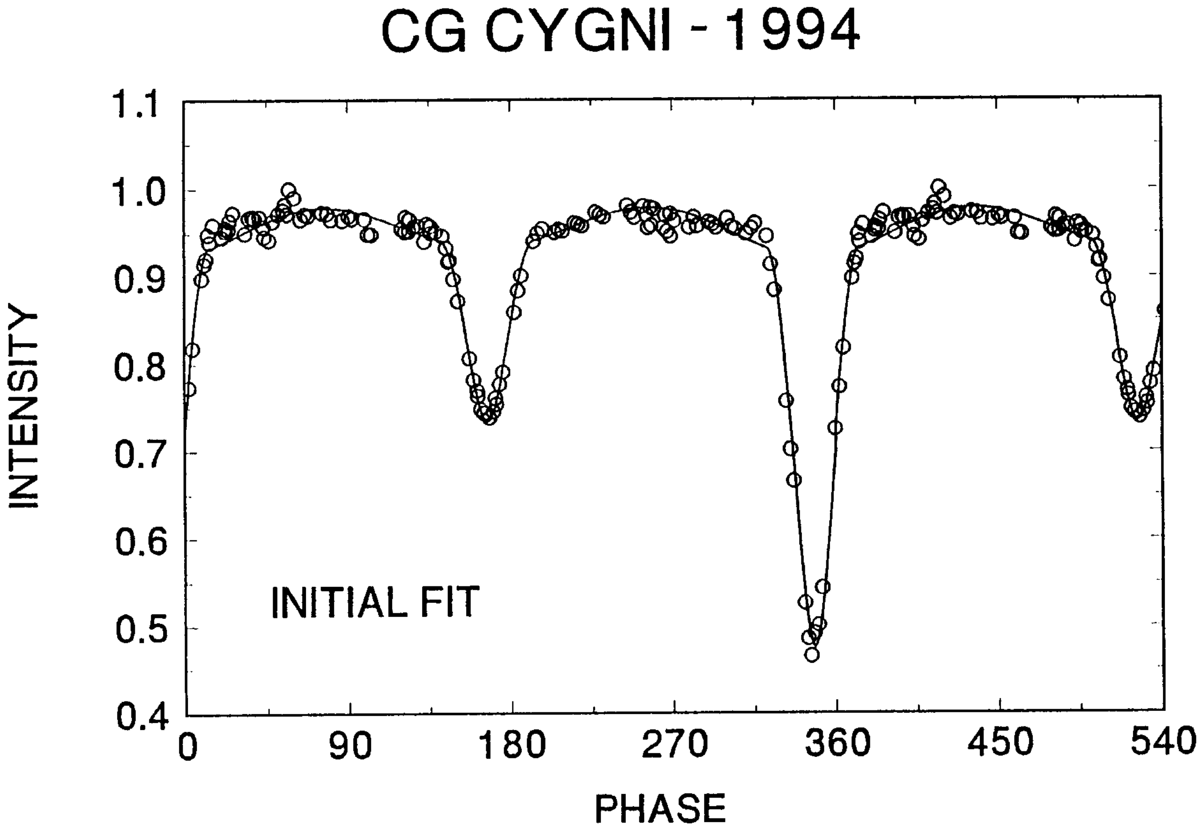

Figure 3

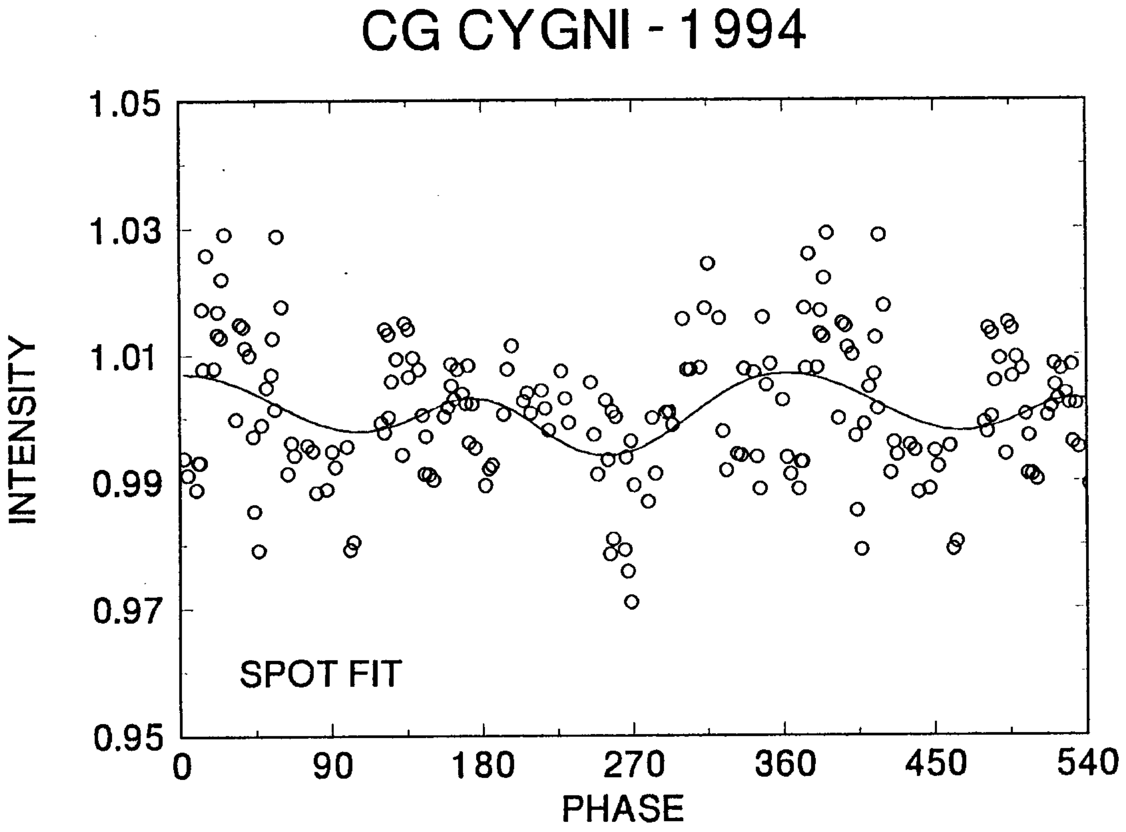

Figure 4

After performing the spot fits, the effects of the distortion wave were removed and clean fits were made to the corrected light curve. I get:

λ	L_1	$k=r_2/r_1$	r_1	i	L_2	$q=M_2/M_1$	χ^2
B	0.700±0.076	0.948±0.181	0.237±0.024	82.8±1.3	0.264±0.079	0.623±0.293	107
V	0.686±0.012	0.883±0.023	0.248±0.005	fixed	0.280±0.012	0.485±0.077	73
R	0.695±0.011	0.836±0.019	0.257±0.005	fixed	0.277±0.012	0.469±0.097	162
I	0.705±0.014	0.790±0.017	0.265±0.005	fixed	0.272±0.015	0.544±0.373	50

The values of L_1, k, r_1, i, and L_2 all agree with the values found by Zeilik et al. (1994). I was only able to simultaneously fit the inclination and mass ratio in the B band. In the other bands I fixed the inclination to try to get some information on the mass ratio because the results of Zeilik et al. (1994) give a good value for the inclination. Most previous values of the mass ratio are 1.0 (Naftilan and Milone 1985, Sowell et al. 1987). Jassur (1980) gets 0.95 and Popper (1993) gets 0.84. The values above are derived from only photometric data at one epoch and are therefore less reliable than values derived using spectroscopic data. However these values lend credence to the lower value of the mass ratio found by Popper (1993).

Because I was unable to observe an entire primary or secondary eclipse on a single night I am not able to give a reliable observed time for either the primary or secondary eclipse. However, the ILOT program makes a best fit correction to the phase of primary minimum. From that information averaged over the 4 observed wavelengths, I find that the eclipses are observed 0.02245+0.0001 days before they are computed to occur during this epoch.

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P. A. HECKERT
Dept. of Chem. & Physics
Western Carolina University
Cullowhee, NC 28723 USA

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B AND V PHOTOELECTRIC OBSERVATIONS OF THE CONTACT BINARY XY Leo

XY Leo is a short period contact binary with multiple CaII H and K emission lines and strong X-ray emission (Hrivnak et al., 1984; Vilhu and Rucinski, 1983). The O−C diagram has a sine-like shape, but sudden changes of period of XY Leo were observed three times (Gehlich et al., 1972). These phenomena were explained sucessfully by BY Dra type activity of the other pair of stars in the system (Barden, 1987). The variations in the light curves of the binary were detected as usually for all W-systems.

Our observations of XY Leo were carried out on three nights: 28, 29 and 30 November 1990). The four channel WBVR photometer attached to the 48-cm reflector was used (Kornilov and Krylov, 1990). The observations were made at High Altitude Alma-Ata Observatory of Sternberg Astronomical Institute. BD +28°2036 served as the comparison star. The mean error of magnitudes range from $0^{\mathrm{m}}_{.}01$ to $0^{\mathrm{m}}_{.}03$ in each filter. These values are due to small ratio of signal to noise (~ 3) for stars of such brightness. V and B light curves of XY Leo are presented in Figure 1. Phases are calculated by the ephemeris from Krzesinski et al. (1990):

$$\mathrm{MinI=J.D.hel}\ 2447612.34748+0^{\mathrm{d}}_{.}2841034\times \mathrm{E}$$

The observations allowed us to determine the times of one primary and two secondary minima by graphical method separately for each colour. Table I contains the moments of minima, type of minima and O−C values as calculated from the same ephemeris.

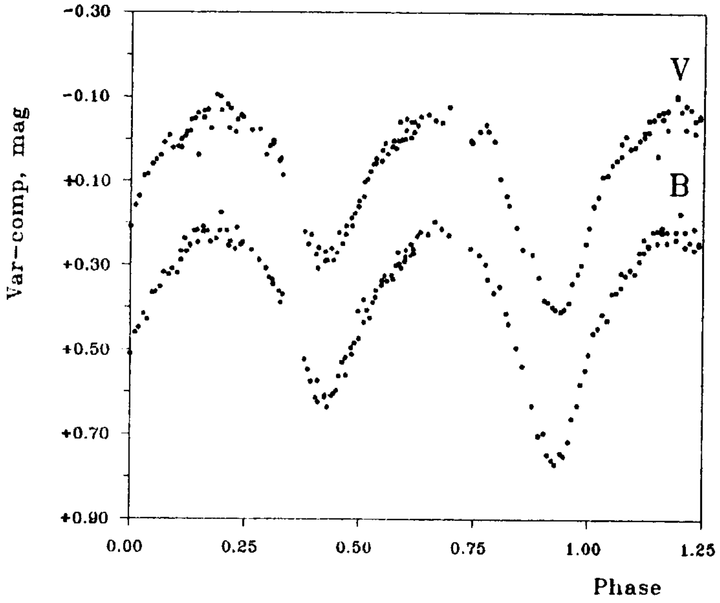

Figure 1

Table I

JD_{hel} 2448000+	Min	Filter	O−C
224.4477:	II	V	−0.0194
224.4470:	II	B	−0.0201
225.4393	I	V	−0.0222
225.4399	I	B	−0.0216
226.4348	II	V	−0.0210
226.4351	II	B	−0.0207

L. T. MARKOVA
Laboratory of Astrophotometry
and Stellar Atmospheres

G. V. ZHUKOV
Department of Astronomy
Kazan University
Lenina 18, 420008 Kazan
Russia
E-mail: gera@astro.kazan.su

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THE IDENTIFICATION OF VARIABLE STARS DISCOVERED WITH THE HUBBLE SPACE TELESCOPE IN THE GLOBULAR CLUSTER MESSIER 3

Recently Guhathakurta *et al.* (1994) published a list of 40 variable stars detected in the core of the globular cluster M3 using HST images. The stars have relative astrometric positions. In another list, by Evstigneeva *et al.* (1994), accurate astrometric positions are given for all known variable stars in this cluster, except 4 objects which the authors could not identify. The examination of these lists shows that they contain common objects. I have reduced the relative positions by Guhathakurta *et al.* to equatorial co-ordinates in the system by Evstigneeva *et al.* using 26 common objects. The agreement between the positions is very good, the r.m.s. deviation being 0.″09.

As a result, 20 variables were identified with 19 ones from the list by Sawyer Hogg (1973), two variables being close components of one earlier known variable V4. V201, a variable lost by Evstigneeva *et al.*, was identified with ID 1600 using a chart by Kholopov (1977). 6 variables were discovered earlier by Kholopov (1977) and 3 variables by Kadla and Gerashchenko (1980).

The identifications are given in the Table. Two identifications, ID 9019 with V156 and ID 9012 with X23, are marginal, because their positions measured with a ground-based telescope may be not accurate. So 11 variables may be new discoveries with the HST. The equatorial co-ordinates are those reduced from relative astrometry by Guhathakurta *et al.*

V.P.GORANSKIJ
Sternberg Astronomical Institute,
13, Universitetskij Prospekt,
119899, Moscow, Russia

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Kholopov, P.N.: 1977, *Variable Stars*, **20**, No. 4, 313

Sawyer-Hogg, H.: 1973, *David Dunlap Obs. Publ.*, **3**, No. 6

ID No.	Desig.	RA(2000)	Decl(2000)	Deviation	Remarks
9001	V132	$13^{\rm h}42^{\rm m}07^{\rm s}.443$	$28^\circ22'19''.85$	$0''.1$	
9002	V168	13 42 08.078	28 22 49.36	0.1	
9003	V4n	13 42 08.193	28 22 33.21	0.2	
9004	V4s	13 42 08.216	28 22 32.86	0.3	
9005	V143	13 42 08.904	28 22 58.93	0.1	
9006	X40	13 42 08.999	28 21 56.60	0.1	
9007	V122	13 42 09.046	28 21 55.05	0.1	
9008	new	13 42 09.197	28 22 28.75		
9009	V142	13 42 09.259	28 21 43.58	0.0	
9010	X14	13 42 09.458	28 22 34.79	0.2	
9012	new?	13 42 09.550	28 22 43.82	1.7	from X23
9011	V213	13 42 09.569	28 22 12.30	0.1	
9013	V184	13 42 09.570	28 22 27.36	0.1	
9014	V189	13 42 09.591	28 22 21.54	0.1	
9015	X36	13 42 09.667	28 22 49.23	0.1	
9016	new	13 42 09.780	28 22 47.53		SX Phe type var.
9017	V212	13 42 09.868	28 22 03.90	0.1	
9018	X13	13 42 09.877	28 22 15.33	0.1	
9019	new?	13 42 09.992	28 21 59.90	1.3	from V156
32	new	13 42 10.082	28 22 39.96		
85	V221	13 42 10.217	28 22 28.50	0.1	
238	V215	13 42 10.439	28 22 41.25	0.1	
9020	V195	13 42 10.492	28 22 14.33	0.1	
9021	V160	13 42 10.807	28 21 58.94	0.0	
507	X17	13 42 10.767	28 22 37.50	0.2	
552	new?	13 42 10.818	28 22 37.00	0.7	from X17
9022	V174	13 42 10.841	28 22 08.38	0.1	
576	new	13 42 10.867	28 22 24.23		SX Phe type var.
586	new	13 42 10.867	28 22 29.74		
684	KG3	13 42 10.958	28 22 33.51	0.4	
734	KG4	13 42 11.000	28 22 43.51	0.1	
9023	V217	13 42 11.467	28 22 15.34	0.0	
9024	V154	13 42 11.647	28 22 13.56	0.1	Cepheid.
9025	new	13 42 11.699	28 22 14.02		
1489	new	13 42 11.709	28 22 15.69		
1600	V201	13 42 11.792	28 22 33.56	-	
1711	new	13 42 11.881	28 22 37.45		Var RGB star.
2042	KG7	13 42 12.149	28 22 32.35	0.1	
9026	X22	13 42 12.255	28 22 15.13	0.1	
2538	V193	13 42 12.614	28 22 35.35	0.1	

Catalogues: V – Sawyer-Hogg (1973); X – Kholopov (1977); KG – Kadla and Gerashchenko (1980).

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SPECTROSCOPIC BINARITY OF THE CEPHEID BY Cas

The variability of BY Cas was discovered by Beljawsky (1931). According to Szabados (1991), this s-type Cepheid shows considerable period variability and after JD 2443000 varies with the period $3^{\mathrm{d}}.222199$.

Joy (1937) published 6 radial velocity values for BY Cas, one radial velocity measurement was later published by Rastorgouev *et al.* (1990). Szabados (1991) was not able to derive γ-velocity for this star. Usenko (1990) suggested the presence of a B5 companion from the star's position in the two-color diagram. In our catalog (Gorynya *et al.*, 1992) of Cepheid radial velocities measured with the CORAVEL-type spectrometer designed by Tokovinin (1987), we presented 9 velocities of the star and suspected variability of its γ-velocity.

We have now added 5 new measurements of the radial velocity of BY Cas. These results clearly confirm that the star is a spectroscopic binary. Though the radial velocity data are still not very abundant, we have attempted to determine provisional orbital elements. Several sets of orbital elements still remain possible, but presently we prefer the solution with small eccentricity: $T_0 = 2449298$, $P_{orb} = 553^d \pm 20^d$, $e = 0.05 \pm 0.05$, $\omega = 240°$, $\gamma = -58$ km/s, $K = 9.5$ km/s.

Table 1

JD_{hel} 244...	V_r, hel, km/s	σ, km/s	Phase, orbit.	Phase, puls.	V_r, orbit.	V_r, puls.
7792.507	−45.0	1.1	0.279	0.469	−48.7	3.7
7793.515	−43.5	1.3	0.281	0.782	−48.7	5.2
8253.282	−49.9	0.8	0.112	0.466	−55.4	5.5
8555.375	−67.3	1.0	0.657	0.217	−61.8	−5.5
8557.306	−58.9	2.0	0.661	0.817	−62.0	3.1
8562.289	−61.5	0.8	0.670	0.363	−62.4	0.9
8565.307	−65.3	0.8	0.675	0.300	−62.7	−2.6
8566.353	−54.4	1.6	0.677	0.624	−62.8	8.4
8567.323	−69.2	1.0	0.679	0.925	−62.9	−6.3
9252.500	−58.8	0.7	0.917	0.563	−66.3	7.5
9255.507	−59.1	0.7	0.923	0.497	−66.2	7.1
9610.585	−49.1	0.6	0.564	0.692	−56.8	7.7
9613.597	−49.8	0.7	0.570	0.626	−57.1	7.3
9615.604	−62.0	0.6	0.574	0.249	−57.2	−4.8

Table 1 presents available correlation-spectrometer radial velocities of BY Cas, as well as the Cepheid's velocities separated into an orbital and a pulsational term. The columns contain: heliocentric Julian dates; measured heliocentric radial velocities; their internal r.m.s. errors; phases of the orbital cycle calculated with our provisional elements; phases of the pulsational cycle calculated using improved light elements in the time interval JD_{hel} 2448200–900:

$$Max_{hel} = 2448441.895 + 3\overset{\mathrm{d}}{.}22227 \times E;$$

orbital motion components of the radial velocity computed from the orbital elements; radial velocity residuals (to be attributed to pulsations).

Thanks are due to Dr. A. Tokovinin for providing possibility to use his spectrometer, and to Sternberg Institute observers and students who took part in observations according to our program.

N.A. GORYNYA
N.N. SAMUS
Institute of Astronomy
of Russian Academy of Sciences
48, Pyatnitskaya Str.
Moscow 109017, Russia

A.S. RASTORGOUEV
Sternberg Astronomical Institute
13, Universitetskij Prosp.,
Moscow 119899, Russia

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WW CEPHEI: ELEMENTS REDISCOVERED AND IMPROVED

[BAV Mitteilungen Nr. 71]

The Algol–type eclipsing binary WW Cep = 241.1928 Cephei was discovered by Schneller (1928) on photographic plates of Babelsberg Observatory. Later, Schneller (1931) published a list of individual photographic magnitudes ranging between $11\overset{\mathrm{m}}{.}0$ and $11\overset{\mathrm{m}}{.}8$, determined the time between first and last contact of the primary minimum as D = $4\overset{\mathrm{h}}{.}1$ and reported the following first elements:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2425098.527 \;+\; 4\overset{\mathrm{d}}{.}60086 \times \mathrm{E}.$$

Metzger rediscovered the variable independently on the same photographic plates and found D= $0\overset{\mathrm{d}}{.}15$ and d= $0\overset{\mathrm{d}}{.}03$ (Staker, 1931). WW Cep was again investigated by Götz (1951) on plates of the Sonneberg Sky Survey. He submitted four minima timings and calculated new elements:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2425029.495 \;+\; 1\overset{\mathrm{d}}{.}53360 \times \mathrm{E}.$$

With these elements WW Cep is listed in the GCVS (1985). Šilhán (1982) reported that in a photographic and visual search the primary minimum could not be found. Lacy (1990) noted that his spectrograms are inconsistent with the ephemeris listed in the GCVS (1985). Photoelectric photometry by Lacy (1992) showed no sign of an eclipse at phase 0.0327. Using the photographic magnitudes published by Schneller (1931) together with the elements from the GCVS, a reduction to one cycle shows that seven measurements contradict the ephemeris used. In spite of all that, two BBSAG observers published 17 visual minima which follow quite well the published elements. These discrepancies made WW Cep a candidate for the observing program of the author.

The observations were made at his private observatory with an SBIG ST6 CCD–camera without filters attached to a 20 cm SC–telescope. WW Cep was observed on 20 nights between Apr. 1993 and Oct. 1994. The rather large scatter in the lightcurve is due to not always photometric weather conditions. The minima times were calculated using the Kwee – van Woerden (1956) method. From about two and a half thousand pictures over almost all phases the true period could be rediscovered. It is very near the original one suggested by Schneller. In the instrumental system the depth of the primary and secondary minima were found to be $0\overset{\mathrm{m}}{.}64$ and $0\overset{\mathrm{m}}{.}16$, respectively.

Using the minima from Parenago and Schneller together with the new observations, a least squares fit yields the following linear ephemeris. The visual observations by the BBSAG seem to be affected by systematic error and had to be excluded.

$$\begin{array}{rcl} \mathrm{Min\,I} = \mathrm{HJD}\,2449662.4438 & + & 4\overset{\mathrm{d}}{.}60084540 \times \mathrm{E} \\ \pm 2 & & \pm 14 \end{array} \qquad (1)$$

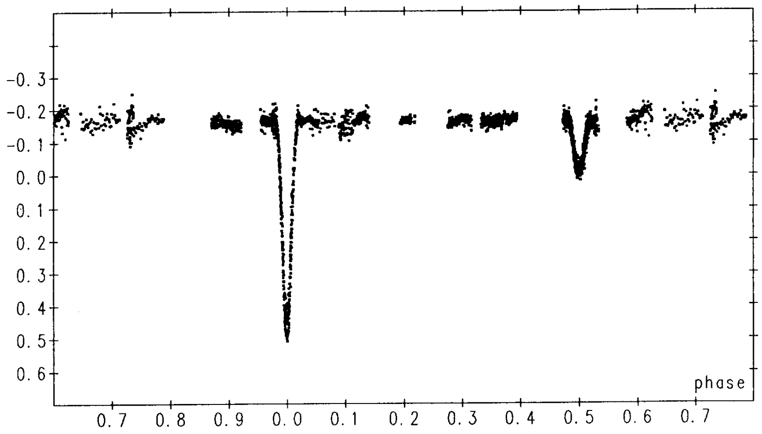

Figure 1: Differential light curve of WW Cep computed with respect to the new ephemeris (1).

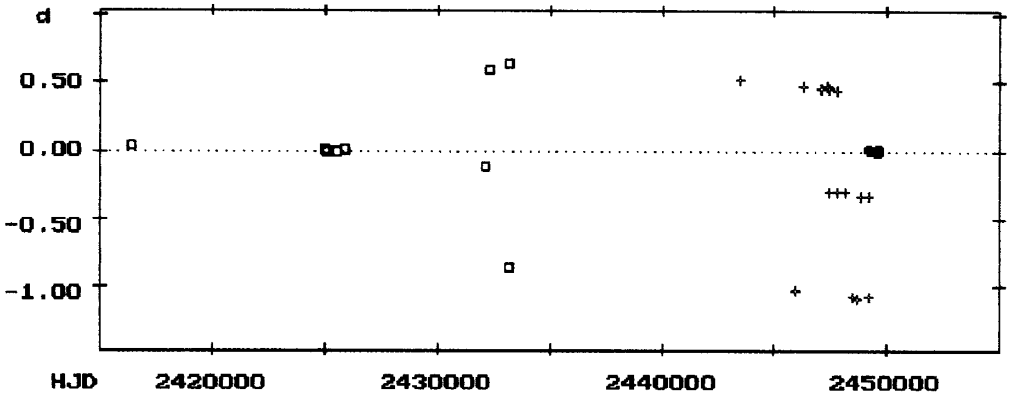

Figure 2: O–C–diagram for WW Cep computed with respect to the new ephemeris (1) using all available minima timings. • represents photoelectric, ○ photographic series, + visual observations and □ photographic plate minima.

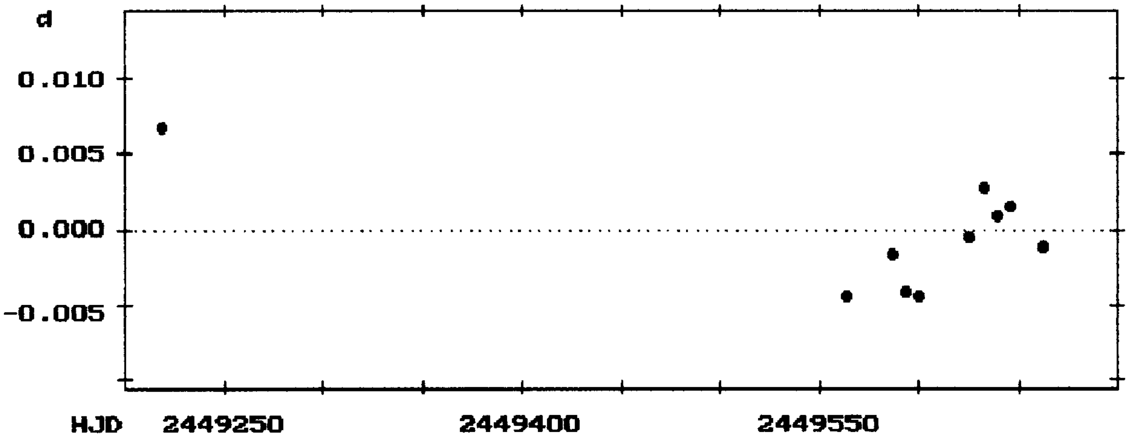

Figure 3: O–C diagram for WW Cep computed with respect to the new ephemeris (1) using only photoelectric observations.

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

N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit	N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit
1	16375.36	2	P	−7235.0	+0.03	[1]	20	47757.392	0	V::	−414.0	–0.302	[11]
2	25029.518	2	P	−5354.0	+0.000	[2]	21	48125.455	0	V::	−334.0	–0.306	[12]
3	25098.526	20	F	−5339.0	–0.004	[2]	22	48444.452	0	V::	−265.5	–1.068	[13]
4	25121.530	2	P	−5334.0	–0.004	[2]	23	48467.451	0	V::	−260.5	–1.073	[13]
5	25503.400	1	P:	−5251.0	–0.005	[2]	24	48490.456	0	V::	−255.5	–1.073	[13]
6	25908.280	1	P:	−5163.0	+0.001	[2]	25	48619.267	0	V::	−227.5	–1.085	[14]
7	32119.308	0	P::	−3813.0	–0.112	[3]	26	48852.363	0	V::	−176.0	–0.332	[15]
8	32292.554	0	P::	−3776.5	+0.602	[3]	27	49217.394	0	V::	−97.5	–1.068	[16]
9	33134.551	0	P::	−3593.5	+0.644	[3]	28	49218.4690	60	E	−97.5	+0.0068	[17]
10	33151.454	0	P::	−3589.5	–0.856	[3]	29	49220.435	0	V::	−96.0	–0.328	[16]
11	43509.335	0	V::	−1338.5	+0.522	[4]	30	49563.5213	60	E	−22.5	–0.0043	[17]
12	45932.434	0	V::	−811.5	–1.025	[5]	31	49586.5283	60	E	−17.5	–0.0016	[17]
13	46320.404	0	V::	−727.5	+0.474	[6]	32	49593.427	30	E:	−15.0	–0.004	[17]
14	47116.329	0	V::	−554.5	+0.453	[7]	33	49600.328	30	E:	−14.5	–0.004	[17]
15	47323.387	0	V::	−509.5	+0.473	[8]	34	49625.6366	60	E	−8.0	–0.0004	[17]
16	47392.381	0	V::	−494.5	+0.454	[9]	35	49632.5410	60	E	−7.5	+0.0027	[17]
17	47412.324	0	V::	−489.0	–0.306	[10]	36	49639.4405	60	E	−5.0	+0.0009	[17]
18	47415.390	0	V::	−489.5	+0.459	[9]	37	49646.3424	60	E	−4.5	+0.0016	[17]
19	47737.432	0	V::	−419.5	+0.442	[11]	38	49662.4427	60	E	0.0	–0.0011	[17]

[1]: Parenago (1934), [2]: Schneller (1931), [3]: Götz (1951), [4]: Peter (1978), [5]: Peter (1984), [6]: Peter (1985), [7]: Peter (1988a), [8]: Blättler (1988), [9]: Peter (1988b), [10]: Blättler (1989), [11]: Peter (1989), [12]: Peter (1990), [13]: Peter (1991), [14]: Peter (1992a), [15]: Peter (1992b), [16]: Peter (1994), [17]: this paper

*) P denotes pg plate min., E CCD min., F pg series and V visual estimates. Those marked with ':' got reduced weight while those marked with '::' were discarded.

It should be mentioned that plate E409 at epoch 2425505.468 ($m = 11.13$) of the list of photographic magnitudes by Schneller (1931), if significant, seems to indicate the descend to a secondary minimum. If this is true, the phase of min II would have been at phase 0.46 whereas the new measurements show min II at phase 0.5. Therefore WW Cep may be a system with apsidal motion.

F. AGERER
Bundesdeutsche Arbeitsgemeinschaft
für Veränderliche Sterne e.V. (BAV)
Zweikirchen, Dorfstrasse 19,
D-84184 Tiefenbach, Germany

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V406 LYRAE: NEW EPHEMERIS AND LIGHTCURVE

[BAV Mitteilungen Nr. 72]

In this paper we report on our photographic and CCD photometry on the β Lyr type variable V406 Lyr.

V406 Lyr = SVS 1015 = CSV 4208 was announced as a short period variable by Parenago (1946) with a brightness range between $12^{\rm m}\!.4$ and $13^{\rm m}\!.3$. Meinunger (1970) investigated this variable on plates of the Sonneberg Sky Survey. He classified the star as eclipsing, gave 23 minima, calculated from them a first ephemeris as

$$\mathrm{Min\,I} = HJD\,2438525.500\ +\ 1^{\rm d}\!.51130 \times \mathrm{E}$$

and published a first photographic light curve. The range in this lightcurve is roughly between $12^{\rm m}\!.5$ and $13^{\rm m}\!.0$. The variable got its definitive name in the 58th name-list of variable stars (Kukarkin et al. 1972). With the data above V406 Lyr was included in the fourth edition of the GCVS (Kholopov et al. 1985).

For more than twenty years the variable had remained obviously unobserved when the BAV published a photographic minimum timing (Moschner, Kleikamp 1990). Since that time we have investigated V406 Lyr photographically and photoelectrically. The photographic observations were made with a 32 cm RC telescope and the exposures were evaluated with a fixed diaphragm photometer. The CCD observations were performed with an SBIG ST6 camera without filters attached to a 20 cm SC telescope (F.A.) or to the 32 cm RC telescope (W.M.). Altogether three new photographic and nine CCD minima could be collected. All minima times were calculated with the Kwee–van Woerden (1956) method. In the instrumental system of the CCD observations the depth of the primary and secondary minima were found to be $0^{\rm m}\!.88$ and about $0^{\rm m}\!.56$, respectively. In compiling the lightcurve (Figure 1) from our data it became evident that the period published in the GCVS was a spurious one with the relation

$$\frac{1}{\mathrm{P}} - \frac{1}{\mathrm{P_{GCVS}}} = \frac{1}{2} \quad .$$

Using all published minima found in the 'BAV Database of Minima of Eclipsing Binaries' together with our new observations, a weighted least squares fit yields the following linear ephemeris:

$$\mathrm{Min\,I} = \mathrm{HJD}\,\underset{\pm 4}{2449250.4582} + \underset{\pm 9}{0^{\rm d}\!.86078384} \times \mathrm{E} \tag{1}$$

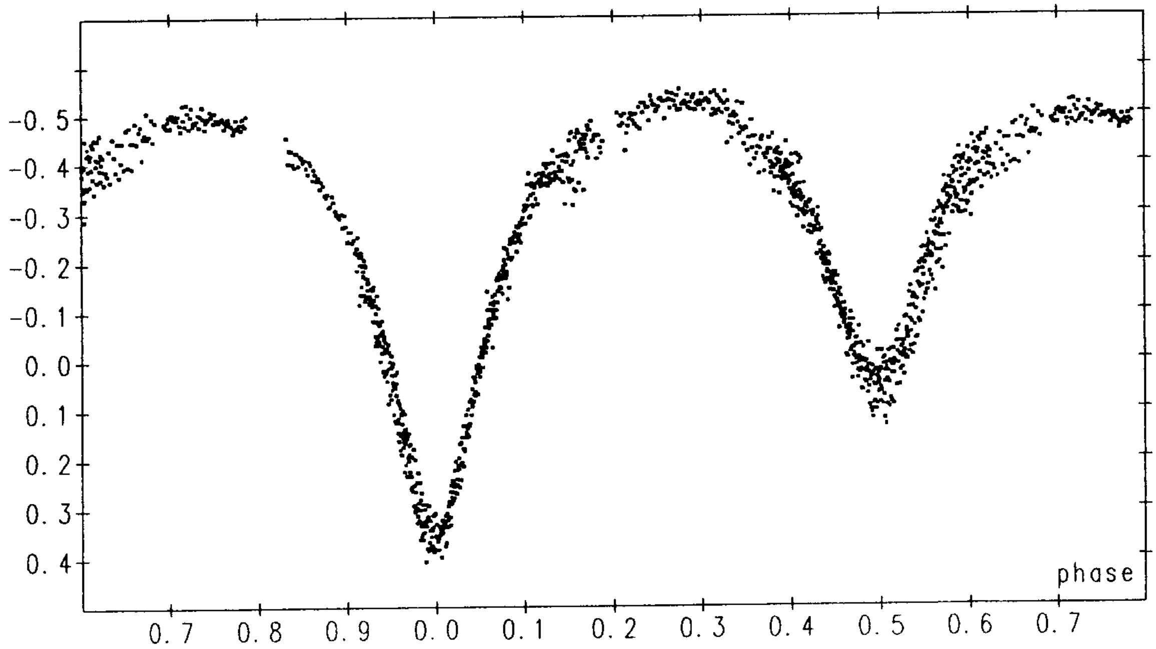

Figure 1: Differential lightcurve of V406 Lyr computed with respect to the new ephemeris (1).

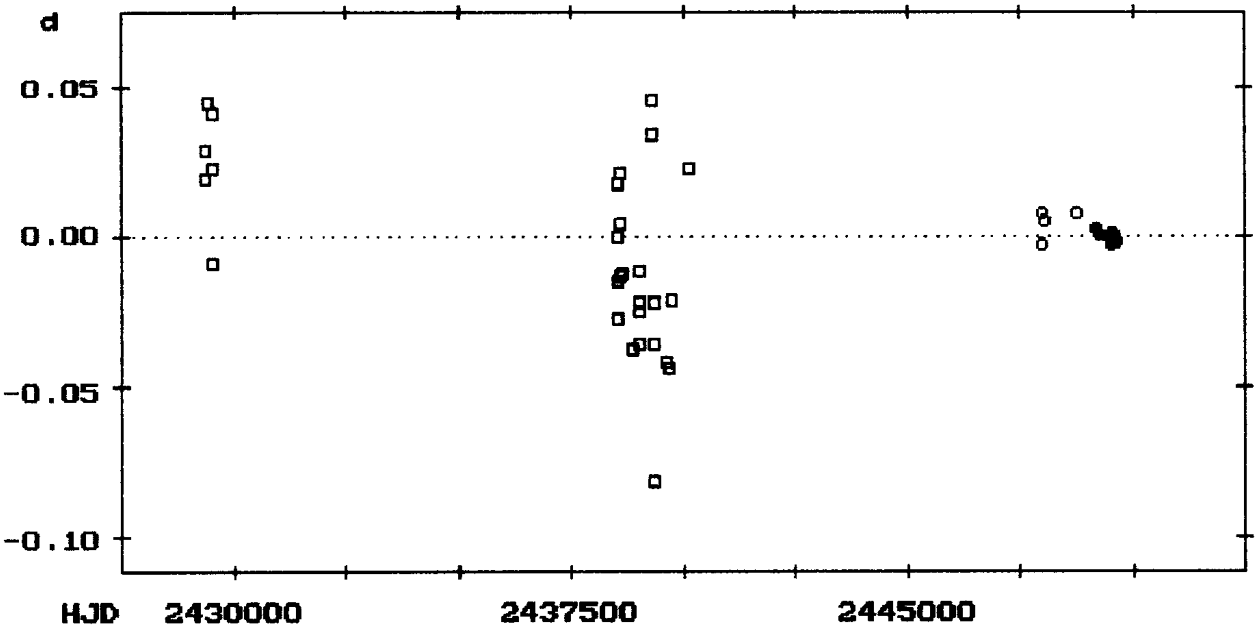

Figure 2: O–C diagram for V406 Lyr computed with respect to the new ephemeris (1) using all available minimum timings. ● represents photoelectric, ○ photographic series and □ photographic plate minima.

Table 1. Observed times of minima for V406 Lyr, epochs and residuals computed with respect to the ephemeris (1) derived in this paper.

N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit	N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit
1	29321.61	2	P	−23152.0	+0.02	[1]	22	39289.502	2	P	−11572.0	+0.034	[2]
2	29365.52	2	P	−23101.0	+0.03	[1]	23	39348.395	2	P	−11504.5	–0.036	[2]
3	29403.41	2	P	−23057.0	+0.04	[1]	24	39351.422	2	P	−11500.0	–0.022	[2]
4	29495.46	2	P	−22950.0	–0.01	[1]	25	39376.325	2	P	−11471.0	–0.082	[2]
5	29515.29	2	P	−22927.0	+0.02	[1]	26	39619.536	2	P	−11189.5	–0.042	[2]
6	29527.36	2	P	−22913.0	+0.04	[1]	27	39709.486	2	P	−11084.0	–0.044	[2]
7	38525.540	2	P	−12460.5	+0.018	[2]	28	39760.295	2	P	−11025.0	–0.021	[2]
8	38528.520	2	P	−12456.0	–0.015	[2]	29	40150.274	2	P	−10572.0	+0.023	[2]
9	38550.470	2	P	−12431.5	–0.015	[2]	30	47969.609	10	F:	−1488.0	–0.003	[3]
10	38553.470	2	P	−12427.0	–0.027	[2]	31	48013.520	20	F	−1437.0	+0.008	[4]
11	38556.510	2	P	−12424.5	–0.000	[2]	32	48016.530	20	F	−1434.5	+0.005	[4]
12	38559.510	2	P	−12420.0	–0.013	[2]	33	48746.477	20	F	−586.5	+0.008	[4]
13	38584.490	2	P	−12391.0	+0.004	[2]	34	49216.4598	60	E	−40.5	+0.0026	[5]
14	38587.520	2	P	−12388.5	+0.022	[2]	35	49250.4595	60	E	0.0	+0.0013	[5]
15	38640.424	2	P	−12326.0	–0.013	[2]	36	49485.4519	60	E	273.0	–0.0003	[6]
16	38883.570	2	P	−12044.5	–0.038	[2]	37	49525.4758	60	E	319.5	–0.0028	[5]
17	39021.309	2	P	−11884.5	–0.024	[2]	38	49547.4292	60	E	345.0	+0.0006	[5]
18	39024.310	2	P	−11880.0	–0.036	[2]	39	49568.5188	60	E	369.5	+0.0010	[5]
19	39027.348	2	P	−11877.5	–0.011	[2]	40	49580.5682	60	E	383.5	–0.0006	[5]
20	39052.300	2	P	−11848.5	–0.022	[2]	41	49597.3529	60	E	403.0	–0.0012	[5]
21	39286.501	2	P	−11576.5	+0.046	[2]	42	49625.3281	60	E	435.5	–0.0015	[5]

[1]: Parenago (1946), [2]: Meinunger (1970), [3]: Moschner, Kleikamp (1990), [4]: Moschner, Kleikamp: this paper, [5]: Agerer: this paper, [6]: Moschner: this paper.

*) P denotes pg plate min., E CCD min. and F photographic series. Those marked with ':' got reduced weight.

F. AGERER
W. KLEIKAMP
W. MOSCHNER
Bundesdeutsche Arbeitsgemeinschaft
für Veränderliche Sterne e.V. (BAV)
Munsterdamm 90,
D-12169 Berlin, Germany

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PHOTOMETRIC OBSERVATION OF V1187 CYGNI

[BAV Mitteilungen Nr. 73]

V1187 Cyg was discovered by Mayer (1965) as a variable of EA–type with $0\overset{\mathrm{m}}{.}35$ and $0\overset{\mathrm{m}}{.}31$ deep primary and secondary minima respectively. He submitted three moments of minima and gave a first ephemeris as:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2438634.5462\; + \;7\overset{\mathrm{d}}{.}535 \times \mathrm{E}. \qquad (1)$$

With the above data V1187 Cyg is listed in the fourth edition of the GCVS (Kholopov et al. 1985) as to be variable between $10\overset{\mathrm{m}}{.}88$ and $11\overset{\mathrm{m}}{.}23$.

The variable had remained obviously unobserved for about 28 years when the BAV published two times of minima (Agerer 1994). Together with V1191 Cyg, which is in the same field of our CCD camera, this variable was further investigated. In contradiction to the ephemeris above, an observing run on Aug. 22 shows a minimum of V1187 Cyg. Two additional minima at times when the variable was expected to be constant, together with observations between minima, proved that the period listed in the GCVS has to be divided by five.

Using all minima times available from the 'BAV Database for Minima of Eclipsing Binaries by D. Lichtenknecker', a least squares fit yields the following linear elements:

$$\begin{array}{llll} \mathrm{Min\,I} = \mathrm{HJD}\,2438634.5496 & + & 1\overset{\mathrm{d}}{.}50700136 & \times\, \mathrm{E} \\ \qquad\qquad\qquad\qquad\quad \pm 3 & & \qquad\quad \pm 4 & \end{array} \qquad (2)$$

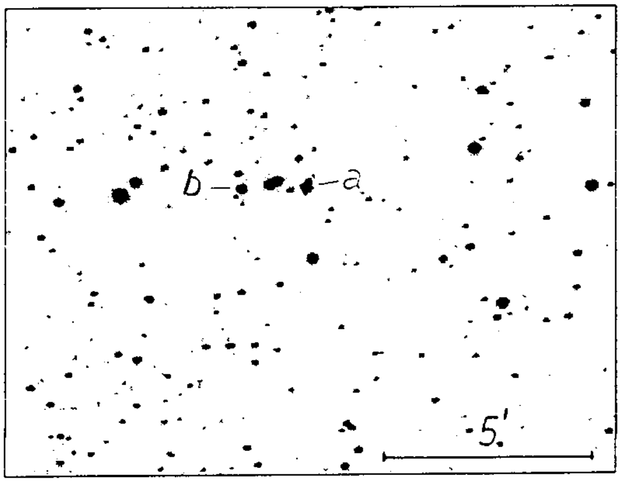

Figure 1: CCD image of V1187 Cyg (a) and V1191 Cyg (b).

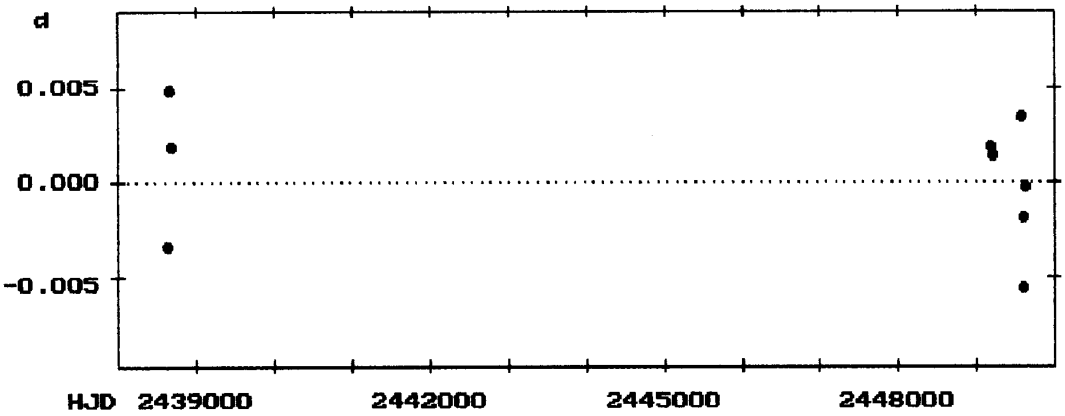

Figure 2: O–C diagram for V1187 Cyg computed with respect to the new ephemeris (2) using all available minima timings.

Table 1. Observed times of minima for V1187 Cyg, epochs and residuals computed with respect to the ephemeris (2) derived in this paper.

N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit
1	38634.5462	60	E	0.0	–0.0034	[1]
2	38653.392	30	E:	12.5	+0.005	[1]
3	38668.459	30	E:	22.5	+0.002	[1]
4	49168.4910	60	E	6990.0	+0.0019	[2]
5	49217.4681	60	E	7022.5	+0.0014	[2]
6	49587.439	30	E:	7268.0	+0.004	[3]
7	49599.4897	60	E	7276.0	–0.0018	[3]
8	49608.528	30	E:	7282.0	–0.006	[3]
9	49621.3428	60	E	7290.5	–0.0002	[3]

[1]: Mayer (1965), [2]: Agerer (1994), [3]: Agerer: this paper

F. AGERER
Bundesdeutsche Arbeitsgemeinschaft
für Veränderliche Sterne e.V. (BAV)
Zweikirchen, Dorfstrasse 19,
D-84184 Tiefenbach, Germany

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VW CANUM VENATICORUM: NEW EPHEMERIS AND LIGHTCURVE

[BAV Mitteilungen Nr. 74]

In this paper we report on our photographic and CCD photometry on the RR Lyr type variable VW CVn.

VW CVn = SVS 1291 was discovered by Kurochkin (1961) as variable of W UMa or β Lyr type with a range of brightness between $11^{\rm m}_{.}4$ and $12^{\rm m}_{.}6$. Kurochkin calculated two sets of first elements and gave first photographic light curves. Elements valid after JD 2436360 were:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2435923.246 \;+\; 0^{\rm d}_{.}850012 \times \mathrm{E}$$

With the above data VW CVn is listed in the fourth edition of the GCVS (Kholopov et al. 1985). Until recently the variable remained almost unobserved (exceptions Diethelm 1976, Diethelm 1980 and German 1982) when Vandenbroere (1994) found the elements to be in error. This prompted us to put VW CVn on our observing program.

One of us (T.B.) investigated this variable on 443 plates of the Sonneberg Sky Survey. The observations by the other were made with an SBIG ST6 camera without filters attached to a 20 cm SC telescope. From these measurements we found the variable to be of RR Lyr type, the range of brightness is between $11^{\rm m}_{.}96$ and $12^{\rm m}_{.}43(pg)$ and M−m = 0.46.

Analysing the CCD measurements we got first elements:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2449466.42 \;+\; 0^{\rm d}_{.}425 \times \mathrm{E}. \tag{1}$$

The timespan covered by the Sonneberg plates (1956 – 1994) was divided into several parts. Using this first ephemeris (1) for each of these parts a mean lightcurve was calculated and the time of the normal maximum was derived (see Table 1). Obviously the period did not remain constant in the time interval studied. Considering the accuracy of estimates on photographic plates the period probably changed about epoch number −21000. Least squares fits in each of these intervals yield the following linear elements:

$$\begin{array}{rl} \mathrm{Min\,I} = \mathrm{HJD}\,2438387.169 & + \; 0^{\rm d}_{.}4249932 \times \mathrm{E} \\ \pm 7 & \qquad\quad \pm 3 \end{array} \tag{2}$$

(valid between JD 2435861 and JD 2440000)

$$\begin{array}{rl} \mathrm{Min\,I} = \mathrm{HJD}\,2449466.428 & + \; 0^{\rm d}_{.}4249786 \times \mathrm{E} \\ \pm 6 & \qquad\quad \pm 7 \end{array} \tag{3}$$

(valid after JD 2440000)

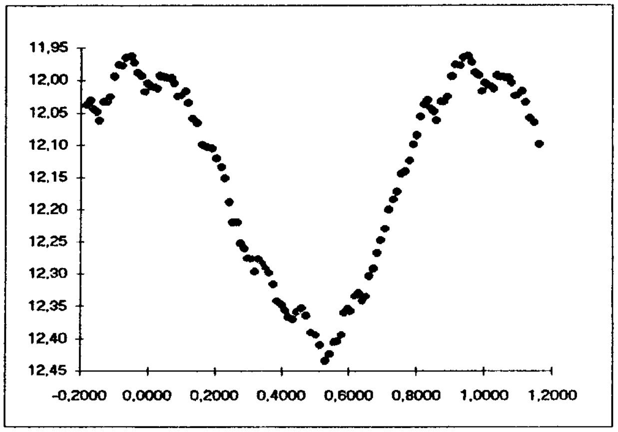

Figure 1: Mean light curve from all photographic estimates of VW CVn on plates of the Sonneberg Sky Survey computed with respect to the new ephemeris (3). Magnitudes according to Kurochkin. The hump near the maximum is a result of very bright observations appearing only temporarily in exactly that range of phase.

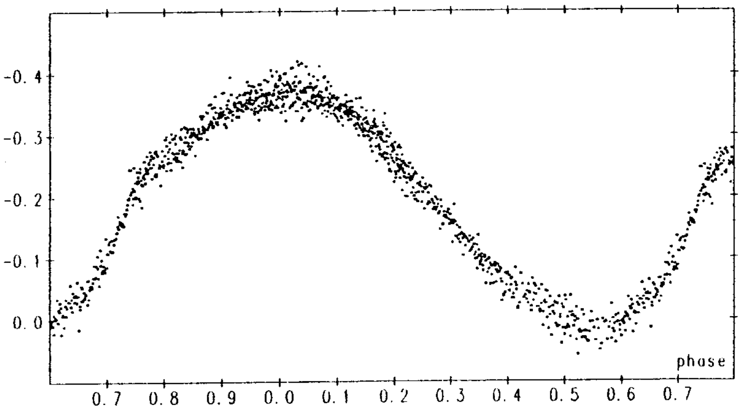

Figure 2: Differential CCD light curve of VW CVn computed with respect to the new ephemeris (3). Each point is the result of one CCD image.

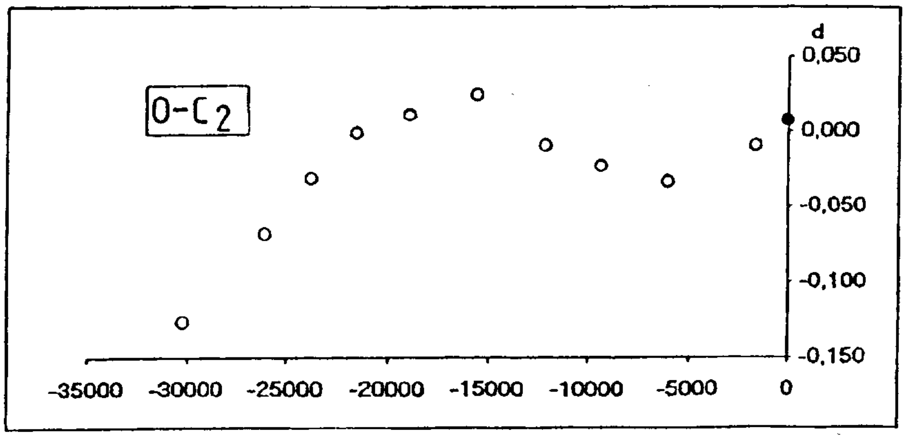

Figure 3: O–C diagram for VW CVn computed with respect to the new ephemeris (3) using all available maximum timings.
• represents photoelectric, ○ photographic normal maxima.

Times of normal maxima for VW CVn, epochs and residuals computed with respect to the ephemeris (3) derived in this paper.

N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Observer
1	36632.372	1	P	−30199.0	-0.127	T.Berthold
2	38387.167	1	P	−26070.0	-0.069	"
3	39352.330	1	P	−23799.0	-0.032	"
4	40291.988	1	P	−21588.0	-0.002	"
5	41393.545	1	P	−18996.0	+0.010	"
6	42840.186	1	P	−15592.0	+0.024	"
7	44292.729	1	P	−12174.0	-0.010	"
8	45486.055	1	P	−9366.0	-0.023	"
9	46914.822	1	P	−6004.0	-0.034	"
10	48761.379	1	P	−1659.0	-0.010	"
11	49466.435	6	E	0.0	+0.007	F.Agerer

*) P denotes photographic normal maxima,
E CCD observed normal maximum.

A detailed paper dealing with further analysis of the long–time behaviour of the period and the results of the CCD photometry is now in progress.

F. AGERER
T. BERTHOLD
Bundesdeutsche Arbeitsgemeinschaft
für Veränderliche Sterne e.V. (BAV)
Munsterdamm 90,
D-12169 Berlin, Germany

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ERRATUM

In the No. 4134 issue of the IBVS all ephemerides of VW CVn refer to normal maxima and not Min I (as stated erroneously in the text). The authors of that note and editors of the IBVS are grateful to Dr. N. Samus for calling their attention to this inconsistency.

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A PRE-MAIN-SEQUENCE COMPANION TO AR AURIGAE?

A recent analysis of the well-known bright eclipsing binary AR Aurigae (HD 34364, HR 1728, $V_{max} = 6.15$, B9VpHgMn + B9.5V, $P_{AB} = 4^{\rm d}\!.13$ days) suggests that the secondary star is still contracting towards the ZAMS, while the primary star appears to be exactly on the ZAMS (Nordström & Johansen 1994). Moreover, AR Aur is a triple system, the existence of the as yet unseen third star being inferred from a light-time effect in the observed minima with a period of ∼24 years (Chochol et al. 1988, Nordström & Johansen 1993).

AR Aur A (2.5 $M_\odot$) and B (2.3 $M_\odot$) are of considerable interest as coeval and nearly equal-mass stars apparently just arriving on the ZAMS. Given the remaining observational uncertainties in the absolute dimensions, it is of interest to verify this scenario by other means. Direct detection of star C would support this scenario and provide an estimate of the mass of star C and the inclination between the two orbital planes. This note discusses how this test could be made.

Models by Mazzitelli (1989) have been used to estimate the radius (R_C), temperature (T_C), and luminosity (L_C) for star C at an age of 4×10^6 yr (the time for star A to reach the ZAMS from the birthline), for different assumed values of i, the inclination of the long-period orbit (the eclipsing pair has $i = 88.^{\circ}5$). The results are given in Table 1. Values of i less than 30°are not listed, since the mass of star C (M_C) would be high enough for C to make a detectable contribution at visible wavelengths, contrary to what is observed. Assuming black-body radiation, the luminosity of star C can then be computed for any wavelength and normalised to units of $L_A + L_B$; thus, the quantity l_C ("third light") plotted in Figure 1 and given for some standard photometric passbands in Table 1 is $l_C = L_C/(L_A + L_B)$.

Table 1. Model properties for AR Aur C at an age of 4×10^6 years

i	M_C	R_C	T_C	$l_C(R)$	$l_C(I)$	$l_C(J)$	$l_C(H)$	$l_C(K)$	$l_C(L)$	$l_C(M)$
90°	0.523	1.097	3825	0.01	0.01	0.02	0.03	0.03	0.05	0.05
70°	0.559	1.129	3877	0.01	0.01	0.02	0.03	0.04	0.05	0.06
60°	0.611	1.172	3953	0.01	0.01	0.02	0.03	0.04	0.05	0.06
50°	0.698	1.218	4090	0.01	0.02	0.03	0.04	0.05	0.06	0.07
40°	0.847	1.348	4321	0.01	0.03	0.04	0.05	0.07	0.08	0.09
30°	1.124	1.553	4682	0.02	0.05	0.06	0.09	0.10	0.12	0.14

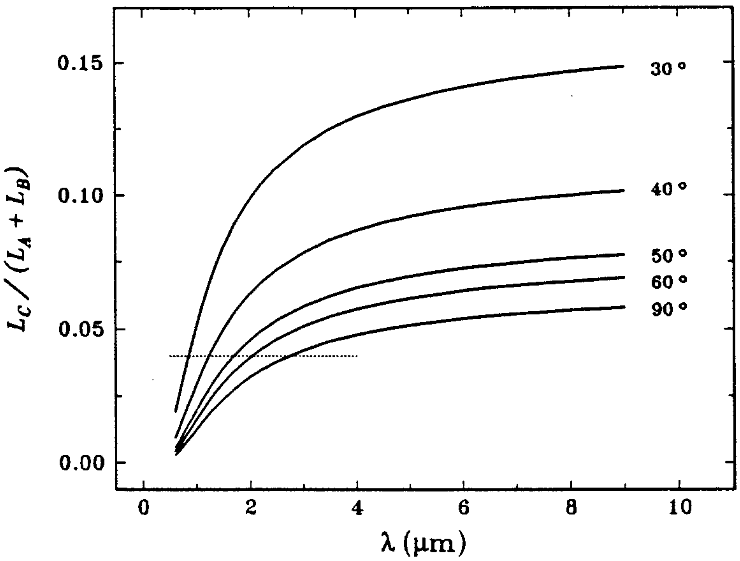

Figure 1. Fractional light of star C as a function of assumed orbital inclination and wavelength.

If the light contribution from star C is significant, the depth of the minima in the light curves of the eclipsing pair AB will be reduced. The question we wish to address is the following: Given the photometric elements, radii and inclination, from our previous analysis of light curves of AB at wavelengths where third light is negligible, at what (larger) wavelength could we observe a reduction in eclipse depth due to star C relative to what we would predict without it?

Using the b_F (4747 Å) light curve and analysis tools from our previous study, we have studied this question by adding specified amounts of third light and then redetermining l_C from the light curve, gradually reducing the number of points used. We find that we can recover l_C rather accurately with a surprisingly few observations of the precision of the b_F light curve, 0.01 mag: Typical standard errors are 0.01 with 40 points, 0.02 with just 10 well-distributed points on the light curve (about half near both mid-eclipses, half outside eclipse). This remarkable economy is possible because the existing high-quality analysis provides an accurate prediction of the eclipse depths in the absence of third light. The errors in l_C scale, of course, with the mean errors of the actual new observations, which will also depend on the wavelength of observation.

The dotted line in Figure 1 indicates the usable wavelength for which 0.04 of third light is measurable with certainty. For inclinations close to 90° (i.e., near co-planarity of the orbits), the K band (2.2 μm) is just at the detection limit for star C with 1% photometry. In the L and M bands (3.5 and 5 μm), detection will be easier, but photometry probably correspondingly more difficult. The N band (9 μm) should be avoided, as dust emission might be significant.

Deviations from the ephemeris derived earlier for the eclipsing pair AB:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2\,438\,402.1847\ +\ 4\overset{\mathrm{d}}{.}1346662\times \mathrm{E}$$

due to motion in the AB-C orbit are not more than 12 minutes, and secondary minima occur midway between primary eclipses since the AB orbit is circular. In planning follow-up photometry, observers should be aware of the problems with variable comparison stars described in Nordström & Johansen (1994). It is proposed to use two of the reliable stars:

HR 1734, HR 1738, or HR 1749. HR 1734 has a faint ($m_V = 11.8$) companion at a distance of $3\overset{''}{.}8$, which always should be included.

K. T. JOHANSEN
B. NORDSTRÖM
The Niels Bohr Institute of
Astronomy,
Physics and Geophysics
Astronomical Observatory
Brorfeldevej 23
DK-4340 Tølløse
Denmark

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AK CANCRI – A NEW LARGE-AMPLITUDE SU UMA-TYPE DWARF NOVA

AK Cnc was discovered by Morgenroth (1933), who classified it as a possible short-period variable star. After a long period of confusion, the object was identified as a dwarf nova (for a review, see Wenzel 1993). The peculiarity of this object was noted by Szkody and Howell (1992), who identified strong Balmer and helium emission lines and a red continuum in the spectrum of AK Cnc, and estimated the quiescent $M_{\rm V}$ value between 10.4 and 11.9. The faintness of quiescent $M_{\rm V}$ and a large outburst amplitude ($>$ 6 mag) make AK Cnc a good candidate for a TOAD (Tremendous Outburst Amplitude Dwarf Nova; Howell 1993). A search for a photometric period, however, has remained unsuccessful (Howell et al. 1990).

On 1992 Jan. 13, the object was caught in one of its rare outbursts at m_V=13.6 (Koshiro, private communication). We obtained a V-band CCD photometry of this star on three nights between Jan. 17 and Jan. 22. The observations were carried out using a 60 cm reflector and a Thomson TH7882 chip (576×384 pixels) at Ouda Station, Department of Astronomy, Kyoto University (for a description of the instruments see Ohtani et al. 1992). The exposure time was between 30 and 60 s to avoid saturation from the strong moonlight. The frames were first corrected for standard de-biasing and flat fielding, and were then processed by a microcomputer-based automatic-aperture photometry package developed by the author. The differential magnitudes of the variables were determined using a local standard star (C$_1$: $08^{\rm h}55^{\rm m}15\overset{\rm s}{.}42$ $+11^\circ14'53\overset{''}{.}8$ (J2000.0), V=13.3), whose constancy was confirmed using a check star (C$_2$: $08^{\rm h}55^{\rm m}26\overset{\rm s}{.}05$ $+11^\circ20'04\overset{''}{.}5$ (J2000.0), V=15.1). Total number of useful frames was 1007.

The resulting overall light curve is shown in Figure 1. The zero-point corresponds to V=13.3. A general trend of slow linear decline is evident. Superimposed on this decline, superhumps with an amplitude of 0.18 mag were detected on all nights. The star was thus for the first time identified as being an SU UMa-type dwarf nova.

A representative light curve is shown in Figure 2; a large scatter in the light curve is caused by a high sky background due to the proximity of the object to the nearly full moon. A period analysis using the phase dispersion minimization (PDM) method (Stellingwerf 1978) implemented in the IRAF package after removing the steady decline yielded the best estimate of the superhump period of 0.06735 ± 0.00005 day. A light curve folded on this period is shown in Figure 3. Each point represents an average of 0.05 phase bin and its standard error. This clearly demonstrates all the characteristics of fully grown superhumps: a rather steep rise to maximum, slower decline, and a broader secondary maximum around superhump phase 0.4 – 0.5. The superhump makes AK Cnc a member of short orbital-period SU UMa-type dwarf novae. This picture is in good agreement with the spectroscopic features described by Szkody and Howell (1992).

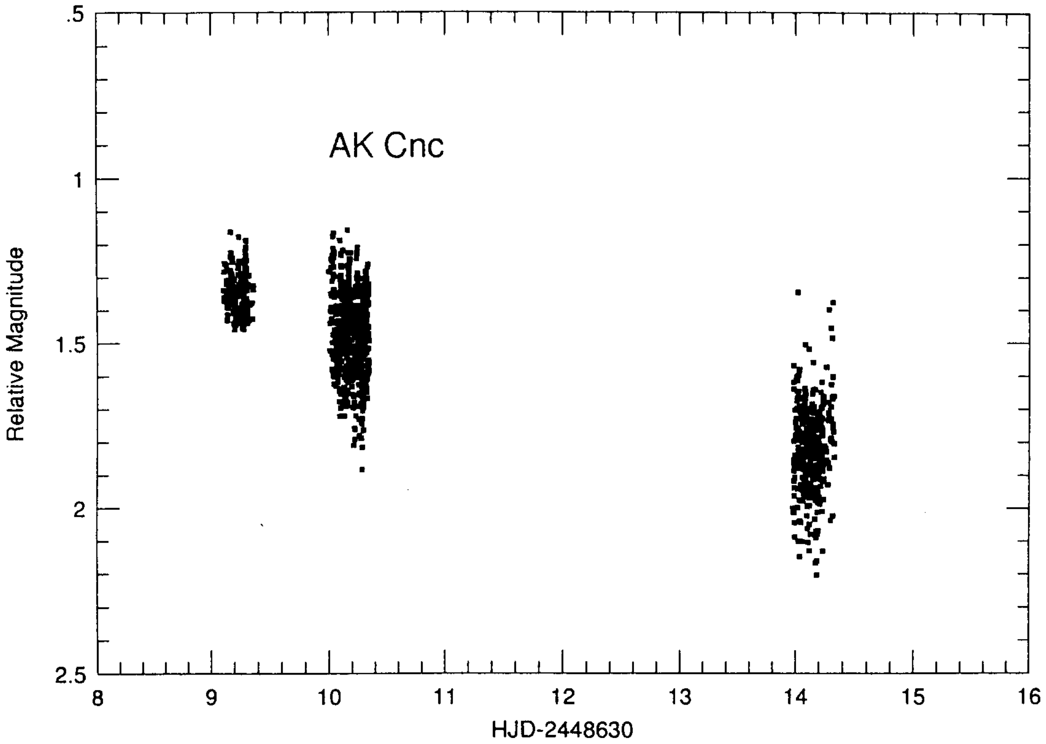

Figure 1. General *V*-band light curve of AK Cnc.
The zero point of the relative magnitudes corresponds to V=13.3.

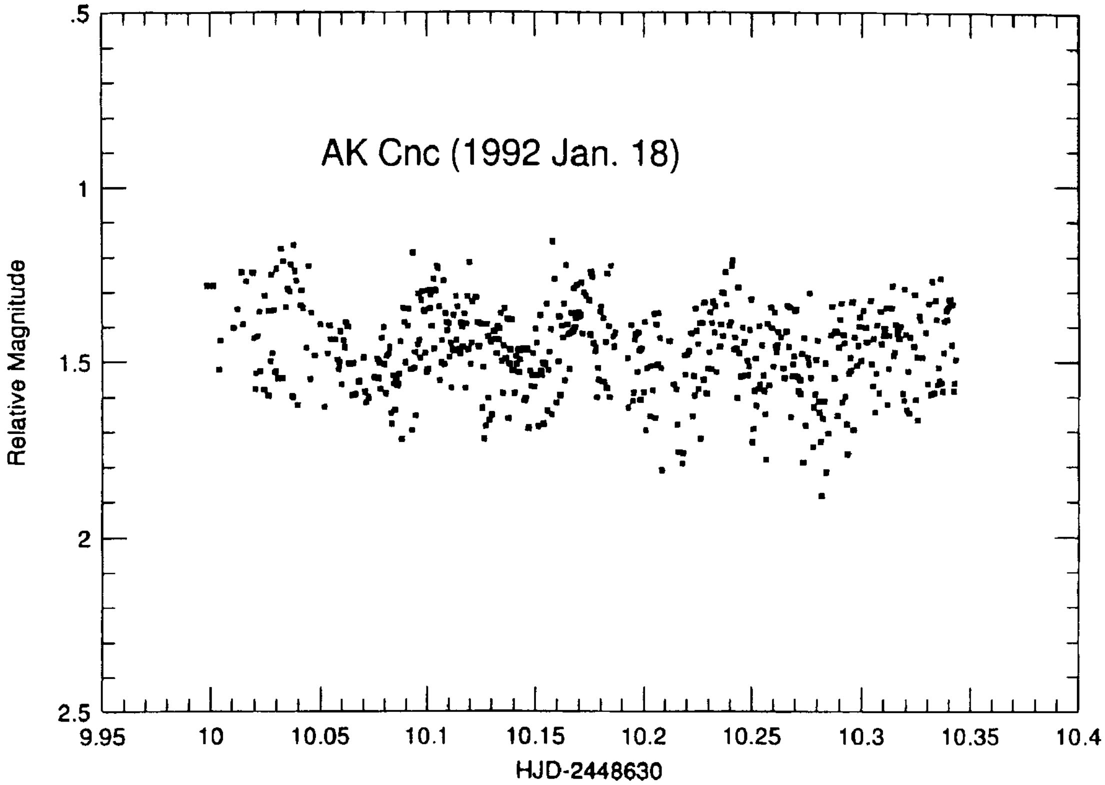

Figure 2. Sample light curve (1992 Jan. 18).
Superhumps with an amplitude of 0.18 mag are clearly seen.

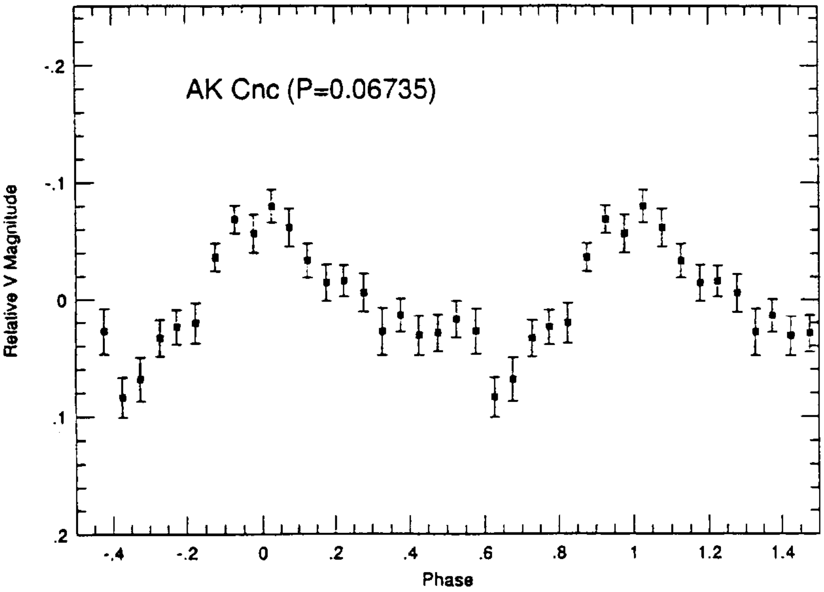

Figure 3. Light curve folded on the superhump period of 0.06735 day.

The outburst characteristics of this dwarf nova is still uncertain. Wenzel (1993) gives five outburst records from Sonneberg plates. The second one in his table (1993 March 8 – 15) is clearly a superoutburst. Further monitoring for outbursts of this dwarf nova is encouraged in order to determine its true outburst frequency and number ratio of super- and normal outbursts, both of which would also be good indicators for discriminating TOADs from other dwarf novae.

The author is grateful to Masami Koshiro (VSOLJ) for notifying us of the outburst. Part of this work was supported by a Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists.

Taichi KATO
Dept. of Astronomy, Faculty of Sci.
Kyoto University
Sakyo-ku, Kyoto 606-01 Japan

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POSITIONS OF VARIABLE STARS IN PLAUT'S FIELD 3

This paper continues the study announced in our previous publication (Antipin *et al.*, 1994a) and deals with the variable stars in the Palomar–Groningen Field 3 (Plaut, 1971). This field contains 1474 variable stars discovered by Plaut. Using photographic finding charts prepared by L. Plaut and available in Moscow, we have checked for possible GSC identifications. 174 stars have been identified with the GSC. We have also checked 83 stars discovered in this field by other authors and identified 23 of them with GSC objects. We are not able to present the corresponding table here because of volume restrictions and are planning to publish this list in Astronomical and Astrophysical Transactions. We have not found very significant positional mistakes among those stars we were able to identify with GSC. We have also checked positions for non-GSC variable stars and found quite a number of serious mistakes in GCVS positions. The corrected coordinates presented in

Table 1. Corrected Coordinates for Variable Stars

Plaut	GCVS, NSV	$\alpha(2000.0)$	$\delta(2000.0)$	$\Delta\alpha$	$\Delta\delta$
23	V2636 Sgr	$18^{h}12^{m}23\overset{s}{.}0$	–31°20'40"	$-0\overset{m}{.}01^{s}$	$-1^{\circ}00\overset{\prime}{.}0$
34	V2647 Sgr	18 12 38.1	–31 08 00	–0 03	–0 00.6
111	V2705 Sgr	18 13 49.7	–34 20 46	–0 02	–0 00.8
307	V2852 Sgr	18 16 43.2	–34 01 22	+0 00	–0 03.4
437	V2965 Sgr	18 18 27.0	–32 10 39	–0 01	–0 11.2
474	V2988 Sgr	18 11 42.2	–36 11 44	+0 10	–0 01.5
521	V3033 Sgr	18 12 32.2	–32 39 15	–0 42	–0 04.0
580	V3081 Sgr	18 20 36.2	–34 46 21	+0 07	+0 00.2
707	V3180 Sgr	18 23 02.2	–33 57 25	+0 00	–0 00.9
732	V3200 Sgr	18 23 26.6	–30 54 07	–0 02	–0 17.6
755	V3220 Sgr	18 23 49.5	–31 11 43	–0 02	–0 16.1
782	V3243 Sgr	18 24 46.0	–32 03 01	–0 32	+0 00.1
835	V3288 Sgr	18 25 15.0	–33 33 46	+0 01	+0 11.3
881	NSV10777	18 26 13.4	–31 41 59	+0 04	+0 00.1
1027	V3447 Sgr	18 21 13.8	–30 53 46	+8 42	–0 00.8
1030	V3443 Sgr	18 29 56.2	–30 57 37	+0 01	–3 44.3
1158	V3549 Sgr	18 33 13.3	–31 22 27	+0 00	–0 11.2
1388	V3723 Sgr	18 39 39.1	–34 41 16	+0 14	–1 52.0
1395	V3729 Sgr	18 38 16.7	–36 51 46	+1 52	+0 00.6
1427	V3758 Sgr	18 32 14.2	–31 09 34	–1 00	+0 00.1
1453	V3774 Sgr	18 41 41.2	–32 54 35	+0 04	–0 33.4
1474	V666 CrA	18 22 22.7	–36 59 57	–0 09	+0 00.1
	NSV 10351	18 12 20.9	–31 50 24	+0 15	+0 01
	NSV 10364	18 12 59.4	–31 46 47	+0 13	+0 00.2

Table 2. Identifications of Several GCVS Stars

474	V2988 Sgr = V655 Sgr	Plaut, 1971
595	NSV 10648 = V1289 Sgr	Mayall, 1951 (chart)
723	V1188 Sgr = NSV 10715	Strohmeier *et al.,* 1964
1063	V3475 Sgr = V2355 Sgr	Rosino, 1962
1105	V3507 Sgr = V2360 Sgr	Rosino, 1962
1388	V3723 Sgr = V1635 Sgr	Plaut, 1971
1395	V3729 Sgr = V2371 Sgr	Plaut, 1971
1414	V3746 Sgr = V948 Sgr = V1154 Sgr	GCVS

Table 1 have been determined by one of us (S.A.) relative to GSC stars. The columns of the table contain: Plaut's numbers (the two last lines, without Plaut's numbers, refer to variables discovered by Rosino (1962), in the field of the globular cluster NGC 6569); GCVS or NSV designations; right ascensions and declinations (2000.0); positional differences found (in the sense GCVS minus present study).

Table 2 contains 8 stars for which positional inaccuracies have led to multiple entries in the GCVS and the NSV catalogue. The first column gives Plaut's numbers. The second column presents the existing GCVS or NSV designations. The last column of the table identifies the source of error. If the star in Table 2 does not enter also Table 1, Plaut's coordinates for this star are to be preferred.

Several final remarks deal with difficult cases. It turns out that Plaut's variable No. 239 ($18^h12^m32^s$, $-31°07\overset{'}{.}3$, 1950.0, Cepheid with a period of 51: days according to Plaut, 1971) never got a GCVS designation. The reasons for this are presently unclear, no indication of any mistakes revealed is present in GCVS team records. Though the star could not be identified with any GSC star, Plaut's coordinates agree with the photograph. We have not been able to find Plaut's No. 1282 = V3643 Sgr. The photograph does not agree with the coordinates, a great mistake in coordinates is probable.

Mr. J. Mánek has turned our attention to a mistake in the second paper of the present series (Antipin *et al.,* 1994b). The declination presented there for V448 Oph = GSC 6237.1702 is wrong, the correct δ(2000.0) value is −18°06'56".

Thanks are due to Mr. Jan Mánek for his attention to our work.

S.V. ANTIPIN
Sternberg Astronomical Institute
of Moscow University
13, Universitetskij Prosp.
Moscow 119899, Russia

N.N. KIREEVA
N.N. SAMUS
Institute of Astronomy
of Russian Academy of Sciences
48, Pyatnitskaya Str.
Moscow 109017, Russia

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TIMINGS OF SELECTED VARIABLE STARS[1]

Changes in the periods of variable stars can be determined by timing the occurrence of a certain point in the light curve, usually the maximum or minimum value. It is necessary to have such timings at frequent enough intervals so that cycle counts can be reliably determined in between. Often in the course of other routine observations, such timings are obtained and the purpose of this paper is to make available such data to other researchers.

Most of the photometric data were obtained with telescopes at Lowell Observatory in Flagstaff, AZ but some came from CTIO in Chile (σ Sco and ν Eri). The raw photometry was corrected for sky, and the atmospheric extinction was removed using a comparison star. Then differential magnitudes were determined and heliocentric corrections applied. For stars with a single mode, plots of the light curves were made and a cross-correlation technique between the ascending and descending branch was used to derive the time of maximum or minimum. The uncertainty of an individual timing varies with data quality, but is typically 0.0005 days. It is planned to submit all of the data upon which these timings have been made to the Journal of Astronomical Data, Twin Press, The Netherlands.

Table 1. Times of Photometric Minimum of Eclipsing Binary Stars.

Star Name	HJD	notes
BX And	2447108.7773	primary min
	2447535.7064	secondary min
	2447573.6826	primary min
TY Boo	2447641.7811	primary min
	2447641.9398	secondary min
W Crv	2447234.7467	primary min
	2447237.8561	primary min
	2447250.8553	secondary min
	2449108.7855	primary min
	2449109.7580	secondary min

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[1] Visiting Observer, Lowell Observatory, Flagstaff, Arizona, USA. Also based in part on data collected at Cerro Tololo Inter-American Observatory, National Optical Astronomy Observatories, operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation.

Table 2. Times of Photometric Maximum/Minimum of β Cephei Stars.

Star Name	HJD	notes
ν Eri	2444450.8184	max for P1 = 0.173506 d
	2444450.8937	max for P2 = 0.178063 d
σ Sco	2444457.6980	max for P2 = 0.246836 d
	2444457.7130	max for P1 = 0.239670 d
BW Vul	2447704.7345	max
	2447704.8300	min
	2447803.6580	max
	2447826.6639	min
	2447833.6100	max
	2447827.5755	max
	2447833.7020	min
	2447840.6484	max
	2447840.7373	min
	2448062.8020	max
	2448062.8885	min
	2448084.8152	min
	2448193.6753	max
	2448193.7676	min
	2448194.6820	max
	2448403.8630	min
	2448403.9713	max
	2448421.7744	min
	2448421.8685	max
	2449662.6000	min
	2449662.7120	max
	2449663.6025	min
	2449663.7164	max

Table 1 lists the times of primary and secondary minimum for three close binary stars. There is enough new data only for W Crv to produce a new ephemeris at this time. For these close binaries, it might be expected that the orbital period might be changing due to mass exchange between the two stars, so both a linear and quadratic ephemeris were computed, combining 12 timings for W Crv from the literature with the five listed in Table 1. The least squares quadratic ephemeris yielded only marginally smaller residuals than the linear, and in any case produced a rate of period change of just 0.025 seconds/century, which is probably only an upper limit. The linear ephemeris can be used to schedule future observations; it is:

$$\mathrm{HJD} = 2427861.3634 + 0.388080835 \times \mathrm{E}.$$

Table 2 gives times of maximum and minimum brightness for three β Cephei stars. For those with multiple modes, cosine functions were fit using the known periods, but solving for the best phase and amplitude of each mode, and the time of maximum was derived.

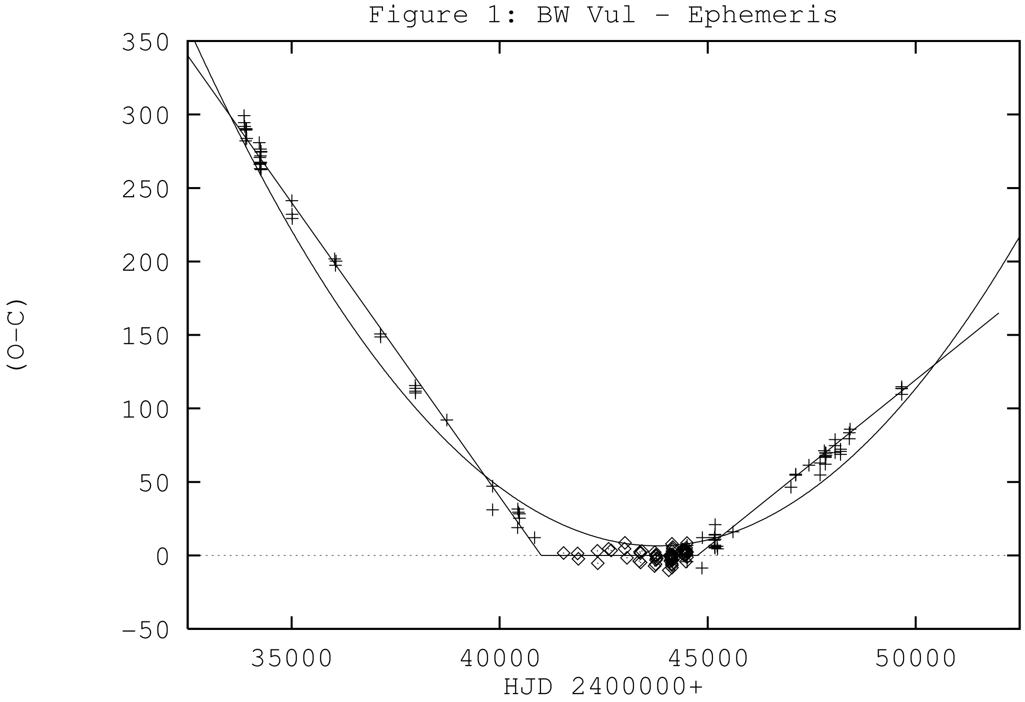

Figure 1. O−C diagram for BW Vul

These timings are completely independent of each other, and depend on the beat phase of the star at the time of the observation. For BW Vul, times of minimum light are included because of the suggestion by Sterken, Young, and Furenlid (1987) that the stillstand in this star's light curve could alter the timings derived for maximum brightness.

A least squares linear ephemeris was fit to all times of maximum brightness measured for BW Vul since 1980, which can be used for predicting maximum brightness for the near future:

$$\text{HJD} = 2447700.1158 + 0.201044444 \times \text{E}$$

with an rms residual of 1.25 minutes.

The period history of BW Vul has been controversial for about ten years, since the discovery of a periodic variation of the residuals after a quadratic ephemeris has been removed, made by Odell (1984). The quadratic ephemeris can be explained in terms of the star's evolution to larger size, and the periodic residuals can be explained either by the light-travel-time over a binary orbit or by two modes beating with a period of about 30 years. The controversy arises from the claim of Chapellier (1985) that the period has been constant except for sudden jumps in 1945 and 1968, and again in 1980 (Chapellier and Garrido, 1990). Pigulski (1993) has derived the properties of the binary star orbit, including an orbital period of 33.5 years.

In order to distinguish between the two proposed behaviors of this star, a linear ephemeris was fit to the previously published timings of maximum between 1968 and 1980, and the residuals computed for all timings since 1950; these are shown in Figure 1.

The diamond symbols in the figure represent timings used in the linear fit, while the pluses represent eras in which a different ephemeris must be used. It can be seen that the residuals are fit well by three straight lines, but the residuals predicted from a quadratic ephemeris also agree reasonably well, especially if a periodic variation on either side of the quadratic is allowed for.

Figure 1 gives a method of determining which of the two types of ephemeris is the correct one. If the quadratic-with-variations ephemeris is correct, the figure predicts that there must be another increase in the period by about 0.25 seconds at HJD about 2452000, or in the year 2000. If the piecewise-linear ephemeris is correct, there is no way to predict when the next period change will occur, or the magnitude, or even the sign of the change. Thus the monitoring of this star for the next ten years becomes important to distinguishing the correct ephemeris form.

Andrew P. ODELL
Northern Arizona University
Dept of Physics and Astronomy
Flagstaff, AZ 86011, U.S.A.
Internet: odell@nauvax.ucc.nau.edu

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UBV OBSERVATIONS OF AB Dor, 1993

The peculiar, active, cool dwarf AB Dor (= HD 36705, SAO 249286) has received considerable international attention in recent years (cf. Vilhu *et al.*, 1993), being the target of several multi-site, multi-wavelength 'campaigns', most recently in 1994 when the HST, EUVE, ASCA and other major facilities were brought into concerted action in its direction.

A good earlier photometric review is that of Innis *et al.* (1988), who supplied the ephemeris Min = JD 2444296.575 + $0\overset{d}{.}51479 \times$E, that has been generally favoured in subsequent studies. AB Dor has been usually assigned a peculiar, early K spectral type.

The star was observed using the automated photometer ('APT') of the Kotipu Place Observatory (Hudson *et al.*, 1993) on six nights between 29 Sep and 14 November, 1993, using the UBV filters provided with the SSP 5 photometer of Optec Inc. The observation period overlaps with the recently published data set of Anders (1994) and Bos (1994). The (partial) light curves of these authors for the time interval involved are essentially confirmed by the APT.

The main comparison star was HD 37297 ($V = 5.34$, $B - V = 1.04$, $U - B = 0.85$, sp. type K0III — cf. SIMBAD) with occasional checks being made on HD 35537, also a K0III star. For this star we derive the following: $V = 7.84$, $B - V = 0.99$, $U - B = 0.71$.

The observations have been reduced on a PC (cf. Budding, 1993), and the resulting V light curve is presented in Figure 1. This light curve results from binning some 683 individual data into 85 "normal" points, and correcting slightly the magnitudes due to the small redness excess of the comparison star with respect to AB Dor ($\Delta(B - V) = 0.20$, $\epsilon = 0.019$).

The B and U light curves are essentially similar in shape to the V one. The B magnitude ranges from 7.68 at brightest ($V = 6.82$) to 7.82 at the phases 0.0 and 0.2, corresponding to the lowest (6.94) on this V data set. Individual B observations have a scatter of about 0.02 mag, i.e. comparable to that of the raw data in V. The U data, on the other hand, has a noticeably larger dispersion — up to 0.04 mag around the phase region 0.4-0.5, where the raw data quality appears to be at its poorest. The U light curve ranges from about 8.03 to 8.19 mag. The conformities in shape, though slightly greater ranges in the B and U, when set against the V light curve, support maculation as a likely explanation for the photometric behaviour. The slight reddening at the minimum was also noted by Bos (1994).

These light curves are almost complete, though there is a small phase interval close to the bottom of the minimum not covered by the present dataset. Bos (private communication) observed this region on Nov 13 1993, just before the last APT night presented here, and essentially confirmed the phase, magnitude range and shape of this minimum.

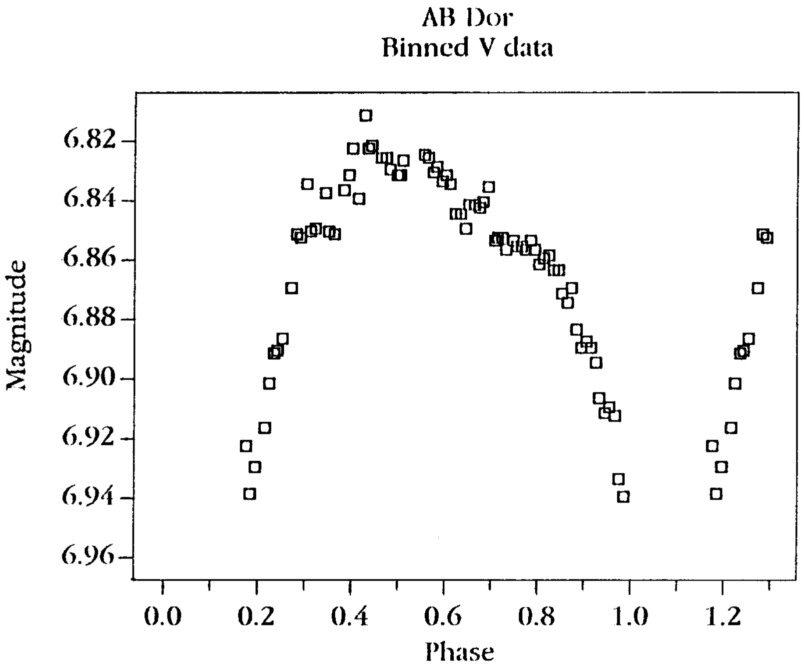

Figure 1

There is a slight difference in phase of Bos' minimum ($\sim$ 0.06) and ours, however, which, from the shape of the descending sides would be located somewhat closer to 0.1. Anders' (1994) minimum, which derives from observations a few weeks later, is still earlier in phase — close to zero, in fact. Hence, there is a suggestion, from these three data sets, which range over the later months of 1993, of a tendency for the 'spot(s)' associated with the maculation, to have drifted slightly backwards in phase, relative to the ephemeris of Innis *et al.* (1988), while preserving the overall shape of the photometric effect.

E. BUDDING,
G. HUDSON and
R. HUDSON
Carter and Kotipu Place
Observatories,
Wellington, New Zealand

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THE 72ND NAME-LIST OF VARIABLE STARS

The present 72nd Name-List of Variable Stars, compiled in the manner first introduced in the 67th Name-List (IBVS No. 2681, 1985), contains all data necessary for identification of 491 new variables finally designated in 1994. The total number of designated variable stars has now reached 31193.

The 72nd Name-List consists of two tables. Table 1 contains the list of new variables arranged in the order of their right ascensions. It gives the ordinal number and the designation of each variable; its equatorial co-ordinates for the equinox 1950.0; the range of variability (sometimes the column "Min" gives, in parentheses, the amplitude of light variation); and the system of magnitudes used (the symbol "Ic" means magnitudes in Cousins' I system, the symbols "y", "b", Strömgren's y, b magnitudes); the type of variability according to the classification system described in the forewords to the first three volumes of the 4th GCVS edition (with the additions introduced in the 68th Name-List, IBVS No. 3058, 1987, and in the 69th Name-List, IBVS No. 3323, 1989, and one addition described below); two references to the reference list which follows Table 2 (the first reference is to the investigation of the star, the second one indicates the paper containing a finding chart, or the corresponding Durchmusterung – BD, CoD, or CPD – containing the variable, or the Hubble Space Telescope Guide Star Catalog – GSC – if the star can be found using it).

In order not to continue using (∗) symbols for comparatively long-period pulsating B stars (periods exceeding one day; see the 71st Name-List, IBVS No. 3840, 1993), we introduce for such variables a provisional type **LBV**.

In a small number of cases, the value of the variability amplitude (column "Min", in parentheses) could not be expressed in the same system of magnitudes as the star's brightness; in such cases we indicate the photometric band for the amplitude separately, an asterisk in the corresponding position for V2027 Cyg means the amplitude measured in white light.

Table 2 contains the list of variables arranged in the order of their variable star names within constellations. After the designation of a variable, its ordinal number from Table 1 is given, as well as identifications with several major catalogues and identifications necessary to find this star in the papers with the first (or independent) announcement of the discovery of its variability. References to such papers are given in square brackets after the corresponding identification. The name of the discoverer accompanies the reference only in the case of its being different from the name of the author(s) of the paper referred to. For the stars having NSV catalogue numbers, the references to discovery papers already taken into account in the NSV catalogue are not always given. After the identifications, some minimal remarks are given if necessary.

Several **new corrections** to earlier Name-Lists have been found. In the **68th Name-List** (IBVS No. 3058, 1987), Table 1, p. 4, there is an obvious misprint in the GCVS name of the star No. 121 (instead of V900 Tau, read V909 Tau). In the same Table, p. 9, the classification given for the star No. 368 (V345 Nor) actually refers to another star (named only in the present, 72nd Name-List as V352 Nor); the most probable variability type for V345 Nor is M:. In Table 2, p. 21, for IW Peg add identification with NSV 14392. In the **70th Name-List** (IBVS No. 3530, 1990), Table 2, p. 7, add identification with AFGL 751 for V1028 Tau; p. 8, identifications with IRC+30229 and Gliese 423 should be added for ξ UMa. Three corrections refer to the **71st Name-List** (IBVS No. 3840, 1993). Rather regretfully, one of them is connected with... a correction to the Name-List No. 69; this correction (p. 2) deals with KR Peg, not KP Peg. Identifications of Table 2 for V1241 Ori (p. 17) should be added with TSN 392 and Haro 404. In the same Table, add He 3-436 to identifications for LX Vel (p. 21).

Thanks are due to S.V. Antipin for his assistance in GSC identifications and positional determinations, to E.N. Pastukhova for help during the preparation of the computer version of the present Name-List, and to members of the GCVS team who prepared information for the variable star data base.

E.V. KAZAROVETS
N.N. SAMUS
Institute of Astronomy
of Russian Academy of Sciences
48, Pyatnitskaya Str.
Moscow 109017, Russia

Table 1

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.
			h m s	o '	m	m			
72001	CO	Tuc	00 26 25	-72 26.7	13.67	14.14	V	RRC	164 165
72002	BU	Cet	00 32 40	-03 52.1	3.86	3.96	K	RS	054 BD
72003	BV	Cet	00 41 15	-10 16.8	14.51	(0.1)	V	ZZ	055 056
72004	PZ	And	02 17 39	+49 55.4	5.59	(0.045)	V	ACV	001 BD
72005	V703	Cas	02 24 01	+60 37.	14.6	15.8	B	I	037
72006	EP	Eri	02 50 07	-12 58.3	6.03	6.08	V	RS	087 BD
72007	XY	Ari	02 53 22	+19 13.5	13.54	17.60	J	NL+EA+X	017 018
72008	V704	Cas	03 03 39	+60 17.8	11.4	12.1	P	SR	022 BD
72009	V514	Per	03 16 05	+49 56.0	11.4	(0.32)	V	E	138 138
72010	V515	Per	03 23 47	+47 47.0	12.7	(9.0):	U	UV	139 139
72011	V516	Per	03 25 18	+50 05.9	14.1	(4.6):	U	UV	139 139
72012	epsil	Eri	03 30 34	-09 37.6	3.73	(0.05)	V	BY	089 BD
72013	V517	Per	03 37 24	+38 50.4	10.5	11.4	P	LB	022 BD
72014	V1064	Tau	03 40 54	+23 07.0	14.8	(18.	U	UV	156
72015	BU	Hyi	03 41 07	-72 04.8	16.96	17.57	B	RR	082 082
72016	BV	Hyi	03 42 23	-72 01.0	19.63	20.29	B	RR	082 082
72017	V1065	Tau	03 43 42	+23 20.7	12.18	(0.15)	V	RS:	157 158
72018	BW	Hyi	03 45 33	-72 05.5	18.78	21.12	B	RRAB	082 082
72019	BX	Hyi	03 45 34	-72 04.8	19.10	20.06	B	RRC	082 082
72020	V1066	Tau	03 47 34	+21 51.3	14.3	(18.	U	UV	156
72021	BY	Hyi	03 48 05	-71 45.5	19.07	19.98	B	RRAB	082 082
72022	V1067	Tau	04 00 12	+25 44.7	12.86	12.98	V	INT:	157 020
72023	V1068	Tau	04 13 22	+28 00.2	14.66	15.74	U	INT	159 160
72024	V1069	Tau	04 15 59	+17 16.0	12.16	12.36	V	INT	019 020
72025	V1070	Tau	04 16 36	+27 42.5	14.35	15.20	U	INT	159 160
72026	V518	Per	04 18 30	+32 47.4	13.15	(22.4	V	XND+ELL:	140 140
72027	V1071	Tau	04 18 57	+28 18.6	13.40	13.60	V	INT	019 160
72028	V1072	Tau	04 24 17	+17 44.0	10.24	10.37	V	INT	161 020
72029	EQ	Eri	04 27 58	-28 59.3	7.7	(0.10)	V	DSCT	088 CoD
72030	V1073	Tau	04 28 30	+18 09.6	10.27	10.34	V	INT	161 020
72031	V1074	Tau	04 28 34	+17 00.0	12.51	12.64	V	INT	019 020
72032	V1075	Tau	04 29 16	+17 51.0	12.01	12.36	V	INT	019 020
72033	V1076	Tau	04 29 50	+17 56.7	13.14	13.30	V	INT	161 020
72034	V1077	Tau	04 31 24	+18 23.9	12.69	12.82	V	INT	161 020
72035	V1078	Tau	04 32 20	+18 15.5	10.92	11.02	V	INT	161 020
72036	TV	Ret	04 34 52	-59 21.4	16.61	20.77	B	UG:	082 082
72037	V1079	Tau	04 36 18	+22 15.2	11.91	12.89	V	INT	019 160
72038	V1080	Tau	04 37 30	+24 20.8	10.29	10.56	V	INA	019 BD
72039	AK	Dor	04 37 51	-59 07.6	16.98	17.70	B	RR	082 082
72040	V1081	Tau	04 40 54	+22 51.1	6.9	7.3	V	E	162 162
72041	V396	Aur	04 52 26	+30 13.2	10.78	11.01	V	INT	019 020
72042	V397	Aur	04 52 51	+30 16.3	11.46	11.71	V	INT	019 020
72043	V398	Aur	05 02 45	+51 32.0	4.93	5.03	V	I:	021 BD
72044	V1261	Ori	05 19 55	-08 42.8	6.91	(0.27)	V	EA/GS/WD	129 BD

Table 1 (continued)

No.	Name	R.A.,Decl.,1950.0		Max	Min	Type	Ref.
		h m s	o ’	m	m		
72045	V399 Aur	05 22 29	+29 35.8	11.1	11.8	P SR	022 GSC
72046	V1262 Ori	05 24 52	-05 42.9	15.4	16.7	U UVN	130 130
72047	V400 Aur	05 25 33	+32 23.1	11.1	11.7	P SR	022 GSC
72048	V401 Aur	05 25 37	+32 26.3	9.6	10.1	P SR:	022 BD
72049	V1263 Ori	05 26 57	-07 26.0	14.0	16.8	U UVN	130 130
72050	V1264 Ori	05 27 50	-06 31	15.0	(18.4	U UVN	130 130
72051	V1265 Ori	05 28 22	-06 09	15.4	(18.4	U UVN	130 130
72052	V1266 Ori	05 29 52	-06 35.9	16.0	(18.6	U UVN	130 130
72053	V1267 Ori	05 30 27	-06 08.1	14.5	(18.4	U UVN	130 130
72054	V1268 Ori	05 30 32	-04 49.4	14.2	16.8	U UVN	130 130
72055	V1269 Ori	05 31 20	-07 18.5	15.7	(18.5	U UVN	130 130
72056	V1270 Ori	05 31 32	-04 23.2	17.1	17.6	U UVN	130 130
72057	V1271 Ori	05 32 24	+10 00.5	9.83	9.95	y INA	131 BD
72058	V1272 Ori	05 32 25	-04 31.0	14.6	16.2	U UV	130 130
72059	V1273 Ori	05 32 27	-05 24.4	15.7	(0.39)	Ic IN	132 133
72060	V1274 Ori	05 32 37	-05 25.1	12.9	(0.39)	Ic IN	132 133
72061	V1275 Ori	05 32 40	-05 31.2	15.0	(0.20)	Ic IN	132 133
72062	V1276 Ori	05 32 45	-05 32.2	15.1	(0.21)	Ic IN	132 133
72063	V1277 Ori	05 32 45	-05 17.3	13.9	(0.27)	Ic IN	132 133
72064	V1278 Ori	05 32 48	-05 24.3	12.7	(0.32)	Ic IN	132 133
72065	V1279 Ori	05 32 49	-05 26.0	11.5	(0.34)	Ic IN	132 133
72066	V1280 Ori	05 32 53	-04 17.9	16.4	(18.6	P UVN	130 130
72067	V1281 Ori	05 32 54	-05 16.9	15.5	(0.16)	Ic IN	132 133
72068	V1282 Ori	05 32 54	-05 28.6	14.1	(0.16)	Ic IN	132 133
72069	V1283 Ori	05 32 57	-05 28.4	13.7	(0.25)	Ic IN	132 133
72070	V1284 Ori	05 32 58	-05 28.6	13.6	(0.26)	Ic IN	132 133
72071	V1285 Ori	05 32 59	-05 27.7	13.5	(0.35)	Ic IN	132 133
72072	V1286 Ori	05 33 00	-05 28.3	12.6	(0.24)	Ic IN	132 133
72073	V1287 Ori	05 33 00	-05 29.3	13.6	(0.33)	Ic IN	132 133
72074	V1288 Ori	05 33 01	-05 26.9	13.1	(0.18)	Ic IN	132 133
72075	V1289 Ori	05 33 02	-05 18.4	13.3	(0.06)	Ic IN	132 133
72076	V1290 Ori	05 33 02	-05 26.8	13.2	(0.24)	Ic IN	132 133
72077	V1291 Ori	05 33 02	-05 11.0	15.6	(0.34)	Ic IN	132 133
72078	V1292 Ori	05 33 03	-05 30.4	14.1	(0.47)	Ic IN	132 133
72079	V1293 Ori	05 33 03	-05 29.2	13.8	(0.20)	Ic IN	132 133
72080	V1294 Ori	05 33 04	-05 17.4	12.1	(0.16)	Ic IN	132 133
72081	V1295 Ori	05 33 23	-03 59.7	15.5	16.1	U UVN	130 130
72082	V1296 Ori	05 33 25	-06 11.9	15.	17.16	U UVN	134 135
72083	V1297 Ori	05 33 28	-04 13.3	16.0	(18.4	U UVN	130 130
72084	V1298 Ori	05 34 48	-04 03.0	15.4	18.2	U UVN	130 130
72085	V1299 Ori	05 35 22	-01 39.2	12.1	13.0	P IB:	022 GSC
72086	V1300 Ori	05 35 25	-06 41.5	12.3	15.47	U UVN	130 130
72087	V1301 Ori	05 35 39	-05 03.0	15.6	16.5	U UVN	130 130
72088	V1302 Ori	05 36 04	-05 05.7	13.7	15.0	U UVN	130 130

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.	
			h m s	o '	m	m				
72089	V1303	Ori	05 37 38	-05 33.9	16.1	17.0	P	UVN	130	130
72090	V1304	Ori	05 38 01	-08 09.1	13.58	13.98	V	INT	136	136
72091	V1305	Ori	05 39 26	-08 01.9	13.12	13.35	U	INT	136	136
72092	V1306	Ori	05 39 51	-05 29.5	15.7	16.6	U	UVN	130	130
72093	TZ	Col	05 50 19	-28 40.0	9.05	(0.06)	V	RS	060	CoD
72094	V1307	Ori	05 59 06	+16 31.0	9.48	(0.35)	V	INA	131	029
72095	V696	Mon	06 01 48	-06 42.3	5.12	5.18	B	*	113	BD
72096	UV	Lep	06 09 07	-15 46.8	6.77	(0.01 B)	V	ACVO	098	BD
72097	V697	Mon	06 10 24	-06 12.3	15.40	16.67	B	INT	114	051
72098	V1308	Ori	06 15 54	+15 18.1	11.47	11.62	V	INA	028	051
72099	V698	Mon	06 28 04	+10 35.3	12.86	13.36	V	IA	028	051
72100	V699	Mon	06 29 56	+10 11.4	10.36	10.84	V	INA	115	029
72101	V700	Mon	06 30 19	+10 21.6	8.62	8.91	V	INA	115	029
72102	PP	Gem	06 53 43	+14 22.9	11.1	12.2	P	SR	022	090
72103	HT	CMa	07 00 22	-11 21.8	11.87	12.24	V	IA	028	029
72104	HU	CMa	07 01 46	-11 21.6	11.61	12.05	V	IA	028	029
72105	HV	CMa	07 02 49	-14 56.4	7.10	9.93	J	M	007	142
72106	HW	CMa	07 06 15	-22 19.7	9.19	(0.13)	y	EA	030	BD
72107	HX	CMa	07 09 54	-20 12.3	6.94	8.62	J	M	007	031
72108	BK	CMi	07 12 59	+05 08.0	12.	13.5	B	SR	032	BD
72109	BL	CMi	07 21 13	+01 43.2	11.5	12.5	P	E:	033	034
72110	V352	Pup	07 38 50	-47 47.3	12.62	(2.4)	V	INT	141	GSC
72111	V701	Mon	07 43 58	-04 37.2	15.27	15.63	Ic	EW	116	116
72112	V702	Mon	07 44 04	-07 37.9	18.20	18.68	Ic	EW/KW	116	116
72113	V703	Mon	07 44 05	-04 35.0	17.70	18.52	Ic	EW/KW	116	116
72114	V704	Mon	07 44 17	-04 34.6	17.20	17.65	Ic	EW/KW	116	116
72115	V705	Mon	07 44 18	-04 30.9	15.96	16.04	Ic	EW/KW	116	116
72116	V706	Mon	07 44 18	-04 36.7	15.28	15.54	Ic	EW/KW	116	116
72117	V707	Mon	07 44 18	-04 35.0	18.31	19.37	Ic	EW	116	116
72118	V708	Mon	07 44 19	-04 35.3	14.55	14.69	Ic	E:	116	116
72119	V709	Mon	07 44 22	-04 28.7	16.16	16.72	Ic	EW/KW	116	116
72120	V710	Mon	07 44 23	-04 34.2	14.57	15.01	Ic	EW/KW	116	116
72121	V711	Mon	07 44 24	-04 32.9	16.85	17.01	Ic	EW/KW	116	116
72122	V712	Mon	07 44 32	-04 31.3	16.85	17.21	Ic	EW/KW	116	116
72123	V353	Pup	07 44 38	-32 11.1	3.10	3.55	J	SR	036	CoD
72124	PQ	Gem	07 48 31	+14 52.1	13.7	14.50	B	XPM	091	091
72125	CD	Cam	07 53 06	+72 54.4	11.63	11.85	V	EW	023	024
72126	FF	Cnc	08 26 49	+17 27.1	10.82	11.40	V	EA	025	025
72127	EQ	UMa	08 32 43	+53 45.1	12.4	(0.2)	V	EW/KW	166	166
72128	FG	Cnc	08 39 18	+20 51.	15.0	15.6	U	UV	026	
72129	FH	Cnc	08 44 06	+20 46.	13.5	(17.	U	UV	026	
72130	BK	Lyn	09 17 08	+34 09.5	14.49	(0.32)	V	NL	109	085
72131	LY	Vel	09 18 48	-47 21.2	7.75	(0.02)	V	LBV	172	CoD
72132	ER	UMa	09 43 47	+52 07.9	12.4	15.2	V	UG:	167	085

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.
			h m s	o ’	m	m			
72133	ES	UMa	09 50 22	+69 27.5	10.99	11.38	V	EW	168 217
72134	LZ	Vel	09 52 38	-43 05.1	7.27	7.39	V	RS:	173 CoD
72135	MM	Vel	10 11 32	-44 49.7	14.9	19.	B	XND	174
72136	ET	UMa	10 20 33	+65 49.2	4.91	(0.05)	B	ACV	169 BD
72137	V433	Car	10 22 06	-57 12.6	8.12	8.17	V	BCEP	035 CPD
72138	V434	Car	10 28 43	-57 33.4	9.26	12.0	J	SRC	036
72139	TU	Crt	11 01 09	-21 21.6	12.1	17.5	B	UGSU	067 068
72140	V870	Cen	11 36 00	-63 04.0	10.41	10.68	V	BE	077 CPD
72141	V871	Cen	11 36 00	-63 05.7	6.48	(0.12)	V	EB	041 CPD
72142	V872	Cen	11 44 45	-61 53.2	12.67	13.12	I	CEP	042
72143	V873	Cen	11 46 32	-62 09.0	11.32	11.75	I	CEP	042
72144	EU	UMa	11 47 20	+29 01.8	16.45	16.93	B	AM	170 170
72145	V874	Cen	11 49 14	-62 57.3	13.76	14.15	I	CEP	042
72146	V875	Cen	11 51 25	-58 41.7	3.90	5.62	L’	M	007
72147	V876	Cen	11 52 11	-62 00.7	12.12	12.54	I	CEP	042
72148	CI	Cru	11 58 13	-62 04.7	13.52	13.85	I	CEP	042
72149	CK	Cru	12 00 24	-62 13.1	12.26	12.67	I	CEP	042
72150	CL	Cru	12 04 23	-64 17.8	6.18	7.74	K	M	007
72151	CM	Cru	12 31 04	-62 33.3	8.03	(1.75)	J	M	036
72152	BP	CVn	12 45 17	+34 39.3	11.9	12.8	P	SR	022 027
72153	DK	Cha	12 49 38	-76 50.7	9.28	11.15	J	INA	057 058
72154	CN	Cru	12 50 51	-60 06.7	8.61	(0.24)	B	EB	069 070
72155	IP	Com	12 54 09	+30 09.9	14.48	15.14	V	RRAB	061 062
72156	V877	Cen	12 56 38	-61 21.9	10.44	11.15	V	EB	043 044
72157	V878	Cen	13 01 09	-61 02.9	10.37	11.12	V	EB	043 044
72158	EV	UMa	13 05 47	+54 07.5	17.	21.	V	AM	171 218
72159	V879	Cen	13 15 46	-64 21.7	6.8	9.2	K	M	036
72160	V880	Cen	13 19 05	-62 35.5	12.44	12.89	I	CEP	042
72161	V881	Cen	13 24 00	-62 45.6	10.26	10.93	I	CEP	042
72162	V882	Cen	13 32 19	-62 24.7	11.56	11.79	I	CEP	042
72163	V883	Cen	14 05 24	-59 02.4	6.40	6.63	b	E	040 CPD
72164	HX	Lup	14 19 22	-48 05.6	6.09	(0.06)	V	ELL:	099 CoD
72165	HY	Lup	14 28 26	-50 57.3	7.97	17.	V	N	197
72166	sigma	Lup	14 29 14	-50 14.2	4.42	(0.02)	V	ELL:	099 CoD
72167	V884	Cen	14 29 46	-60 10.4	7.93	(1.71)	H	M	036
72168	ER	Dra	14 30 21	+60 26.7	6.18	(0.03)	V	DSCTC	083 BD
72169	HZ	Lup	15 03 31	-30 43.5	5.96	(0.07 U)	V	ACV	101 CoD
72170	delta	Cir	15 12 53	-60 46.4	5.08	(0.1)	V	ELL	059 CPD
72171	II	Lup	15 19 27	-51 15.3	4.37	5.97	H	M	007 102
72172	ES	Dra	15 24 37	+62 11.4	13.9	16.3	P	NL	084 085
72173	theta	CrB	15 30 55	+31 31.6	4.06	4.33	V	BE	066 BD
72174	IK	Lup	15 36 16	-34 36.6	12.59	12.89	V	INT	103 104
72175	V351	Nor	15 40 50	-54 13.7	6.97	7.19	J	LB	036
72176	IL	Lup	15 43 34	-47 30.9	14.6	16.7	V	XNG	105 106

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.
			h m s	o '	m	m			
72177	IM	Lup	15 52 51	-37 47.4	11.73	12.09	y	INT	107 108
72178	V839	Her	15 53 49	+42 42.6	5.74	5.84	V	BE	093 BD
72179	V352	Nor	16 03 03	-51 56.5	13.	(16.	B	ZAND:	117 118
72180	UY	CrB	16 04 19	+28 15.1	12.5	13.8	P	RR:	065 065
72181	V1000	Sco	16 08 15	-18 57.0	11.90	12.06	V	INT	063 151
72182	V1001	Sco	16 09 05	-18 59.2	11.61	11.70	V	INT	063 151
72183	V1002	Sco	16 09 46	-18 51.8	10.74	10.93	V	INT	063 151
72184	V353	Nor	16 10 42	-51 39.8	7.38	(2.16)	K	M	036
72185	V840	Her	16 30 23	+07 01.0	11.2	12.2	V	E	094 095
72186	V1003	Sco	16 34 54	-43 18.0	5.83	(0.03)	V	ELL:	099 CoD
72187	V835	Ara	16 40 26	-48 33.7	9.0	(0.008)	B	ACVO	014 CoD
72188	V1004	Sco	16 41 32	-44 57.8	8.25	(1.39)	K	M	036
72189	V1005	Sco	16 47 26	-44 18.4	7.92	(1.46)	H	M	036
72190	V1006	Sco	16 49 31	-43 27.7	7.80	10.40	J	SR	036
72191	V2292	Oph	16 50 27	+00 04.5	6.78	(0.04)	V	BY:	119 BD
72192	V1007	Sco	16 50 39	-41 44.7	6.06	(0.24)	V	EB	041 CoD
72193	V841	Her	16 55 22	+35 21.8	11.08	11.25	U	UV	096 096
72194	V836	Ara	16 56 13	-46 14.6	7.51	(0.15)	V	E:	015 CoD
72195	V1008	Sco	17 00 25	-41 19.8	3.00	5.85	L'	M	036
72196	V1009	Sco	17 03 50	-40 26.9	3.52	5.10	L'	SR	036
72197	V837	Ara	17 04 48	-56 51.1	10.9	12.4	V	*	179 CPD
72198	V1010	Sco	17 07 21	-42 25.1	9.11	(1.43)	H	M	036
72199	V1011	Sco	17 07 25	-39 55.0	7.53	(2.72)	J	M	036
72200	V1012	Sco	17 11 57	-38 09.4	6.76	6.83	b	EB	040 CoD
72201	V1013	Sco	17 12 52	-37 48.8	8.34	(1.64)	K	SR	036
72202	V1014	Sco	17 14 28	-37 45.9	10.83	(1.61)	J	M	036
72203	V1015	Sco	17 16 05	-37 18.6	10.47	(2.68)	H	SR	036
72204	V2293	Oph	17 16 33	-24 58.0	17.1	21.5	B	XND	120
72205	V2294	Oph	17 17 09	-08 44.0	3.99	5.7	K	M	121
72206	V2295	Oph	17 22 04	-23 08.5	9.0	(21.	V	NA	122
72207	V2296	Oph	17 25 40	+05 04.7	3.0	4.1	K	M	121
72208	V1016	Sco	17 27 08	-34 25.5	9.44	(2.79)	K	SR	036
72209	V1017	Sco	17 27 11	-34 30.1	8.23	8.27	V	RS:	152 CoD
72210	V2297	Oph	17 30 49	+08 22.7	6.7	7.5	K	M	121
72211	V1018	Sco	17 31 45	-33 31.6	2.42	4.70	L'	SR	036
72212	V1019	Sco	17 36 02	-30 12.9	8.11	(3.39)	J	SR	036
72213	V2298	Oph	17 41 17	+05 33.3	14.0	14.9	B	RRC:	123 124
72214	V2299	Oph	17 43 58	+05 32.2	12.42	(0.08)	V	BY:	125 126
72215	V1020	Sco	17 44 34	-35 43.1	16.0	18.5	B	UV	153 153
72216	V1021	Sco	17 46 48	-35 49.4	16.0	18.0	B	UV	153 153
72217	V1022	Sco	17 48 01	-35 12.4	15.5	18.0	B	UV	153 153
72218	V1023	Sco	17 49 08	-36 07.1	16.7	18.1	B	UV	153 153
72219	V4201	Sgr	17 50 11	-26 56.0	7.76	(2.20)	J	SR	036 142
72220	V1024	Sco	17 50 31	-36 14.6	15.9	17.7	B	UV	153 153

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.	
			h m s	o ’	m	m				
72221	ET	Dra	17 51 03	+70 46.3	11.52	11.83	U	FKCOM	086	BD
72222	V1025	Sco	17 52 08	-36 25.7	15.7	17.2	B	UV	153	153
72223	V2300	Oph	17 57 41	+06 33.3	6.7	(0.02)	V	ELL:	045	BD
72224	V2301	Oph	17 58 12	+08 10.2	16.0	22.0	V	E+AM	127	085
72225	V4202	Sgr	18 00 23	-22 37.2	8.21	(0.25)	V	E:	015	BD
72226	V4203	Sgr	18 01 19	-24 22.4	9.60	10.19	V	INA	028	143
72227	V4204	Sgr	18 02 46	-24 15.6	11.06	11.35	V	INA	028	143
72228	V4205	Sgr	18 03 29	-24 54.2	16.5	18.1	B	RRAB	144	144
72229	V4206	Sgr	18 03 40	-31 21.9	16.6	17.7	B	RRAB	145	145
72230	V4207	Sgr	18 03 41	-31 06.5	16.8	18.3	B	RRAB	145	145
72231	V4208	Sgr	18 03 41	-31 01.7	17.0	18.2	B	RRAB	145	145
72232	V4209	Sgr	18 03 44	-31 35.9	16.6	17.0	B	RRC	145	145
72233	V4210	Sgr	18 03 49	-30 48.6	17.1	18.5	B	RRAB	145	145
72234	V4211	Sgr	18 03 50	-25 22.2	15.5	16.9	B	RRAB	144	144
72235	V4212	Sgr	18 03 53	-31 21.3	17.3	18.3	B	RRAB	145	145
72236	V4213	Sgr	18 03 55	-31 21.1	16.1	17.6	B	RRAB	145	145
72237	V4214	Sgr	18 04 01	-31 41.0	16.6	18.0	B	RRAB	145	145
72238	V4215	Sgr	18 04 10	-31 40.9	17.6	18.1	B	RRC	145	145
72239	V4216	Sgr	18 04 10	-30 46.5	18.0	18.6	B	RRC	145	145
72240	V4217	Sgr	18 04 10	-31 42.1	17.7	18.7	B	RRAB	145	145
72241	V4218	Sgr	18 04 11	-31 38.9	16.7	17.8	B	RRAB	145	145
72242	V4219	Sgr	18 04 12	-31 07.3	16.5	18.2	B	RRAB	145	145
72243	V4220	Sgr	18 04 12	-31 19.6	17.5	18.0	B	EW	145	145
72244	V4221	Sgr	18 04 13	-31 24.8	17.3	17.7	B	RRC	145	145
72245	V4222	Sgr	18 04 14	-30 38.6	16.8	18.1	B	RRAB	145	145
72246	V4223	Sgr	18 04 19	-31 31.3	17.3	18.3	B	RRAB	145	145
72247	V4224	Sgr	18 04 20	-30 53.9	17.6	18.2	B	RRC	145	145
72248	V4225	Sgr	18 04 22	-31 26.4	16.8	17.7	B	RRAB	145	145
72249	V4226	Sgr	18 04 23	-31 33.9	16.7	18.1	B	RRAB	145	145
72250	V4227	Sgr	18 04 24	-30 50.2	16.9	17.9	B	RRAB	145	145
72251	V4228	Sgr	18 04 25	-31 24.0	16.7	18.3	B	RRAB	145	145
72252	V4229	Sgr	18 04 25	-31 04.1	17.4	18.1	B	RRAB	145	145
72253	V4230	Sgr	18 04 31	-31 43.1	16.8	18.1	B	RRAB	145	145
72254	V4231	Sgr	18 04 34	-31 23.1	16.2	17.5	B	RRAB	145	145
72255	V4232	Sgr	18 04 36	-30 40.6	17.1	18.0	B	RRAB	145	145
72256	V4233	Sgr	18 04 38	-31 27.0	17.5	18.0	B	EW/KW	145	145
72257	V4234	Sgr	18 04 40	-30 41.6	16.1	17.1	B	RRAB	145	145
72258	V4235	Sgr	18 04 40	-30 43.6	17.1	18.3	B	RRAB	145	145
72259	V4236	Sgr	18 04 40	-30 49.0	18.0	18.7	B	RRC	145	145
72260	V4237	Sgr	18 04 40	-31 33.8	17.1	18.1	B	RRAB	145	145
72261	V4238	Sgr	18 04 41	-30 43.5	17.2	18.3	B	RRAB	145	145
72262	V4239	Sgr	18 04 45	-31 27.7	16.8	18.1	B	RRAB	145	145
72263	V4240	Sgr	18 04 45	-31 25.0	16.9	18.0	B	RRAB	145	145
72264	V4241	Sgr	18 04 46	-30 58.9	16.7	18.3	B	RRAB	145	145

Table 1 (continued)

No.	Name	R.A.,Decl.,1950.0		Max	Min		Type	Ref.
		h m s	o ’	m	m			
72265	V4242 Sgr	18 04 48	-30 48.1	17.2	18.3	B	RRAB	145 145
72266	V4243 Sgr	18 04 49	-30 59.0	16.7	17.5	B	RRAB	145 145
72267	V4244 Sgr	18 04 49	-30 40.8	17.1	18.3	B	RRAB	145 145
72268	V4245 Sgr	18 04 50	-30 38.0	16.3	17.2	B	RRAB	145 145
72269	V4246 Sgr	18 04 53	-31 35.7	18.2	18.7	B	EA	145 145
72270	V4247 Sgr	18 04 54	-31 43.4	16.6	17.2	B	RRC	145 145
72271	V4248 Sgr	18 04 55	-31 29.4	17.2	18.0	B	RRAB	145 145
72272	V4249 Sgr	18 04 56	-30 48.0	18.0	18.3	B	RRC	145 145
72273	V4250 Sgr	18 04 58	-31 20.2	16.7	17.9	B	RRAB	145 145
72274	V4251 Sgr	18 05 01	-30 49.1	16.1	17.8	B	RRAB	145 145
72275	V4252 Sgr	18 05 06	-30 59.7	17.3	18.7	B	RRAB	145 145
72276	V4253 Sgr	18 05 08	-31 32.7	16.5	17.1	B	RRC	145 145
72277	V4254 Sgr	18 05 08	-31 15.5	15.4	16.8	B	RRAB	145 145
72278	V4255 Sgr	18 05 08	-31 31.0	17.2	17.7	B	RRC	145 145
72279	V4256 Sgr	18 05 09	-31 32.3	16.3	17.6	B	RRAB	145 145
72280	V4257 Sgr	18 05 10	-31 15.5	16.9	17.2	B	EA:	145 145
72281	V4258 Sgr	18 05 10	-31 39.3	17.1	17.7	B	RRC	145 145
72282	V4259 Sgr	18 05 13	-31 39.1	17.2	18.3	B	RRAB	145 145
72283	V4260 Sgr	18 05 15	-30 37.7	17.8	18.4	B	RRC	145 145
72284	V4261 Sgr	18 05 16	-31 02.3	16.9	17.9	B	RRAB	145 145
72285	V4262 Sgr	18 05 19	-31 42.2	17.5	18.3	B	RRAB	145 145
72286	V4263 Sgr	18 05 24	-31 31.4	17.2	17.9	B	RRC	145 145
72287	V4264 Sgr	18 05 25	-31 08.2	16.7	17.7	B	RRAB	145 145
72288	V4265 Sgr	18 05 25	-31 31.8	17.0	17.4	B	RRC:	145 145
72289	V4266 Sgr	18 05 26	-31 20.6	16.8	17.9	B	RRAB	145 145
72290	V4267 Sgr	18 05 26	-31 33.1	16.5	17.9	B	RRAB	145 145
72291	V4268 Sgr	18 05 30	-30 37.7	16.1	17.6	B	RRAB	145 145
72292	V4269 Sgr	18 05 31	-31 27.0	18.2	18.6	B	RRC	145 145
72293	V4270 Sgr	18 05 32	-31 01.4	17.3	18.5	B	RRAB	145 145
72294	V4271 Sgr	18 05 33	-31 35.8	17.8	18.3	B	RRC	145 145
72295	V4272 Sgr	18 05 33	-31 21.2	16.5	18.0	B	RRAB	145 145
72296	V4273 Sgr	18 05 35	-31 03.3	16.8	18.4	B	RRAB	145 145
72297	V4274 Sgr	18 05 45	-30 40.4	17.1	17.8	B	RRC	145 145
72298	V4275 Sgr	18 05 47	-31 00.5	16.9	18.1	B	RRAB	145 145
72299	V4276 Sgr	18 05 47	-31 41.9	16.2	16.6	B	RRC	145 145
72300	V4277 Sgr	18 05 48	-31 16.8	17.0	18.4	B	RRAB	145 145
72301	V4278 Sgr	18 05 53	-31 44.3	16.2	17.3	B	RRAB	145 145
72302	V4279 Sgr	18 06 03	-31 21.6	17.0	18.1	B	RRAB	145 145
72303	V4280 Sgr	18 06 06	-30 54.8	16.5	18.0	B	RRAB	145 145
72304	V4281 Sgr	18 06 08	-31 00.9	17.5	18.2	B	RRAB	145 145
72305	V4282 Sgr	18 06 09	-30 49.5	16.3	17.4	B	RRAB	145 145
72306	V4283 Sgr	18 06 12	-31 17.6	16.5	18.0	B	RRAB	145 145
72307	V4284 Sgr	18 06 12	-31 38.3	15.7	16.6	B	RRAB	145 145
72308	V4285 Sgr	18 06 13	-30 41.2	16.8	17.8	B	RRAB	145 145

Table 1 (continued)

No.	Name	R.A.,Decl.,1950.0		Max	Min		Type	Ref.
		h m s	o ’	m	m			
72309	V4286 Sgr	18 06 18	-30 51.9	16.8	17.7	B	RRAB	145 145
72310	V4287 Sgr	18 06 20	-31 36.3	16.9	17.4	B	RRC:	145 145
72311	V4288 Sgr	18 06 25	-31 34.0	16.1	17.6	B	RRAB	145 145
72312	V4289 Sgr	18 06 34	-31 34.4	16.2	17.3	B	RRAB	145 145
72313	V4290 Sgr	18 06 35	-30 43.2	17.1	18.2	B	RRAB	145 145
72314	V4291 Sgr	18 06 38	-30 51.9	17.0	17.5	B	RRC	145 145
72315	V4292 Sgr	18 06 40	-31 23.4	16.5	17.9	B	RRAB	145 145
72316	V4293 Sgr	18 06 44	-31 05.3	15.8	17.0	B	RRAB	145 145
72317	V4294 Sgr	18 06 46	-30 45.6	17.2	18.1	B	RRAB	145 145
72318	V4295 Sgr	18 06 48	-30 47.5	17.4	18.2	B	EA	145 145
72319	V4296 Sgr	18 06 50	-30 59.0	16.6	17.2	B	RRAB	145 145
72320	V4297 Sgr	18 06 51	-30 49.7	15.7	17.3	B	RRAB	145 145
72321	V4298 Sgr	18 06 52	-30 54.0	16.6	17.6	B	RRAB	145 145
72322	V4299 Sgr	18 06 55	-31 27.7	16.8	17.3	B	RRC	145 145
72323	V4300 Sgr	18 06 55	-30 50.2	16.8	17.9	B	RRAB	145 145
72324	V2302 Oph	18 06 56	+09 11.7	4.07	5.5	K	M	121
72325	V4301 Sgr	18 06 58	-31 44.4	17.1	18.0	B	RRAB	145 145
72326	V4302 Sgr	18 07 00	-31 22.8	16.2	17.3	B	RRAB	145 145
72327	V4303 Sgr	18 07 07	-31 09.2	16.7	17.2	B	RRC	145 145
72328	V4304 Sgr	18 07 08	-30 44.6	16.0	17.4	B	RRAB	145 145
72329	V4305 Sgr	18 07 11	-31 03.4	15.5	16.5	B	RRAB	145 145
72330	V4306 Sgr	18 07 14	-31 35.8	16.8	17.9	B	RRAB	145 145
72331	V4307 Sgr	18 07 16	-31 23.8	17.0	17.4	B	RRC	145 145
72332	V4308 Sgr	18 07 16	-31 00.8	17.5	18.0	B	DSCT	145 145
72333	V4309 Sgr	18 07 17	-31 17.0	16.8	17.9	B	RRAB	145 145
72334	V4310 Sgr	18 07 17	-30 36.6	16.5	17.7	B	RRAB	145 145
72335	V4311 Sgr	18 07 19	-30 54.4	15.5	16.5	B	RRAB	145 145
72336	V4312 Sgr	18 07 19	-30 45.7	16.0	17.2	B	RRAB	145 145
72337	V4313 Sgr	18 07 19	-30 55.7	16.0	17.4	B	RRAB	145 145
72338	V4314 Sgr	18 07 20	-30 23.3	16.9	17.4	B	RRC:	145 145
72339	V4315 Sgr	18 07 25	-30 43.5	17.6	18.2	B	EA	145 145
72340	V4316 Sgr	18 07 26	-30 56.8	16.0	17.3	B	RRAB	145 145
72341	V4317 Sgr	18 07 30	-31 08.4	17.4	18.2	B	DSCT	145 145
72342	V4318 Sgr	18 07 34	-30 39.6	16.4	17.1	B	RRAB	145 145
72343	V4319 Sgr	18 07 37	-30 45.6	15.7	17.2	B	RRAB	145 145
72344	V4320 Sgr	18 07 39	-30 57.2	16.6	17.2	B	EA	145 145
72345	V4321 Sgr	18 07 42	-31 32.6	15.5	16.8	B	RRAB	145 145
72346	V4322 Sgr	18 07 44	-31 12.0	16.6	17.5	B	RRAB	145 145
72347	V4323 Sgr	18 07 44	-30 49.2	18.0	18.5	B	EA	145 145
72348	V4324 Sgr	18 07 45	-31 02.5	15.8	17.4	B	RRAB	145 145
72349	V4325 Sgr	18 07 47	-31 28.6	16.5	17.8	B	RRAB	145 145
72350	V4326 Sgr	18 07 49	-31 06.8	16.8	17.8	B	RRAB	145 145
72351	V4327 Sgr	18 09 38	-29 29.9	8.	(12.	V	NA	146
72352	V4328 Sgr	18 14 40	-31 10.0	9.32	12.73	H	M	147

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.
			h m s	o ’	m	m			
72353	V4329	Sgr	18 14 59	-32 23.6	8.22	9.02	J	M	147
72354	NW	Ser	18 19 01	+05 24.7	5.39	5.59	U	BE	093 BD
72355	V4330	Sgr	18 24 04	-28 32.3	10.48	12.94	J	M	147
72356	V445	Sct	18 27 40	-14 31.0	11.45	11.7	J	SR	155 155
72357	V4331	Sgr	18 27 56	-27 07.8	9.61	12.20	J	M	147
72358	NX	Ser	18 33 19	+05 33.3	2.8	4.7	K	M	121
72359	V2303	Oph	18 36 09	+11 08.9	11.1	(12.5	VB	SR	128 128
72360	V491	Lyr	18 38 22	+40 17.0	9.2	10.5	B	SRB	075 BD
72361	V1417	Aql	18 39 48	-02 20.4	12.0	13.4	I	M	006 006
72362	V492	Lyr	18 41 45	+40 36.8	18.23	(0.22)	V	UG	110
72363	V4332	Sgr	18 47 37	-21 27.0	8.	17.	V	*	149
72364	V702	CrA	18 58 39	-37 12.0	10.48	10.58	V	INT	063 064
72365	V493	Lyr	18 59 58	+42 50.4	13.2	(17.2	P	UG	111 111
72366	V1418	Aql	19 00 53	+07 26.3	6.66	9.33	J	M	007 008
72367	V494	Lyr	19 01 22	+33 53.5	11.2	(15.0	V	M	071 071
72368	V337	Vul	19 04 15	+25 30.0	12.5	(16.0	V	M	071 071
72369	V495	Lyr	19 05 23	+31 38.1	12.6	14.4	V	SR	071 071
72370	V496	Lyr	19 05 38	+35 41.7	12.0	13.0	V	IB	071 071
72371	V497	Lyr	19 06 02	+36 18.3	11.9	13.5	V	IB	071 071
72372	V498	Lyr	19 07 10	+32 48.5	11.3	12.3	V	SR	071 071
72373	V338	Vul	19 08 07	+23 15.7	13.2	(15.	V	SR	071 071
72374	V339	Vul	19 09 08	+24 39.4	12.7	16.0	V	M	071 071
72375	V1419	Aql	19 10 35	+01 29.2	7.66	(22.	V	NA	009 010
72376	V340	Vul	19 10 36	+23 06.3	11.8	(15.	V	M	071 071
72377	V499	Lyr	19 10 52	+30 14.5	16.4	17.1	B	SRD:	112 112
72378	V500	Lyr	19 11 17	+26 53.6	13.8	(15.3	V	M	071 071
72379	V501	Lyr	19 12 51	+36 55.8	11.5	14.8	V	M	071 071
72380	V502	Lyr	19 15 55	+34 20.4	12.0	14.8	V	M	071 071
72381	V1420	Aql	19 17 35	-08 07.9	6.18	8.33	J	M	007 011
72382	V341	Vul	19 19 40	+24 37.4	12.9	(15.8	V	SR	071 071
72383	V342	Vul	19 19 54	+23 00.8	12.2	15.2	V	M	071 071
72384	V343	Vul	19 19 59	+26 16.6	13.4	(16.2	V	SR	071 071
72385	V344	Vul	19 20 37	+25 52.8	12.5	(15.2	V	M	071 071
72386	V345	Vul	19 21 46	+26 21.3	13.3	14.7	V	IB	071 071
72387	V503	Lyr	19 22 28	+32 13.3	11.7	(15.2	V	SRB	071 071
72388	V346	Vul	19 23 52	+26 32.3	13.2	(15.2	V	SR	071 071
72389	V504	Lyr	19 24 12	+34 56.9	11.6	(15.2	V	M	071 071
72390	V1421	Aql	19 24 48	+06 58.2	6.66	7.98	J	M	007 031
72391	V1985	Cyg	19 25 17	+35 17.6	11.6	(15.2	V	M	071 071
72392	V347	Vul	19 25 41	+24 36.4	11.9	15.2	V	M	071 071
72393	V348	Vul	19 28 09	+24 04.0	14.2	(16.0	V	M	071 071
72394	V1986	Cyg	19 28 13	+28 03.2	12.4	(15.2	V	M	071 071
72395	V349	Vul	19 29 04	+23 24.2	11.4	15.2	V	M	071 071
72396	V1987	Cyg	19 29 42	+28 44.0	12.7	14.5	V	SR	071 071

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.	
			h m s	o ’	m	m				
72397	V345	Pav	19 31 26	-59 15.0	13.5	14.7	B	EA+NL	137	137
72398	V4333	Sgr	19 33 31	-18 57.9	5.48	5.60	V	DSCT	150	BD
72399	V1988	Cyg	19 33 59	+34 09.2	12.3	15.2	V	M	071	071
72400	QS	Tel	19 34 58	-46 19.8	15.25	16.09	V	AM	163	163
72401	V350	Vul	19 37 13	+23 37.5	11.7	(15.0	V	M	071	071
72402	V351	Vul	19 38 13	+23 26.0	14.0	15.0	V	IB	071	071
72403	V352	Vul	19 38 57	+24 45.5	12.1	(15.2	V	M	071	071
72404	V1989	Cyg	19 40 09	+30 06.6	12.0	(15.2	V	M	071	071
72405	V1990	Cyg	19 41 41	+34 22.2	10.4	13.0	V	M	071	071
72406	V1991	Cyg	19 41 55	+32 22.2	10.2	14.7	V	M	071	071
72407	V1992	Cyg	19 44 27	+31 32.8	11.9	15.0	V	M	071	071
72408	V1993	Cyg	19 45 27	+35 38.4	12.7	14.6	V	SRA:	071	071
72409	V1994	Cyg	19 46 35	+31 58.6	13.0	15.1	V	SRA	071	071
72410	V353	Vul	19 47 12	+22 30.2	13.0	(15.5	V	M	071	071
72411	V1995	Cyg	19 47 13	+29 24.0	10.0	12.6	V	M	071	071
72412	V354	Vul	19 47 58	+22 25.0	13.2	(15.2	V	M	071	071
72413	V1996	Cyg	19 48 45	+29 21.5	12.8	15.2	V	M:	071	071
72414	V355	Vul	19 49 10	+26 02.9	12.7	(15.2	V	M:	071	071
72415	V1997	Cyg	19 49 33	+32 40.0	13.0	(15.1	V	M	071	071
72416	V356	Vul	19 49 58	+27 01.8	12.0	15.0	V	SR	071	071
72417	V1998	Cyg	19 50 23	+30 42.4	12.5	14.2	V	SR	071	071
72418	V357	Vul	19 51 49	+23 00.7	13.0	15.0	V	SR	071	071
72419	V1999	Cyg	19 52 29	+33 56.7	12.5	(15.2	V	M	071	071
72420	V358	Vul	19 53 03	+22 23.1	12.1	(15.0	V	M	071	071
72421	V359	Vul	19 53 47	+22 13.1	11.3	14.5	V	M	071	071
72422	V360	Vul	19 54 19	+23 08.4	12.4	14.2	V	SRB	071	071
72423	V2000	Cyg	19 55 31	+30 35.0	13.9	(15.2	V	SR	071	071
72424	V361	Vul	19 55 53	+22 41.3	13.0	14.7	V	IB	071	071
72425	V2001	Cyg	19 56 07	+31 46.7	14.1	(15.2	V	SRA:	071	071
72426	V2002	Cyg	19 56 13	+29 33.1	12.6	(15.2	V	M	071	071
72427	V2003	Cyg	19 57 08	+31 05.3	11.9	15.1	V	M	071	071
72428	V2004	Cyg	20 00 29	+29 43.3	11.8	15.1	V	M	071	071
72429	V362	Vul	20 00 37	+22 20.0	16.0	17.7	P	NL	175	176
72430	V2005	Cyg	20 01 12	+31 15.8	12.8	13.7	V	I	071	071
72431	V2006	Cyg	20 01 23	+29 46.4	11.8	13.6	V	SR	071	071
72432	V363	Vul	20 04 14	+25 18.9	12.5	(15.2	V	M	071	071
72433	V2007	Cyg	20 04 20	+35 09.0	12.6	15.1	V	M	071	071
72434	V2008	Cyg	20 04 30	+35 50.0	5.36	(0.05)	V	RS:	073	BD
72435	V2009	Cyg	20 04 43	+33 49.4	12.5	15.1	V	M	071	071
72436	V1422	Aql	20 04 51	+15 07.3	8.09	(0.10)	V	BY	012	BD
72437	V1423	Aql	20 06 09	+15 31.8	7.8	(0.045)	V	RS	012	BD
72438	V364	Vul	20 06 21	+25 27.3	13.8	(15.2	V	IB	071	071
72439	V2010	Cyg	20 07 44	+31 49.9	13.0	(15.2	V	M	071	071
72440	V365	Vul	20 07 56	+25 29.2	11.8	15.1	V	M	071	071

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.	
			h m s	o ’	m	m				
72441	V1424	Aql	20 08 27	+15 03.1	8.69	(0.14)	V	EA	013	BD
72442	V366	Vul	20 10 30	+24 27.7	12.4	(15.2	V	M	071	071
72443	V2011	Cyg	20 10 47	+40 07.0	7.93	(0.07)	B	*	074	BD
72444	V367	Vul	20 13 34	+25 17.7	10.3	(15.2	V	M	071	071
72445	V368	Vul	20 13 57	+24 04.4	11.6	(15.2	V	M	071	071
72446	V2012	Cyg	20 15 11	+31 23.9	11.6	12.2	P	LB	075	BD
72447	V369	Vul	20 16 16	+26 29.8	11.8	(15.2	V	M	071	071
72448	V370	Vul	20 16 33	+28 25.7	13.5	15.0	V	SRA	071	071
72449	V371	Vul	20 18 11	+22 34.2	6.7	8.7	K	M	121	
72450	V2013	Cyg	20 19 30	+30 15.1	13.0	(15.2	V	SR	071	071
72451	V372	Vul	20 19 31	+29 05.1	12.4	15.0	V	SR	071	071
72452	V373	Vul	20 19 57	+22 13.8	13.0	14.9	V	SRD	071	071
72453	V374	Vul	20 24 03	+27 59.7	12.8	(15.0	V	SR:	071	071
72454	V375	Vul	20 25 18	+24 07.5	12.0	(16.0	V	M	071	071
72455	V2014	Cyg	20 28 31	+48 47.0	4.86	(0.03 b)	B	BCEP:	045	BD
72456	V2015	Cyg	20 32 16	+46 31.3	5.62	(0.02 b)	B	ACV	045	BD
72457	LV	Del	20 39 56	+18 58.6	14.2	15.4	V	RV:	081	081
72458	V379	Cep	20 41 58	+56 56.0	6.65	(0.06 b)	B	EA	045	BD
72459	V2016	Cyg	20 44 51	+43 33.5	13.46	13.90	V	INA	028	076
72460	V2017	Cyg	20 44 56	+43 35.8	15.13	15.41	V	INA	028	076
72461	V2018	Cyg	20 45 00	+43 34.1	11.83	11.97	V	INA	028	076
72462	V2019	Cyg	20 46 18	+43 36.3	11.15	11.42	V	INA	028	076
72463	V2020	Cyg	20 46 34	+43 28.8	10.96	11.33	V	INA	028	076
72464	V2021	Cyg	20 51 10	+33 55.8	8.9	9.5	V	EA	078	BD
72465	V2022	Cyg	20 51 13	+44 03.8	11.88	12.15	V	INA	028	076
72466	V2023	Cyg	20 53 24	+44 51.7	11.77	12.18	V	INA	028	076
72467	V2024	Cyg	20 57 30	+44 06.1	14.24	14.40	V	INA	028	076
72468	V2025	Cyg	20 57 45	+44 24.3	13.78	13.91	V	INA	028	076
72469	V2026	Cyg	20 59 54	+44 08.3	13.37	14.02	V	INA	028	076
72470	V380	Cep	21 01 00	+67 57.9	7.10	7.36	U	INA	187	046
72471	HU	Aqr	21 05 20	-05 29.8	15.3	19.8	V	XRM+E	003	177
72472	V2027	Cyg	21 15 03	+33 59.8	13.16	(0.04 *)	V	ZZO	079	080
72473	V381	Cep	21 17 53	+58 24.7	5.51	5.71	V	LC:	047	BD
72474	V382	Cep	21 18 20	+64 39.6	5.08	5.23	V	BE	048	BD
72475	HV	Aqr	21 18 49	-03 22.4	9.71	10.11	V	EW/KW/RS	004	BD
72476	KY	Peg	21 47 23	+12 28.7	10.7	11.2	P	SR	022	BD
72477	V383	Cep	21 50 20	+61 42.4	7.27	7.58	V	EB	050	050
72478	V384	Cep	22 24 08	+60 05.4	13.72	15.34	I	M	006	006
72479	V376	Lac	22 30 41	+54 57.3	13.5	14.6	B	SRB	097	097
72480	V385	Cep	22 47 12	+61 55.3	13.97	14.74	V	INA	028	051
72481	V377	Lac	22 50 54	+39 54.0	6.25	(0.02 b)	B	LBV	045	BD
72482	V386	Cep	22 51 19	+61 01.2	8.8	11.5	V	SR	052	052
72483	KZ	Peg	22 51 40	+08 37.9	3.61	(1.41)	J	M	036	
72484	V387	Cep	23 01 19	+60 10.5	6.72	(0.02 b)	B	LBV	045	BD

Table 1 (continued)

No.	Name		R.A.,Decl.,1950.0		Max	Min		Type	Ref.
			h m s	o ’	m	m			
72485	CG	Gru	23 05 04	-47 43.1	15.06	15.47	V	EW/KW	092 092
72486	V388	Cep	23 13 41	+70 36.9	5.56	(0.07)	V	DSCT:	053 BD
72487	QQ	And	23 15 28	+40 34.3	10.5	11.2	P	SR	002 BD
72488	LL	Peg	23 16 43	+16 55.1	9.64	11.60	K	M	007
72489	LM	Peg	23 33 38	+27 24.6	10.6	11.3	P	SR	022 BD
72490	V705	Cas	23 39 23	+57 14.4	5.8	(16.	V	NA	039 039
72491	HW	Aqr	23 48 47	-24 24.9	15.52	(0.2)	B	ZZA	005

Table 2

PZ And = 72004 = 63 And [001, *Winzer*] = HR 682 = HD 14392 (A0p) = SAO 037960 = NSV 00790.
QQ And = 72487 = BD+40°5040 (9.1) [002] = ADS 16659.
HU Aqr = 72471 = RX 21 [003] = RXJ 2107.9–0518 = RE 2107–05 [177] = GSC 5200.0849.
HV Aqr = 72475 = BD–3°5183 (9.3) [004, *Hutton*] = GSC 5198.0659.
HW Aqr = 72491 = EC 23487–2424 [005].
V1417 Aql = 72361 = IRC 00365 = AFGL 2233 = IRAS 18398–0220 = CCS 2642 = NSV 11233 [006].
V1418 Aql = 72366 = IRC +10401 [007] = AFGL 2310 = IRAS 19008+0726 = CCS 2694 = NSV 11689.
V1419 Aql = 72375 = Nova Aql 1993 [009, *Yamamoto*].
V1420 Aql = 72381 = IRC–10502 [007] = AFGL 2368 = IRAS 19175–0807 = NSV 11912.
V1421 Aql = 72390 = AFGL 2392 [007] = IRAS 19248+0658.
V1422 Aql = 72436 = HD 191011 (K5) [012] = BD+14°4179 (8.0) = SAO 105709 = IRAS 20048+1507.
V1423 Aql = 72437 = HD 191262 (G5) [012] = BD+15°4057 (7.8) = SAO 105740.
V1424 Aql = 72441 = HD 191706(A0) [178] = BD+14°4211 (8.0) = SAO 105786.
V835 Ara = 72187 = HD 150562(A2) [014] = CoD–48°11127 (9.8) = CPD–48°8769 (9.0) = SAO 227125.
V836 Ara = 72194 = HD 153140(B3) = CoD–46°11150 (7.6) = CPD–46°8327 (7.6) = SAO 227533 = LSS 3877 = NSV 08082.
V837 Ara = 72197 = CPD–56°8032 (9.8) [016] = IRAS 17047–5650 = He 3-1333. PNN. RCB-like minima.
XY Ari = 72007 = H 0253+193 [017,018] = 1H 0253+193.
V396 Aur = 72041 = LkCa 19 [019] = HBC 426 = NTTS 045226+3013 = TAP 56 [161].
V397 Aur = 72042 = HBC 427 [019] = NTTS 045251+3016 [180] = TAP 57NW [020].
V398 Aur = 72043 = 9 Aur = HR 1637 [181] = HD 32537(F0) = BD+51°1024 (5.2) = SAO 025019 = ADS 3675A = Gliese 187.2 = IRAS 05027+5131.
V399 Aur = 72045 = DHK 30 [022] = IRAS 05224+2935 = GSC 1859.0163.
V400 Aur = 72047 = DHK 32 [022] = IRAS 05255+3222 = GSC 2407.0390.
V401 Aur = 72048 = DHK 31 [022] = HD 35816 (Mb) = BD+32°996 (8.8) = SAO 058083 = IRC+30117 = IRAS 05256+3226.
CD Cam = 72125 = Comparison star *c* for UY Cam [023].
FF Cnc = 72126 = GSC 1383.0600 [025,182].
FG Cnc = 72128 = Ton 25[026] = Prf 25.
FH Cnc = 72129 = Ton 26[026] = Prf 26.
BP CVn = 72152 = DHK 26[022] = Wr 127 [027] = GSC 2533.2081 = CSV 6959 = NSV 05949.
HT CMa = 72103 = LkHα 218 [028] = HBC 548 = IRAS 07003–1121.
HU CMa = 72104 = LkHα 220 [028] = HBC 551 = IRAS 07017–1121.
HV CMa = 72105 = AFGL 1062 [007] = IRAS 07028–1456.
HW CMa = 72106 = HD 54549 (A2) [030] = BD–22°1714 (9.0) = CoD–22°4063 (9.1) = CPD –22°1793 (8.7) = SAO 173044.

Table 2 (continued)

HX	CMa =	72107	= AFGL 1085 [007] = IRAS 07098–2012.
BK	CMi =	72108	= DHK 17 [032] = BD+5°1606 (9.5) = SAO 115161 = IRC+10158 = IRAS 07129+0509.
BL	CMi =	72109	= P 461 = 132.1929 = CSV 1032 = NSV 03570.
V433	Car =	72137	= HD 90288 (B3) [035, *Lampens*] = CoD–56°3324 (8.4) = CPD–56°3250 (8.2) = SAO 238024.
V434	Car =	72138	= OH/IR 285.05+0.07 [036] = IRAS 10287–5733 = OH 285.05+0.07.
V703	Cas =	72005	= M 301 [037].
V704	Cas =	72008	= DHK 25 [022] = BD+59°594 (9.5) = IRC+60111 = AFGL 4249S = IRAS 03036+6017= Zi 173 = CSV 100256 = NSV 01040.
V705	Cas =	72490	= Nova Cas 1993 [038, *Kanatsu*].
V870	Cen =	72140	= CPD–62°2167 (9.4) [183].
V871	Cen =	72141	= HD 101205 (B2) [041] = CoD–62°551 (7.5) = CPD–62°2168 (7.2) = SAO 251511 = IDS 1133.7S6249 = LSS 2427 = CSV 102670 = NSV 05277. Erroneously named HD 101191 in [040].
V872	Cen =	72142	= 11447–6153 [042].
V873	Cen =	72143	= 11465–6209 [042].
V874	Cen =	72145	= 11492–6257 [042].
V875	Cen =	72146	= IRAS 11514–5841 [007].
V876	Cen =	72147	= 11521–6200 [042].
V877	Cen =	72156	= LSS 2854 [043].
V878	Cen =	72157	= LSS 2895 [184, 185, 043].
V879	Cen =	72159	= OH/IR 305.91–1.91 [036] = IRAS 13157–6421 = OH 305.91–1.91 [186].
V880	Cen =	72160	= 13190–6235 [042].
V881	Cen =	72161	= 13240–6245 [042].
V882	Cen =	72162	= 13323–6224 [042].
V883	Cen =	72163	= HR 5292 = HD 123335 (B5) [040] = CoD–58°5469 (6.9) = CPD–58°5383 (7.0) = SAO 241478.
V884	Cen =	72167	= OH/IR 315.22+0.01 [036] = IRAS 14297–6010 = OH 315.22+0.01 [186].
V379	Cep =	72458	= HR 7940 [045] = HD 197770 (B3) = BD+56°2477 (6.7) = SAO 032832 = IRAS 20420+5655.
V380	Cep =	72470	= HD 200775 (B5) = BD+67°1283 (6.8) = SAO 019158 = MWC 361 = HBC 726 = Zi 1979 = CSV 102052 = NSV 13489. In ref. neb. NGC 7023.
V381	Cep =	72473	= HR 8164 [047] = HD 203338 (K0) = BD+58°2249 (5.6) = SAO 033318 = ADS 14864 = IRC+60313 = AFGL 2748 = IRAS 21178+5824.
V382	Cep =	72474	= 6 Cep [048, *Szabados, Kun*] = HR 8171 = HD 203467 (B3p) = BD+64°1527 (5.5) = SAO 019313 = MWC 367 = IRAS 21183+6439. According to [049], 4.8–5.3 vis during JD 2445123–46773.
V383	Cep =	72477	= HD 208106 (B3) [050] = BD+61°2209 = SAO 019685 = NSV 13911.
V384	Cep =	72478	= AFGL 2901 [006] = IRAS 22241+6005.
V385	Cep =	72480	= LkHα 350 [028] = HRC 314 = NSV 14330.
V386	Cep =	72482	= TAV 2251+61 [052, *Collins*] = IRC+60374 = AFGL 2982 = IRAS 22512+6100.
V387	Cep =	72484	= HR 8777 [045] = HD 217943 (B5) = BD+59°2631 (6.7) = SAO 020393 = ADS 16481.
V388	Cep =	72486	= HR 8851 [053] = HD 219586 (A3) = BD+70°1311 (6.0) = SAO 010671 = IRAS 23137+7037.
BU	Cet =	72002	= 13 Cet = HR 142 = HD 3196 (G0) = BD–4°62 (5.0) = SAO 128839 = ADS 490A = Gliese 23A = IRAS 00327–0351 = RE 003517–033558 = P 20 = CSV 100041 = NSV 00212.
BV	Cet =	72003	= Feige 7 [055] = G 270-48 [188] = Gr 267 = WD 0041–102 = BPM 70331 = PHL 814 = L 795-7 = LP 705-94.
DK	Cha =	72153	= IRAS 12496–7650 [058].
δ	Cir =	72170	= δ Cir [059, *Cousins*] = HR 5664 = HD 135240 (Oe5) = CoD–60°5539 (5.3) = CPD–60°5701 (5.4) = SAO 253084 = IDS 1508.9S6035 = LSS 3331 = CSV 7175 = NSV 06998.
TZ	Col =	72093	= HD 39576 (G0) [060] = CoD–28°2525 (8.7) = CPD–28°1019 (8.8) = SAO 170952 =1H 0543–289.
IP	Com =	72155	= Case 167 = SVS 1250 [062] = CSV 6968 = NSV 06031.

Table 2 (continued)

V702	CrA =	72364	= CoD–37°13029 (9.4) = CPD–37°8453 (9.6) = HBC 678 [063] =Wa CrA/2.
UY	CrB =	72180	= Wr 88 = CSV 7263 = NSV 07453.
θ	CrB =	72173	= θ CrB = 4 CrB = HR 5778 = HD 138749 (B5) = BD+31°2750 (4.2) = SAO 064769 = MWC 237 = IRAS 15309+3131 = NSV 07134.
TU	Crt =	72139	= J 05.23 [189].
CI	Cru =	72148	= 11582–6204 [042].
CK	Cru =	72149	= 12003–6213 [045].
CL	Cru =	72150	= IRSV 1204–6417 [007] = IRAS 12043–6417.
CM	Cru =	72151	= OH/IR 300.93–0.03 [036] = IRAS 12310–6233 = OH 300.93–0.03 [186].
CN	Cru =	72154	= CPD–59°4557 (9.7) = III-05 (NGC 4755) [190, 069].
V1985	Cyg =	72391	= LD 125 [071] = GSC 2662.2213.
V1986	Cyg =	72394	= LD 127 [071] = IRAS 19282+2803.
V1987	Cyg =	72396	= LD 129 [071].
V1988	Cyg =	72399	= LD 130 [071].
V1989	Cyg =	72404	= LD 134 [171].
V1990	Cyg =	72405	= TAV 1941+34 [072, *Collins*] = LD 135 [071] = IRAS 19416+3422 = AFGL 2443 = CCS 2783 = IRC+30385 = GSC 2664.0331 = Q 1989/78.
V1191	Cyg =	72406	= LD 136 [071] = IRAS 19419+3222.
V1992	Cyg =	72407	= LD 137 [071] = IRAS 19444+3132.
V1993	Cyg =	72408	= LD 139 [071].
V1994	Cyg =	72409	= LD 176 [071].
V1995	Cyg =	72411	= LD 141 [071] = IRAS 19472+2923 = GSC 2152.0824.
V1996	Cyg =	72413	= LD 177 [071] = IRAS 19487+2921 = GSC 2152.0122.
V1997	Cyg =	72415	= LD 146 [071] = IRAS 19495+3239.
V1998	Cyg =	72417	= LD 178 [071] = IRAS 19503+3042.
V1999	Cyg =	72419	= LD 179 [071] = IRAS 19524+3356.
V2000	Cyg =	72423	= LD 181 [071] = IRAS 19554+3035.
V2001	Cyg =	72425	= LD 152 [071] = IRAS 19560+3146.
V2002	Cyg =	72426	= LD 153 [071] = IRAS 19562+2933.
V2003	Cyg =	72427	= LD 154 [071] = GSC 2670.2068.
V2004	Cyg =	72428	= LD 155 [071] = IRAS 20004+2943.
V2005	Cyg =	72430	= LD 156 [071] = GSC 2670.2272.
V2006	Cyg =	72431	= LD 157 [071] = IRAS 20013+2946 = GSC 2153.0130.
V2007	Cyg =	72433	= LD 159 [071] = IRAS 20043+3508.
V2008	Cyg =	72434	= 27 Cyg [191, 192] = HR 7689 = HD 191026 (K0) = BD+35°3959 (5.5) = SAO 069413 = IRAS 20044+3549.
V2009	Cyg =	72435	= LD 160 [071] = IRAS 20047+3349.
V2010	Cyg =	72439	= LD 162 [071] = IRAS 20077+3149.
V2011	Cyg =	72443	= HD 192281 (B3) [074] = BD+39°4082 (7.5) = SAO 049319 = LS II+40°5 = NSV 12907. Periodic ($P=9\overset{\mathrm{d}}{.}59$) variability of an O5Vnfp (SB1, $P_{orb}=5\overset{\mathrm{d}}{.}480$) star.
V2012	Cyg =	72446	= DHK 22 [032] = HD 332077 (K2) = BD+31°4024 (9.2) = SAO 069757 = IRAS 20152+3124.
V2013	Cyg =	72450	= LD 168 [071] = IRAS 20194+3015.
V2014	Cyg =	72455	= ω^1 Cyg [045] = 45 Cyg = HR 7844 = HD 195556 (B3) = BD+48°3142 (4.9) = SAO 049712 = ADS 13932 = IRAS 20285+4846. Similar to λ Eri.
V2015	Cyg =	72456	= HR 7870 [193, 045] = HD 196178 (B9) = BD+46°2977 (6.0) = SAO 049804.
V2016	Cyg =	72459	= LkHα 131 [028] = UHα 18 = NSV 13293.
V2017	Cyg =	72460	= LkHα 132 [028] = CSV 8572 = NSV 13294.
V2018	Cyg =	72461	= AS 441 [028] = MHα 235-37 = NSV 13295.
V2019	Cyg =	72462	= LkHα 134 [028] = AS 443 = NSV 13317.
V2020	Cyg =	72463	= LkHα 135 [028] = AS 444 = MHα 148-95 = UHα 28 = NSV 13322.
V2021	Cyg =	72464	= DHK 29 [022] = BD+33°4070 (8.8) = SAO 070629.
V2022	Cyg =	72465	= LkHα 176 [028] = NSV 13384.
V2023	Cyg =	72466	= LkHα 183 [028] = NSV 13409.
V2024	Cyg =	72467	= LkHα 192 [028].
V2025	Cyg =	72468	= LkHα 193 [028] = NSV 13452.
V2026	Cyg =	72469	= LkHα 194 [028] = NSV 13470.

Table 2 (continued)

V2027	Cyg =	72472	= RXJ 2117.1+3412 [194, *Watson*; 079]. * – white light amplitude.
LV	Del =	72457	= New var near HR Del [081].
AK	Dor =	72039	= R 5 [082].
ER	Dra =	72168	= HR 5437 [083] = HD 127929 (F0) = BD+60°1547 (6.2) = SAO 016411 = IRAS 14303+6026.
ES	Dra =	72172	= PG 1524+622 [084].
ET	Dra =	72221	= BD+70°959 (9.5) = 1E 1751+7046 [195] = 1E 1751.0+7046 = MS 1751.0+7046 = GSC 4432.1301.
EP	Eri =	72006	= HR 857 = HD 17925 (G5) [087] = BD–13°544 (5.8) = SAO 148647 = IRAS 02501–1258 = Gliese 117 = LTT 1372 = NSV 00975.
EQ	Eri =	72029	= HD 28665 (F0) [088] = CoD–29°1748 (7.5) = CPD–29°588 (7.9) = SAO 169509.
ε	Eri =	72012	= ε Eri [089] = 18 Eri = HR 1084 = HD 22049 (K0) = BD–9°697 (3.3) = SAO 130564 = IRC–10048 = AFGL 497 = IRAS 03305–0937 = Gliese 144 = LFT 291.
PP	Gem =	72102	= DHK 34 [022] = (1900.0) $06^{h}50^{m}53^{s}+14°27'$ Gem [090] = Wr 25 = IRAS 06537+1422 = CSV 6529 = NSV 03288.
PQ	Gem =	72124	= RE 0751+14 [091] = REJ 0751+14.
CG	Gru =	72485	= V [092].
V839	Her =	72178	= 4 Her [196, 093] = HR 5938 = HD 142926 (B8) = BD+42°2652 (6.0) = SAO 045790 = MWC 584.
V840	Her =	72185	= Zi 1256 = CSV 101596 = NSV 07814 [094].
V841	Her =	72193	= BD+35°2891 (8.4) [096] = SAO 065670 = IRAS 16553+3521.
BU	Hyi =	72015	= No.1 [082].
BV	Hyi =	72016	= No.2 [082].
BW	Hyi =	72018	= No.3 [082].
BX	Hyi =	72019	= No.4 [082].
BY	Hyi =	72021	= No.5 [082].
V376	Lac =	72479	= P 2345 = 736.1933 = IRAS 22307+5456 = CSV 5571 = NSV 14200 [097].
V377	Lac =	72481	= HR 8706 [045] = HD 216538 (B8) = BD+39°4957 (6.7) = SAO 072812 = CSV 103106 = NSV 14346.
UV	Lep =	72096	= HD 42659 (A3) [098] = BD–15°1299(7.0) = SAO 151199.
HX	Lup =	72164	= HR 5375 [099] = HD 125721 (B3) = CoD–47°9082 (6.5) = CPD–47°6483 (6.6) = SAO 224870 = LSS 3231.
HY	Lup =	72165	= Possible Nova in Lupus [100, *Liller*] = Nova Lup 1993.
HZ	Lup =	72169	= HR 5619 [101] = HD 133652 (A0p) = CoD–30°11960 (6.5) = CPD–30°3961 (7.0) = SAO 206300.
II	Lup =	72171	= IRAS 15194–5115 [007].
IK	Lup =	72174	= Sz 65 [103] = HBC 597 = IRAS 15362–3436.
IL	Lup =	72176	= Optical counterpart of the transient X-ray source 4U 1543–47 [198].
IM	Lup =	72177	= HBC 605 = Sz 82 [103] = The 15-2 = IRAS 15528–3747.
σ	Lup =	72166	= σ Lup [199] = HR 5425 = HD 127381 (B2) = CoD–49°8831 (5.2) = CPD–49°7073 (4.5) = SAO 241781 = IRAS 14292–5014.
BK	Lyn =	72130	= PG 0917+342 [200] = CBS 96 = Ton 1051.
V491	Lyr =	72360	= DHK 19 [032] = HD 172740 (Mb) = BD+40°3449 (8.4) = SAO 047682 = IRC+40324 = AFGL 2225 = IRAS 18383+4017.
V492	Lyr =	72362	= LP 229-30 = LHS 3406 [110].
V493	Lyr =	72365	= UG type var [111] = S 10930.
V494	Lyr =	72367	= LD 106 [071] = IRAS 19013+3353.
V495	Lyr =	72369	= LD 108 [071] = IRAS 19054+3138 = GSC 2640.2384.
V496	Lyr =	72370	= LD 109 [071].
V497	Lyr =	72371	= LD 110 [071] = GSC 2652.1471.
V498	Lyr =	72372	= LD 111 [071] = IRAS 19071+3248 = GSC 2644.1985.
V499	Lyr =	72377	= Var [112].
V500	Lyr =	72378	= LD 115 [071] = IRAS 19112+2653.
V501	Lyr =	72379	= LD 116 [071] = IRAS 19128+3655.
V502	Lyr =	72380	= LD 173 [071].
V503	Lyr =	72387	= LD 122 [071] = IRAS 19224+3213.
V504	Lyr =	72389	= LD 124 [071] = IRAS 19241+3457.

Table 2 (continued)

V696	Mon =	72095	= HR 2142 [113]= HD 41335 (B2p) = BD–6°1391 (6.0) = SAO 132793 = MWC 133= IRAS 16017–0642 = CSV 6419 = NSV 02817. Be star, mass transfer binary with recurrent shell events.
V697	Mon =	72097	= Bretz 4 in GGD 17 [114] = HRC 198 = GSC 4795.1414 = NSV 02871.
V698	Mon =	72099	= LkHα 341 [028] = HRC 201 = NSV 02992.
V699	Mon =	72100	= LkHα 215 [201] = HBC 528 = AFGL 5198 = IRAS 06299+1011.
V700	Mon =	72101	= HD 259431 (B3) [202, 201] = BD+10°1172 (8.7) = SAO 095823 = HBC 529 = MWC 147 = LS VI+10°9 = RAFGL 4508S = IRAS 06303+1021.
V701	Mon =	72111	= V10 (open cluster Be 39) [116].
V702	Mon =	72112	= V11 (open cluster Be 39) [116].
V703	Mon =	72113	= V8 (open cluster Be 39) [116].
V704	Mon =	72114	= V7 (open cluster Be 39) [116].
V705	Mon =	72115	= V3 (open cluster Be 39) [116].
V706	Mon =	72116	= V2 (open cluster Be 39) [116].
V707	Mon =	72117	= V9 (open cluster Be 39) [116].
V708	Mon =	72118	= V12 (open cluster Be 39) [116].
V709	Mon =	72119	= V4 (open cluster Be 39) [116].
V710	Mon =	72120	= V1 (open cluster Be 39) [116].
V711	Mon =	72121	= V5 (open cluster Be 39) [116].
V712	Mon =	72122	= V6 (open cluster Be 39) [116].
V351	Nor =	72175	= IRAS 15408–5413 = IRSV 1540–5413 [203].
V352	Nor =	72179	= Possible Nova in Norma [117, *Liller*] = Nova Nor 1985/2 = Liller's variable in the vicinity of NSV 07429 = IRAS 16030–5156.
V353	Nor =	72184	= IRAS 16107–5139 [036].
V2292	Oph =	72191	= HD 152391 (G5) [204, 205] = BD+0°3593 (7.0) = SAO 121921 = Gliese 641 = G 19-4 = LFT 1307.
V2293	Oph =	72204	= X-ray Nova in Ophiuchus [120, *Della Valle, Mirabel, Cordier*] = Optical counterpart of X-ray transient GRS 1716–249 = GRO J1719–24 = X-ray Nova Oph 1993.
V2294	Oph =	72205	= IRAS 1717–087P04 [206] = IRAS 17171–0843.
V2295	Oph =	72206	= Nova Oph 1993 [122, *Camilleri*].
V2296	Oph =	72207	= IRC+10329 [206] = IRAS 17256+0504.
V2297	Oph =	72210	= IRAS 1730+083P08 [206] = IRAS 17308+0822.
V2298	Oph =	72213	= HV 11030 = CSV 3406 = NSV 09595.
V2299	Oph =	72214	= P38 (IC 4665) [125] = V108.
V2300	Oph =	72223	= HD 164257 (A0) [045] = BD+6°3593 (7.5) = SAO 123001.
V2301	Oph =	72224	= 1H 1758+081 [085, *Remillard*].
V2302	Oph =	72324	= IRAS 1806+091P08 [207] = IRAS 18069+0911.
V2303	Oph =	72359	= TAV 1836+11 [128] = IRAS 18361+1108.
V1261	Ori =	72044	= HD 35155 (K5p) [208, *Wing*; 219] = BD–8°1099 (7.0) = SAO 132035 = IRC–10086 = CSS 98 = AFGL 736 = IRAS 05199–0842.
V1262	Ori =	72046	= Ton 340 [130] = Tof 340 = GSC 4765.0053.
V1263	Ori =	72049	= Ton 341 [130] = Tof 341 = GSC 4765.1740.
V1264	Ori =	72050	= Ton 342 [130] = Tof 342.
V1265	Ori =	72051	= Ton 343 [130] = Tof 343.
V1266	Ori =	72052	= Ton 344 [130] = Tof 344.
V1267	Ori =	72053	= Ton 345 [130] = Tof 345.
V1268	Ori =	72054	= Ton 346 [130] = Tof 346= Π 1062 = GSC 4774.0542.
V1269	Ori =	72055	= Ton 347 [130] = Tof 347.
V1270	Ori =	72056	= Ton 348 [130] = Tof 348.
V1271	Ori =	72057	= HD 245185 (A5) = BD+9°880 (9.3) [211, 131] = HBC 451 = IRAS 05324+0959.
V1272	Ori =	72058	= Ton 350 [130] = Tof 350 = Π 1631 = GSC 4774.0059.
V1273	Ori =	72059	= JW 145 [132].
V1274	Ori =	72060	= JW 248 [132].
V1275	Ori =	72061	= JW 311 [133, 132].
V1276	Ori =	72062	= JW 379 [132].
V1277	Ori =	72063	= JW 388 [133, 132].

Table 2 (continued)

V1278	Ori =	72064	= JW 466 [132].
V1279	Ori =	72065	= JW 526 [212] = Π 1896.
V1280	Ori =	72066	= Ton 351 [130] = Tof 351.
V1281	Ori =	72067	= JW 691 [132].
V1282	Ori =	72068	= JW 695 [132].
V1283	Ori =	72069	= JW 758 [132].
V1284	Ori =	72070	= JW 786 [132].
V1285	Ori =	72071	= JW 792 [132].
V1286	Ori =	72072	= JW 813 [132] = Π 2047.
V1287	Ori =	72073	= JW 815 [132].
V1288	Ori =	72074	= JW 830 [132].
V1289	Ori =	72075	= JW 837 [132].
V1290	Ori =	72076	= JW 839 [132].
V1291	Ori =	72077	= JW 842 [132].
V1292	Ori =	72078	= JW 855 [132].
V1293	Ori =	72079	= JW 860 [132].
V1294	Ori =	72080	= JW 866 [132] = Π 2073.
V1295	Ori =	72081	= Ton 352 [130] = Tof 352 = Π 2220 = GSC 4774.0609.
V1296	Ori =	72082	= TSN 333 = Haro Hα 204 = IRAS 05334–0611 = CSV 6303 = NSV 02379 [134] = Kiso Area A-0976 No.217.
V1297	Ori =	72083	= Ton 353 [130] = Tof 353.
V1298	Ori =	72084	= Ton 354 [130] = Tof 354.
V1299	Ori =	72085	= DHK 33 [022] = GSC 4767.0829.
V1300	Ori =	72086	= Ton 355 [130] = Tof 355 = Π 2612 = GSC 4778.0437 = NSV 02486.
V1301	Ori =	72087	= Ton 356 [130] = Tof 356 = TSN 460 = Haro Hα 65 = Kiso Area A-0976 No.318.
V1302	Ori =	72088	= Ton 357 [130] = Tof 357 = Π 2685 = GSC 4775.0141.
V1303	Ori =	72089	= Ton 358 [130] = Tof 358.
V1304	Ori =	72090	= HRC 179 = TSN 515 = Haro Hα 478 = Haro 7-4 = IRAS 05380–0809 [136] = NSV 02551.
V1305	Ori =	72091	= HRC 182 = TSN 527 = Haro 7-2 = IRAS 05394–0801 [136] = GSC 5346.0193 = NSV 02582.
V1306	Ori =	72092	= Ton 359 [130] = Tof 359 = GSC 4775.387.
V1307	Ori =	72094	= HD 250550 (A0) [131] = BD+16°974 (9.1) = HRC 192 = MWC 789 = IRAS 05591+1630 = NSV 02784.
V1308	Ori =	72098	= MWC 137 [028] = HRC 199 = LSS 33 = Central star of PN Sh 2-266 = IRAS 06158+1517 = NSV 02906.
V345	Pav =	72397	= EC 19314–5915 [137].
KY	Peg =	72476	= DHK 36 [022] = BD+12°4694 (9.1) = BV 317 = CSV 8691 = NSV 13889.
KZ	Peg =	72483	= IRC+10523 [036] = AFGL 2984 = IRAS 22516+0838 = NSV 14352.
LL	Peg =	72488	= CRL 3068 [210] = AFGL 3068 [007] = IRAS 23166+1655.
LM	Peg =	72489	= DHK 28 [022] = BD+26°4660 (9.0) = SAO 091369 = IRAS 23336+2724.
V514	Per =	72009	= Comparison star A for AP 125 (α Per cluster) [138].
V515	Per =	72010	= FS 2 in the α Per cluster region [139].
V516	Per =	72011	= FS 1 in the α Per cluster region [139].
V517	Per =	72013	= DHK 27 [022] = HD 275647 (G5) = BD+38°780 (9.2) = SAO 056620 = IRC+40064 = IRAS 03374+3850.
V518	Per =	72026	= GRO J0422+32 [140] = X-ray Nova Per 1992.
V352	Pup =	72110	= PDS 28[141] = Wray 15-54 = IRAS 07388–4747 = GSC 8137.2426.
V353	Pup =	72123	= CoD–31°5049 (8.4)=CPD–32°1761 (10.0) = SAO 198422 = IRC–30100 [036] = AFGL 4633S = IRAS 07446–3210A = GSC 7110.2226 = NSV 03431. Sp A0 (SAO) is doubtful.
TV	Ret =	72036	= R1 [082].
V4201	Sgr =	72219	= OH/IR 02.60–0.4 [186, 036] = OH 2.58–0.43 = CRL 2019 [142] = IRAS 17501–2656.
V4202	Sgr =	72225	= HD 164717 (B3) [015] = BD–22°4522 (8.3) = CoD–22°12481 (8.6) = CPD –22°6589 (8.6) = SAO 186185 = LSS 4586 = IRAS 18004–2238 = BV 551 = NSV 10075.
V4203	Sgr =	72226	= CoD–24°13830 (10) = CPD–24°6162 (9.2) = LkHα 112 [028] = K/W 58 (NGC 6530) [213] = V/J 180 (NGC 6530).

Table 2 (continued)

V4204 Sgr = 72227 = LkHα 118 [028] = HRC 281 = LSS 4643 = NSV 10174.
V4205 Sgr = 72228 = F2 (NGC 6544) [144]. Field star.
V4206 Sgr = 72229 = Var 1 [145].
V4207 Sgr = 72230 = Var 2 [145].
V4208 Sgr = 72231 = Var 3 [145].
V4209 Sgr = 72232 = Var 4 [145].
V4210 Sgr = 72233 = Var 5 [145].
V4211 Sgr = 72234 = F1 (NGC 6544) [144]. Field star.
V4212 Sgr = 72235 = Var 6 [145].
V4213 Sgr = 72236 = Var 7 [145].
V4214 Sgr = 72237 = Var 8 [145].
V4215 Sgr = 72238 = Var 9 [145].
V4216 Sgr = 72239 = Var 10 [145].
V4217 Sgr = 72240 = Var 11 [145].
V4218 Sgr = 72241 = Var 12 [145].
V4219 Sgr = 72242 = Var 13 [145].
V4220 Sgr = 72243 = Var E2 [145].
V4221 Sgr = 72244 = Var 14 [145].
V4222 Sgr = 72245 = Var 15 [145].
V4223 Sgr = 72246 = Var 16 [145].
V4224 Sgr = 72247 = Var 17 [145].
V4225 Sgr = 72248 = Var 18 [145].
V4226 Sgr = 72249 = Var 19 [145].
V4227 Sgr = 72250 = Var 20 [145].
V4228 Sgr = 72251 = Var 21 [145].
V4229 Sgr = 72252 = Var 22 [145].
V4230 Sgr = 72253 = Var 23 [145].
V4231 Sgr = 72254 = Var 24 [145].
V4232 Sgr = 72255 = Var 25 [145].
V4233 Sgr = 72256 = Var E3 [145].
V4234 Sgr = 72257 = Var 26 [145].
V4235 Sgr = 72258 = Var 27 [145].
V4236 Sgr = 72259 = Var 28 [145].
V4237 Sgr = 72260 = Var 29 [145].
V4238 Sgr = 72261 = Var 30 [145].
V4239 Sgr = 72262 = Var 31 [145] = P 1468 = 596.1933 = HV 9254 = CSV 3761 = NSV 10225.
V4240 Sgr = 72263 = Var 32 [145].
V4241 Sgr = 72264 = Var 33 [145].
V4242 Sgr = 72265 = Var 34 [145].
V4243 Sgr = 72266 = Var 35 [145].
V4244 Sgr = 72267 = Var 36 [145].
V4245 Sgr = 72268 = Var 37 [145].
V4246 Sgr = 72269 = Var E4 [145].
V4247 Sgr = 72270 = Var 38 [145].
V4248 Sgr = 72271 = Var 39 [145].
V4249 Sgr = 72272 = Var 40 [145].
V4250 Sgr = 72273 = Var 41 [145].
V4251 Sgr = 72274 = Var 42 [145].
V4252 Sgr = 72275 = Var 43 [145].
V4253 Sgr = 72276 = Var 44 [145].
V4254 Sgr = 72277 = Var 45 [145].
V4255 Sgr = 72278 = Var 46 [145].
V4256 Sgr = 72279 = Var 47 [145].
V4257 Sgr = 72280 = Var E5 [145].
V4258 Sgr = 72281 = Var 48 [145].
V4259 Sgr = 72282 = Var 49 [145].
V4260 Sgr = 72283 = Var 50 [145].

Table 2 (continued)

V4261 Sgr = 72284 = Var 51 [145].
V4262 Sgr = 72285 = Var 52 [145].
V4263 Sgr = 72286 = Var 53 [145].
V4264 Sgr = 72287 = Var 54 [145].
V4265 Sgr = 72288 = Var 55 [145].
V4266 Sgr = 72289 = Var 56 [145].
V4267 Sgr = 72290 = Var 57 [145].
V4268 Sgr = 72291 = Var 58 [145].
V4269 Sgr = 72292 = Var 59 [145].
V4270 Sgr = 72293 = Var 60 [145].
V4271 Sgr = 72294 = Var 61 [145].
V4272 Sgr = 72295 = Var 62 [145].
V4273 Sgr = 72296 = Var 63 [145].
V4274 Sgr = 72297 = Var 64 [145].
V4275 Sgr = 72298 = Var 65 [145].
V4276 Sgr = 72299 = Var 66 [145].
V4277 Sgr = 72300 = Var 67 [145].
V4278 Sgr = 72301 = Var 68 [145].
V4279 Sgr = 72302 = Var 69 [145].
V4280 Sgr = 72303 = Var 70 [145].
V4281 Sgr = 72304 = Var 71 [145].
V4282 Sgr = 72305 = Var 72 [145].
V4283 Sgr = 72306 = Var 73 [145].
V4284 Sgr = 72307 = Var 74 [145].
V4285 Sgr = 72308 = Var 75 [145].
V4286 Sgr = 72309 = Var 76 [145].
V4287 Sgr = 72310 = Var 77 [145].
V4288 Sgr = 72311 = Var 78 [145].
V4289 Sgr = 72312 = Var 79 [145].
V4290 Sgr = 72313 = Var 80 [145].
V4291 Sgr = 72314 = Var 81 [145].
V4292 Sgr = 72315 = Var 82 [145].
V4293 Sgr = 72316 = Var 83 [145].
V4294 Sgr = 72317 = Var 84 [145].
V4295 Sgr = 72318 = Var E6 [145].
V4296 Sgr = 72319 = Var 85 [145].
V4297 Sgr = 72320 = Var 86 [145].
V4298 Sgr = 72321 = Var 87 [145].
V4299 Sgr = 72322 = Var 88 [145].
V4300 Sgr = 72323 = Var 89 [145].
V4301 Sgr = 72325 = Var 90 [145].
V4302 Sgr = 72326 = Var 91 [145].
V4303 Sgr = 72327 = Var 92 [145].
V4304 Sgr = 72328 = Var 93 [145].
V4305 Sgr = 72329 = Var 94 [145].
V4306 Sgr = 72330 = Var 95 [145].
V4307 Sgr = 72331 = Var 96 [145].
V4308 Sgr = 72332 = Var 97 [145].
V4309 Sgr = 72333 = Var 98 [145].
V4310 Sgr = 72334 = Var 99 [145].
V4311 Sgr = 72335 = Var 100 [145].
V4312 Sgr = 72336 = Var 101 [145].
V4313 Sgr = 72337 = Var 102 [145].
V4314 Sgr = 72338 = Var 103 [145].
V4315 Sgr = 72339 = Var E7 [145].
V4316 Sgr = 72340 = Var 104 [145].

Table 2 (continued)

V4317	Sgr =	72341	= Var 105 [145].
V4318	Sgr =	72342	= Var 106 [145].
V4319	Sgr =	72343	= Var 107 [145].
V4320	Sgr =	72344	= Var E8 [145].
V4321	Sgr =	72345	= Var 108 [145].
V4322	Sgr =	72346	= Var 109 [145].
V4323	Sgr =	72347	= Var E9 [145].
V4324	Sgr =	72348	= Var 110 [145].
V4325	Sgr =	72349	= Var 111 [145].
V4326	Sgr =	72350	= Var 112 [145].
V4327	Sgr =	72351	= Nova Sgr 1993 [146, *Sugano, Liller*].
V4328	Sgr =	72352	= IRAS 18146–3110 [147].
V4329	Sgr =	72353	= IRAS 18149–3223 [147]. To E from V2952 Sgr, close to it.
V4330	Sgr =	72355	= IRAS 18240–2832 [147]. Not identical with V931 Sgr.
V4331	Sgr =	72357	= IRAS 18279–2707 [147]. Not identical with V1897 Sgr.
V4332	Sgr =	72363	= Nova Sgr 1994 [148, *Yamamoto*] = Luminous red variable in Sgr. A red star with a nova-like outburst.
V4333	Sgr =	72398	= HR 7439 [150] = HD 184705 (A5) = BD–19°5521 (5.8) = CPD–19°7544 (6.5) = SAO 162809.
V1000	Sco =	72181	= HBC 630 [063] = Wa Oph/1 = 160814–1857 [180] = GSC 6209.0968.
V1001	Sco =	72182	= HBC 633 [063] = Wa Oph/2 = GSC 6209.1039.
V1002	Sco =	72183	= HBC 634 [063] = Wa Oph/3 = GSC 6209.1316.
V1003	Sco =	72186	= HR 6174 [099] = HD 149711 (B3) = CoD–43°10959 (6.3) = CPD–43°7635 (6.6) = SAO 226989.
V1004	Sco =	72188	= OH/IR 339.93+0.37 [036] = OH 339.93+0.37 [186] = IRAS 16415–4458.
V1005	Sco =	72189	= OH/IR 341.12–0.01 [036] = OH 341.12–0.00 [186] = IRAS 16474–4418.
V1006	Sco =	72190	= OH/IR 342.01+0.25 [036] = OH 342.01+0.25 [186] = IRAS 16494–4327.
V1007	Sco =	72192	= HD 152248 (B) [041] = CoD–41°11033 (7.3) = CPD–41°7728 (6.6) = SAO 227382 = IDS 1647.1S4140 = Seggewiss 291 (NGC 6231) = Braes 143 (NGC 6231) = CSV 7520 = NSV 08022.
V1008	Sco =	72195	= OH/IR 344.93+0.01 [036] = OH 344.93+0.01 = IRAS 17004–4119.
V1009	Sco =	72196	= OH/IR 346.01+0.04 [036] = OH 346.01+0.04 = IRAS 17038–4026.
V1010	Sco =	72198	= OH/IR 344.83–1.67 [036] = OH 344.83–1.67 [186] = IRAS 17073–4225.
V1011	Sco =	72199	= OH/IR 346.86–0.18 [036] = OH 346.86–0.18 [186] = IRAS 17073–3955.
V1012	Sco =	72200	= HD 155775 (B3) [040] = CoD–38°11680 (7.1) = CPD–38°6750 (7.2) = SAO 208582.
V1013	Sco =	72201	= OH/IR 349.18+0.20 [036] = OH 349.18+0.20 [186] = IRAS 17128–3748.
V1014	Sco =	72202	= OH/IR 349.39–0.01 [036] = OH 349.39–0.01 [186] = IRAS 17144–3745.
V1015	Sco =	72203	= OH/IR 349.96–0.03 [036] = OH 349.96–0.03 [186] = IRAS 17160–3718.
V1016	Sco =	72208	= OH/IR 353.60–0.23 [036] = OH 353.60–0.23 [186] = IRAS 17271–3425. Not identical with V481 Sco.
V1017	Sco =	72209	= HD 158394/5 (F5,A5) [152] = CoD–34°11732 (7.8) = CPD–34°6846 (8.5) = SAO 208893 = EXOSAT 1727–3430.
V1018	Sco =	72211	= OH/IR 354.88–0.54 [036] = OH 354.88–0.54 [186] = IRAS 17317–3331 = AFGL 5356.
V1019	Sco =	72212	= OH/IR 358.16+0.50 [036] = OH 358.16+0.49 = AFGL 1992 [142, 186] = IRAS 17360–3012.
V1020	Sco =	72215	= No.1 (M7) [153].
V1021	Sco =	72216	= No.6 (M7) [153].
V1022	Sco =	72217	= No.4 (M7) [153].
V1023	Sco =	72218	= No.2 (M7) [153].
V1024	Sco =	72220	= No.5 (M7) [153].
V1025	Sco =	72222	= No.3 (M7) [153].
V445	Sct =	72356	= OH/IR 17.7–2.0 [154] = 0H 17.7–2.0 [214] = AFGL 5497 = IRAS 18276–1431.

Table 2 (continued)

NW	Ser =	72354	= HR 6873 [093] = HD 168797 (B5) = BD+5°3704 (6.9) = SAO 123385 = MWC 601 = NSV 10688.
NX	Ser =	72358	= AFGL 2199 [142] = IRAS 18333+0533 [121].
V1064	Tau =	72014	= Nos.92, 93 [156].
V1065	Tau =	72017	= HII 1136 [157].
V1066	Tau =	72020	= No.99 [156]. Co-ordinates in [156] are wrong.
V1067	Tau =	72022	= WTT 040012+2545 [157] = NTTS 040012+2545N+S = TAP 14 [161] = HBC 356/357.
V1068	Tau =	72023	= LkCa 4 [019, 159] = HBC 370.
V1069	Tau =	72024	= TAP 26 [019, 161] = HBC 376 = NTTS 041559+1716.
V1070	Tau =	72025	= LkCa 7 [160] = HBC 379 = TAP 29 = NTTS 041636+2743.
V1071	Tau =	72027	= LkCa 21 [019] = HBC 382.
V1072	Tau =	72028	= TAP 35 [161] = HBC 388 = NTTS 042417+1744.
V1073	Tau =	72030	= TAP 39 [161].
V1074	Tau =	72031	= TAP 40 [019, 161] = HBC 392 = NTTS 042835+1700.
V1075	Tau =	72032	= TAP 41 [019, 161] = HBC 397 = NTTS 042916+1751 = L 1551-51.
V1076	Tau =	72033	= TAP 45 [161] = HBC 403 = NTTS 042950+1757 = L 1551-55.
V1077	Tau =	72034	= TAP 49 [161] = HBC 407 = NTTS 043124+1824.
V1078	Tau =	72035	= TAP 51S [161] = NTTS 043220+1815.
V1079	Tau =	72037	= LkCa 15 [160] = HBC 419 = IRAS 04363+2215.
V1080	Tau =	72038	= BD+24°676 (9.4) [019].
V1081	Tau =	72040	= HD 29935 (B9) = BD+22°743 (8.0) [162] = SAO 076729 = NSV 01702.
QS	Tel =	72400	= RE 1938–4612 [163].
CO	Tuc =	72001	= HV 814 = 7317 (NGC 104) = V 12 (Globular cluster NGC 104 = 47 Tuc). Not cluster member, not SMC member.
EQ	UMa =	72127	= New variable in the SW UMa field [166].
ER	UMa =	72132	= PG 0943+521 [167, *Iida*] = GSC 3439.0550.
ES	UMa =	72133	= GSC 4383.0384 [215].
ET	UMa =	72136	= 30H UMa = HR 4072 [169] = HD 89822 (A0) = BD+66° 664 (5.0) = SAO 015163 = IRAS 10205+6549 = Zi 814 = CSV 101122 = NSV 04839.
EU	UMa =	72144	= RE 1149+28 [170].
EV	UMa =	72158	= RE 1307+535 [171].
LY	Vel =	72131	= HD 80859 (B8) [172] = CoD–47°4850 (7.7) = CPD–47°3241 (7.9) = SAO 221084.
LZ	Vel =	72134	= HD 86005 (K0) [216,173] = CoD–42°5741 (7.9) = CPD–42°4159(8.4) = SAO 221596 = IRAS 09526–4305.
MM	Vel =	72135	= X-ray Nova in Vela [174, *Della Valle, Benetti*] = Optical counterpart of GRC 1009–45.
V337	Vul =	72368	= LD 107 [071] = IRAS 19042+2529.
V338	Vul =	72373	= LD 112 [071] = IRAS 19081+2315 = GSC 2123.1515.
V339	Vul =	72374	= LD 113 [071] = IRAS 19091+2439.
V340	Vul =	72376	= LD 114 [071] = IRAS 19105+2306 = GSC 2123.1937.
V341	Vul =	72382	= LD 174 [071] = IRAS 19196+2437.
V342	Vul =	72383	= LD 117 [071] = IRAS 19199+2300.
V343	Vul =	72384	= LD 118 [071] = IRAS 19199+2616 = GSC 2132.2539.
V344	Vul =	72385	= LD 119 [071].
V345	Vul =	72386	= LD 121 [071] = IRAS 19217+2621.
V346	Vul =	72388	= LD 123 [071] = IRAS 19238+2632.
V347	Vul =	72392	= LD 126 [071].
V348	Vul =	72393	= LD 175 [071].
V349	Vul =	72395	= LD 128 [071] = IRAS 19290+2324 = IRC+20412 = GSC 2125.0932.
V350	Vul =	72401	= LD 131 [071] = IRAS 19372+2337.

Table 2 (continued)

V351 Vul = 72402 = LD 132 [071] = IRAS 19382+2325.
V352 Vul = 72403 = LD 133 [071] = IRAS 19389+2445 = GSC 2143.1826.
V353 Vul = 72410 = LD 140 [071] = IRAS 19472+2230.
V354 Vul = 72412 = LD 143 [071].
V355 Vul = 72414 = LD 145 [071] = IRAS 19491+2602.
V356 Vul = 72416 = LD 147 [071] = IRAS 19499+2701 = GSC 2148.1963.
V357 Vul = 72418 = LD 148 [071] = IRAS 19518+2300.
V358 Vul = 72420 = LD 149 [071] = IRAS 19530+2223 = GSC 2140.2164.
V359 Vul = 72421 = LD 150 [071] = AFGL 2474 = IRAS 19537+2212.
V360 Vul = 72422 = LD 151 [071] = IRAS 19543+2308.
V361 Vul = 72424 = LD 182 [071] = IRAS 19558+2241.
V362 Vul = 72429 = E 2000+223 [175]. Not identical with QQ Vul.
V363 Vul = 72432 = LD 158 [071].
V364 Vul = 72438 = LD 161 [071] = IRAS 20063+2527.
V365 Vul = 72440 = LD 163 [071] = IRAS 20079+2529.
V366 Vul = 72442 = LD 165 [071] = IRAS 20104+2427 = GSC 2158.1697.
V367 Vul = 72444 = LD 166 [071] = IRAS 20135+2517.
V368 Vul = 72445 = LD 167 [071] = IRAS 20139+2404.
V369 Vul = 72447 = LD 184 [071] = IRAS 20162+2629.
V370 Vul = 72448 = LD 185 [071].
V371 Vul = 72449 = IRAS 20181+2234 [121].
V372 Vul = 72451 = LD 169 [071] = IRAS 20195+2905.
V373 Vul = 72452 = LD 170 [071].
V374 Vul = 72453 = LD 171 [071] = IRAS 20240+2759.
V375 Vul = 72454 = LD 172 [071] = IRAS 20253+2407.

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BVR OBSERVATIONS OF THE DOUBLE-MODE CEPHEIDS AS Cas, V367 Sct and BQ Ser

Recently one of us (Berdnikov, 1992) has decomposed the available photoelectric observations of all double-mode Cepheids into two oscillations. It was pointed out as well that the number of existing observations is not sufficient for reliable investigation of light curve variations for the majority of these stars. Therefore we continue to carry out observations of all accessible double-mode Cepheids.

Photoelectric observations of double-mode Cepheids were carried out in summer – autumn 1994. The 60-cm reflector of the Mt. Maidanak observatory was used and 87 BVR$_c$ measurements of AS Cas (Table 1), 83 BVR$_c$ measurements of V367 Sct (Table 2), and 85 BVR$_c$ measurements of BQ Ser (Table 3) were obtained.

This study was partially supported by the Russian Foundation for Fundamental Research through grants No. 94-02-04344 and No. 94-02-04347.

Table 1. BVR$_c$ observations of AS Cas.

JD hel 2440000+	V	B−V	V−R$_c$	JD hel 2440000+	V	B−V	V−R$_c$
9617.3164	12.322	1.255	.863	9623.4090	12.112	1.314	.815
9617.3504	12.259	1.386	.852	9623.4310	12.123	1.298	.814
9618.3861	12.354	1.298	.883	9623.4534	12.151	1.329	.834
9620.3324	11.918	1.205	.737	9623.4716	12.191	1.324	.850
9620.3539	11.908	1.132	.736	9623.4832	12.170	1.336	.831
9620.3766	11.887	1.165	.754	9624.1588	12.503	1.538	.877
9620.4128	11.819	1.211	.721	9624.2814	12.569	1.490	.908
9620.4432	11.895	1.152	.764	9624.3650	12.584	1.506	.921
9621.1692	12.280	1.343	.857	9624.3841	12.565	1.518	.908
9621.3032	12.390	1.383	.874	9624.4003	12.515	1.523	.893
9621.3502	12.435	1.434	.862	9624.4195	12.542	1.530	.888
9621.3744	12.441	1.420	.874	9624.4383	12.528	1.505	.913
9621.4077	12.454	1.472	.876	9624.4607	12.505	1.484	.889
9621.4436	12.455	1.417	.863	9625.1723	12.529	1.504	.875
9622.3680	12.693	1.498	.906	9625.2322	12.521	1.468	.885
9622.4203	12.637	1.444	.901	9625.3175	12.533	1.463	.871
9623.3008	12.048	1.256	.799	9625.3804	12.498	1.406	.886
9623.3332	12.169	1.289	.790	9625.3995	12.492	1.451	.888
9623.3576	12.137	1.325	.801	9625.4333	12.460	1.453	.882
9623.3780	12.132	1.310	.816	9625.4523	12.441	1.461	.892

Table 1 (cont.)

JD hel 2440000+	V	B−V	V−R_c	JD hel 2440000+	V	B−V	V−R_c
9626.2049	12.403	1.348	.877	9633.4340	12.333	1.337	.862
9631.1784	12.654	1.550	.884	9633.4456	12.324	1.362	.868
9631.3015	12.686	1.508	.931	9633.4655	12.308	1.419	.853
9632.1944	12.210	1.336	.831	9634.2147	12.439	1.474	.850
9632.2367	12.218	1.327	.825	9634.3259	12.408	1.483	.876
9632.2991	12.293	1.321	.825	9635.3464	11.917	1.198	.764
9632.3259	12.208	1.379	.823	9635.3636	11.916	1.183	.776
9632.3449	12.159	1.286	.824	9635.3751	11.891	1.211	.756
9632.3457	12.182	1.395	.807	9635.3899	11.911	1.182	.795
9632.3758	12.250	1.407	.826	9635.4033	11.870	1.193	.718
9632.3922	12.285	1.345	.865	9635.4134	11.818	1.198	.721
9632.3940	12.116	1.293	.813	9635.4379	11.851	1.199	.759
9632.4123	12.244	1.406	.830	9635.4521	11.837	1.236	.747
9632.4317	12.288	1.374	.869	9635.4655	11.833	1.241	.743
9632.4552	12.280	1.399	.849	9635.4751	11.847	1.203	.776
9632.4740	12.238	1.334	.843	9635.4833	11.830	1.191	.752
9633.2048	12.309	1.395	.840	9635.4998	11.824	1.193	.744
9633.2313	12.401	1.346	.828	9640.2452	12.335	1.401	.876
9633.3173	12.427	1.383	.867	9640.3355	12.357	1.387	.866
9633.3380	12.391	1.356	.859	9640.4015	12.321	1.378	.857
9633.3590	12.339	1.345	.872	9641.3499	12.202	1.274	.821
9633.3734	12.311	1.400	.815	9647.3170	12.096	1.285	.806
9633.3949	12.342	1.369	.871	9647.4003	12.080	1.284	.786
9633.4108	12.312	1.400	.871				

Table 2. BVR_c observations of V367 Sct.

JD hel 2440000+	V	B−V	V−R_c	JD hel 2440000+	V	B−V	V−R_c
9514.3396	11.440	1.755	1.139	9534.3365	11.732	1.952	1.230
9514.4089	11.467	1.757	1.175	9535.2592	11.895	1.961	1.256
9515.3672	11.525	1.774	1.189	9535.3229	11.913	1.990	1.263
9516.3873	11.786	1.913	1.247	9535.3923	11.902	1.970	1.263
9517.3863	11.928	1.956	1.261	9536.2505	11.804	1.878	1.243
9519.4093	11.304	1.674	1.132	9536.3729	11.792	1.880	1.238
9521.3388	11.697	1.910	1.230	9537.2542	11.516	1.796	1.161
9522.3603	11.843	1.916	1.244	9537.3209	11.531	1.765	1.185
9522.4212	11.841	1.938	1.243	9537.3932	11.520	1.771	1.173
9523.3170	11.812	1.882	1.245	9538.2774	11.493	1.783	1.173
9523.3971	11.730	1.921	1.199	9538.3272	11.485	1.824	1.159
9524.2973	11.618	1.821	1.186	9539.2520	11.611	1.830	1.200
9524.3667	11.632	1.796	1.203	9539.3396	11.604	1.861	1.188
9524.4299	11.601	1.861	1.180	9542.3691	11.777	1.947	1.242
9525.2927	11.574	1.778	1.210	9543.2439	11.803	1.918	1.232
9534.2910	11.732	1.917	1.238	9543.3125	11.789	1.926	1.230
9534.3296	11.743	1.947	1.222	9545.2329	11.339	1.701	1.124

Table 2 (cont.)

JD hel 2440000+	V	B−V	V−R$_c$	JD hel 2440000+	V	B−V	V−R$_c$
9545.2881	11.365	1.685	1.144	9557.2403	11.576	1.812	1.208
9546.2361	11.505	1.786	1.180	9559.2140	11.502	1.825	1.190
9946.3026	11.508	1.801	1.172	9559.2894	11.512	1.854	1.187
9546.3769	11.535	1.811	1.188	9560.2235	11.776	1.940	1.237
9547.2263	11.752	1.926	1.238	9560.3277	11.775	1.977	1.244
9547.2830	11.773	1.932	1.248	9561.3035	11.924	2.013	1.248
9548.3120	11.915	1.969	1.259	9563.3070	11.322	1.684	1.123
9548.3508	11.934	1.971	1.265	9564.2313	11.478	1.814	1.173
9549.2258	11.788	1.908	1.215	9621.1487	11.572	1.811	1.144
9549.2979	11.793	1.868	1.237	9623.1519	11.958	1.935	1.252
9549.3458	11.756	1.898	1.224	9624.1356	11.938	1.978	1.253
9550.2969	11.421	1.687	1.155	9625.1434	11.685	1.877	1.168
9551.2928	11.501	1.761	1.179	9631.1407	11.771	2.036	1.193
9552.2914	11.678	1.825	1.224	9632.1379	11.659	1.859	1.200
9553.2830	11.716	1.843	1.209	9633.1322	11.348	1.715	1.144
9554.2971	11.714	1.815	1.223	9634.1418	11.512	1.856	1.174
9556.2860	11.736	1.949	1.251				

Table 3. BVR observations of BQ Ser.

JD hel 2440000+	V	B−V	V−R$_c$	JD hel 2440000+	V	B−V	V−R$_c$
9514.3464	9.755	1.568	.951	9534.2937	9.509	1.491	.907
9514.4133	9.751	1.575	.940	9534.3406	9.524	1.489	.911
9515.3724	9.241	1.315	.821	9534.3965	9.522	1.520	.903
9516.3902	9.409	1.458	.887	9535.2625	9.750	1.585	.936
9517.3892	9.709	1.592	.950	9535.3275	9.771	1.583	.955
9519.4131	9.364	1.391	.866	9535.3956	9.769	1.604	.950
9521.3329	9.540	1.480	.911	9536.2553	9.458	1.424	.866
9522.3627	9.576	1.518	.917	9536.3761	9.367	1.367	.854
9522.4247	9.597	1.513	.913	9537.2575	9.288	1.393	.856
9523.3214	9.656	1.521	.922	9537.3236	9.320	1.397	.855
9523.4009	9.648	1.491	.915	9537.3965	9.342	1.415	.859
9524.3012	9.230	1.355	.828	9538.2810	9.621	1.548	.919
9524.3704	9.244	1.331	.846	9538.3301	9.639	1.567	.932
9524.4329	9.238	1.342	.844	9539.2555	9.718	1.558	.939
9525.2976	9.457	1.473	.907	9539.3417	9.699	1.551	.929
9526.2867	9.733	1.584	.947	9539.3794	9.703	1.534	.932
9529.2874	9.553	1.541	.919	9540.2445	9.446	1.431	.887
9530.2713	9.652	1.541	.923	9540.3371	9.420	1.429	.870
9530.3559	9.650	1.530	.924	9541.2485	9.450	1.453	.874
9530.4108	9.636	1.534	.914	9541.3138	9.468	1.432	.884
9533.2732	9.318	1.400	.848	9541.3805	9.459	1.449	.883
9533.3506	9.321	1.399	.854	9542.2496	9.440	1.479	.883
9533.4046	9.322	1.409	.861	9542.3022	9.463	1.457	.895

Table 3 (cont.)

JD hel 2440000+	V	B−V	V−R$_c$	JD hel 2440000+	V	B−V	V−R$_c$
9530.3559	9.650	1.530	.924	9541.2485	9.450	1.453	.874
9530.4108	9.636	1.534	.914	9541.3138	9.468	1.432	.884
9533.2732	9.318	1.400	.848	9541.3805	9.459	1.449	.883
9533.3506	9.321	1.399	.854	9542.2496	9.440	1.479	.883
9533.4046	9.322	1.409	.861	9542.3022	9.463	1.457	.895
9542.3715	9.466	1.449	.883	9556.2931	9.729	1.595	.945
9543.2500	9.534	1.520	.904	9557.2447	9.632	1.462	.914
9543.3144	9.549	1.508	.922	9559.2195	9.545	1.520	.917
9545.2367	9.291	1.355	.841	9559.2952	9.567	1.522	.907
9545.2912	9.260	1.356	.836	9560.2280	9.701	1.546	.947
9546.2404	9.376	1.416	.885	9560.3322	9.682	1.563	.926
9546.3047	9.386	1.433	.874	9561.3083	9.517	1.478	.886
9546.3794	9.406	1.458	.879	9563.3111	9.391	1.419	.869
9547.2296	9.663	1.573	.936	9564.2363	9.498	1.485	.902
9547.2857	9.696	1.578	.955	9617.0962	9.627	1.486	.885
9548.3153	9.714	1.541	.920	9620.2112	9.785	1.542	.939
9548.3546	9.693	1.527	.932	9621.1813	9.551	1.461	.873
9549.2296	9.294	1.362	.837	9623.1762	9.500	1.444	.886
9549.3012	9.290	1.367	.839	9625.1939	9.651	1.545	.912
9549.3496	9.310	1.364	.858	9626.2175	9.438	1.423	.877
9550.3007	9.474	1.494	.883	9631.1572	9.406	1.478	.858
9551.2960	9.592	1.510	.907	9632.2027	9.620	1.530	.928
9552.2953	9.566	1.514	.909	9633.1754	9.634	1.497	.931
9553.2908	9.607	1.509	.907	9634.1830	9.591	1.518	.925
9554.3017	9.270	1.351	.831				

L.N. BERDNIKOV
O.V. VOZIAKOVA
Sternberg Astronomical Institute
13, Universitetskij prosp.
Moscow 119899, Russia

M.A. IBRAGIMOV
Astronomical Institute
33, Astronomicheskaya str.
Tashkent, 700052
Republic of Uzbekistan

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UBVR PHOTOELECTRIC OBSERVATIONS OF THE DOUBLE-MODE CEPHEIDS CO Aur, TU Cas AND EW Sct

Recently one of us (Berdnikov, 1992) has decomposed the available photoelectric observations of all double-mode Cepheids into two oscillations. It was pointed out as well that the number of existing observations is not sufficient for reliable investigation of light curve variations for the majority of these stars. Therefore we continue to carry out observations of all accessible double-mode Cepheids.

Photoelectric observations of double-mode Cepheids were carried out in summer – autumn 1994. The 60-cm reflector of the Mt. Maidanak observatory was used and 79 UBVR$_c$ measurements of CO Aur (Table 1), 121 UBVR$_c$ measurements of TU Cas (Table 2), and 85 UBVR$_c$ measurements of EW Sct (Table 3) were obtained.

This study was partially supported by the Russian Foundation for Fundamental Research through grants No. 94-02-04344 and No. 94-02-04347.

Table 1. UBVR observations of CO Aur.

JD hel 2440000+	V	U–B	B–V	V–R$_c$	JD hel 2440000+	V	U–B	B–V	V–R$_c$
9617.3379	-	-	.655	.369	9623.4852	7.805	.405	.616	.420
9617.3620	7.654	.319	.644	.391	9623.4996	7.787	.347	.634	.405
9620.3451	7.461	.428	.580	.355	9624.3407	7.696	.492	.699	.423
9620.3931	7.427	.452	.592	.341	9624.3685	7.748	.502	.682	.418
9620.4579	7.523	.412	.557	.383	9624.3699	7.736	.412	.667	.413
9621.3914	7.910	.415	.762	.451	9624.3866	7.758	.422	.672	.428
9621.5005	7.969	.416	.728	.451	9624.4029	7.743	.410	.691	.411
9622.4244	7.642	.474	.640	.398	9624.4240	7.764	.415	.683	.411
9622.4455	7.655	.404	.654	.398	9624.4425	7.781	.383	.682	.414
9622.4795	7.666	-	.639	.381	9624.4532	7.788	.441	.688	.424
9622.4994	7.776	.389	.584	.404	9624.4850	7.745	.407	.698	.437
9623.3030	7.824	.436	.770	.441	9624.5015	7.759	.417	.684	.452
9623.3247	7.825	.446	.719	.440	9625.3671	7.768	.436	.677	.408
9623.3502	7.807	.444	.700	.429	9625.4255	7.730	.366	.659	.410
9623.3852	7.809	.375	.728	.412	9625.4455	7.717	.384	.628	.420
9623.3985	7.802	.395	.690	.416	9625.4666	7.727	-	.634	.405
9623.4245	7.802	-	.696	.415	9625.4851	7.712	-	.625	.404
9623.4464	7.824	.394	.648	.416	9625.4963	7.727	.436	.597	.393
9623.4648	7.820	.418	.663	.415	9631.3256	7.683	.417	.691	.413
9623.4762	7.813	.374	.634	.419	9631.3575	7.661	-	.671	.393

Table 1 (cont.)

JD hel 2440000+	V	U−B	B−V	V−R$_c$	JD hel 2440000+	V	U−B	B−V	V−R$_c$
9632.3020	7.776	.384	.696	.402	9633.4483	7.754	.418	.641	.405
9632.3283	7.802	.445	.712	.435	9633.4682	7.770	-	.664	.408
9632.3497	7.813	.461	.711	.426	9633.4874	7.768	.378	.664	.404
9632.3624	7.812	.398	.699	.436	9634.3088	7.785	.460	.673	.395
9632.3665	7.808	.396	.691	.435	9634.3426	7.733	.428	.675	.410
9632.3867	7.811	.403	.681	.422	9635.3701	7.826	-	.701	.451
9632.4068	7.803	.406	.679	.425	9635.3948	7.845	-	.707	.429
9632.4353	7.806	.384	.662	.416	9635.4536	7.879	-	.725	.429
9632.4482	7.795	.365	.653	.406	9635.4684	7.878	-	.732	.429
9632.4681	7.745	-	.665	.409	9635.4777	7.889	-	.727	.437
9632.4849	7.773	.448	.687	.488	9635.4863	7.896	-	.711	.437
9632.5026	7.739	.445	.687	.481	9635.5045	7.946	-	.690	.438
9632.5236	7.713	-	.654	.414	9635.5145	7.897	-	.723	.441
9633.2856	7.634	.428	.672	.409	9640.4056	7.637	-	.633	.409
9633.3301	7.656	.436	.664	.414	9640.4702	7.650	-	.649	.410
9633.3530	7.682	.404	.663	.397	9640.5272	7.671	-	.664	.410
9633.3682	7.697	.421	.650	.420	9644.3946	7.899	-	.750	.469
9633.3894	7.706	.456	.671	.409	9644.4938	7.869	-	.724	.455
9633.4060	7.708	.419	.676	.412	9647.4171	7.601	-	.624	.400
9633.4277	7.731	.437	.669	.399					
9617.3238	8.082	-	.737	.415	9622.4310	7.127	.414	.345	.196
9617.3623	8.041	.467	.762	.419	9622.4536	7.171	.317	.365	.233
9618.3919	7.610	-	.576	.340	9622.4738	7.216	.293	.365	.232
9618.4572	7.659	.385	.580	.348	9622.5094	7.287	.340	.415	.226
9619.1962	7.941	.365	.680	.388	9623.1427	7.910	.411	.687	.416

Table 2. UBVR observations of TU Cas.

JD hel 2440000+	V	U−B	B−V	V−R$_c$	JD hel 2440000+	V	U−B	B−V	V−R$_c$
9620.3307	7.557	.331	.487	.295	9623.2952	7.886	.400	.710	.406
9620.3514	7.513	.329	.488	.290	9623.3190	7.934	.413	.734	.406
9620.3595	7.505	.326	.499	.282	9623.3308	8.048	.409	.703	.412
9620.3831	7.499	.341	.488	.281	9623.3556	7.996	.407	.731	.412
9620.4213	7.438	.321	.493	.293	9623.3837	8.001	-	.724	.422
9620.4496	7.460	.337	.465	.296	9623.4076	7.981	.440	.734	.409
9621.1741	7.811	-	.647	.368	9623.4297	7.985	.400	.726	.409
9621.3012	7.893	.405	.647	.397	9623.4516	8.017	.433	.734	.411
9621.3585	7.923	.401	.692	.401	9623.4701	8.009	.425	.729	.428
9621.3815	7.997	.419	.716	.411	9623.4819	8.026	.462	.705	.427
9621.4154	7.946	.425	.700	.386	9623.5078	8.030	.387	.724	.418
9621.4408	7.959	.459	.691	.394	9624.1577	7.780	-	.596	.336
9621.5106	7.990	-	.702	.402	9624.2802	7.647	.343	.513	.309
9622.3899	7.114	.334	.301	.205	9624.3203	7.618	.326	.509	.390

Table 2 (cont.)

JD hel 2440000+	V	U−B	B−V	V−R_c	JD hel 2440000+	V	U−B	B−V	V−R_c
9624.3607	7.589	.341	.501	.306	9632.5077	8.100	.460	.730	.420
9624.3819	7.550	.324	.496	.298	9633.1570	7.263	.302	.374	.239
9624.3987	7.546	.322	.483	.300	9633.2036	7.314	.357	.411	.260
9624.4252	7.529	.337	.495	.287	9633.2306	7.370	.276	.442	.265
9624.4439	7.540	.294	.513	.293	9633.2860	7.474	.339	.469	.273
9624.4667	7.547	.328	.488	.307	9633.3029	7.462	.328	.472	.294
9624.4780	7.552	-	.496	.306	9633.3163	7.462	.337	.489	.294
9624.4870	7.572	.335	.493	.310	9633.3362	7.483	.361	.519	.311
9624.5064	7.557	.293	.518	.291	9633.3574	7.532	.315	.511	.317
9624.5150	7.574	.307	.530	.297	9633.3723	7.553	.404	.509	.312
9625.1716	7.736	.332	.593	.361	9633.3935	7.562	.364	.545	.336
9625.2397	7.773	.327	.589	.364	9633.4102	7.564	.385	.555	.330
9625.3156	7.780	.322	.608	.364	9633.4334	7.598	.388	.568	.317
9625.3405	7.766	.353	.630	.361	9633.4526	7.624	.412	.549	.336
9625.3588	7.768	.399	.631	.367	9633.4646	7.631	.355	.586	.336
9625.3781	7.779	.371	.627	.357	9633.4953	7.657	.378	.596	.350
9625.3973	7.805	.334	.621	.375	9634.1781	7.987	.427	.709	.404
9625.4312	7.799	.356	.628	.373	9634.2131	7.997	.392	.707	.382
9625.4508	7.803	.397	.612	.386	9634.2543	7.997	.343	.716	.391
9625.4824	7.798	-	.639	.361	9634.2798	8.049	.375	.706	.394
9625.5013	7.833	.377	.638	.392	9634.2948	8.056	-	.720	.410
9625.5140	7.825	-	.642	.377	9634.3313	8.016	.485	.707	.403
9626.2044	8.046	.412	.686	.407	9634.3532	8.029	.415	.712	.411
9631.1773	7.387	.316	.448	.270	9635.3431	7.596	-	.502	.325
9631.2207	7.398	.275	.455	.267	9635.3620	7.590	-	.499	.324
9631.2999	7.412	.317	.458	.318	9635.3743	7.603	-	.525	.313
9631.3264	7.508	.286	.448	.285	9635.3894	7.603	-	.551	.325
9631.3461	7.451	-	.475	.290	9635.4025	7.604	-	.522	.313
9631.3562	7.431	-	.476	.296	9635.4124	7.584	-	.526	.305
9632.1928	8.005	.397	.719	.407	9635.4374	7.604	-	.541	.321
9632.2352	8.011	.356	.713	.396	9635.4584	7.607	-	.552	.311
9632.2980	8.086	.412	.697	.406	9635.4695	7.627	-	.550	.340
9632.3252	8.042	.393	.716	.416	9635.4789	7.623	-	.550	.340
9632.3506	7.986	.462	.741	.412	9635.4872	7.617	-	.547	.335
9632.3514	8.046	-	.730	.419	9635.5042	7.609	-	.583	.310
9632.3741	8.060	.419	.725	.410	9640.2521	7.851	-	.649	.381
9632.3911	8.074	.431	.712	.418	9640.3318	7.859	-	.663	.380
9632.3979	8.056	-	.730	.410	9640.3995	7.872	-	.657	.384
9632.4113	8.082	.436	.731	.418	9641.3461	7.896	-	.644	.373
9632.4365	8.083	.420	.736	.421	9647.3231	7.987	-	.701	.403
9632.4542	8.071	.423	.738	.418	9647.4045	8.014	-	.719	.409
9632.4787	8.101	-	.751	.420					

Table 3. UBVR$_c$ observations of EW Sct

JD hel 2440000+	V	U−B	B−V	V−R$_c$	JD hel 2440000+	V	U−B	B−V	V−R$_c$
9514.3505	7.752	-	1.644	1.074	9541.3840	8.160	-	1.794	1.155
9514.4166	7.758	-	1.659	1.081	9542.2532	7.778	-	1.628	1.076
9515.3758	7.933	-	1.754	1.129	9542.3059	7.743	-	1.636	1.056
9516.3930	8.220	-	1.861	1.177	9542.3754	7.747	-	1.605	1.066
9517.3920	8.259	-	1.828	1.169	9543.2529	7.734	-	1.648	1.069
9519.4161	7.792	-	1.668	1.086	9543.3171	7.754	-	1.652	1.079
9521.3289	8.145	-	1.819	1.159	9545.2402	8.229	-	1.863	1.186
9522.3669	8.082	-	1.775	1.137	9545.2950	8.233	-	1.883	1.187
9522.4278	8.077	-	1.786	1.139	9546.2441	8.192	-	1.818	1.157
9523.3250	8.004	-	1.757	1.128	9546.3076	8.164	-	1.816	1.151
9523.4044	8.009	-	1.744	1.121	9546.3826	8.154	-	1.807	1.145
9524.3050	8.013	-	1.763	1.124	9547.2328	7.838	-	1.662	1.079
9524.3773	8.014	-	1.748	1.128	9547.2888	7.821	-	1.663	1.076
9524.4418	8.007	-	1.764	1.121	9548.3187	7.877	-	1.704	1.105
9525.3014	7.889	-	1.680	1.102	9548.3584	7.884	-	1.707	1.095
9526.2907	7.820	-	1.686	1.087	9549.2327	7.988	-	1.766	1.130
9529.2910	8.245	-	1.854	1.175	9549.3056	7.994	-	1.766	1.129
9530.2756	7.786	-	1.653	1.060	9549.3532	7.998	-	1.773	1.133
9530.3598	7.747	-	1.627	1.061	9550.3050	8.010	-	1.785	1.120
9530.4150	7.719	-	1.633	1.053	9551.3001	7.997	-	1.750	1.130
9533.2763	8.196	-	1.861	1.172	9552.2994	8.076	-	1.808	1.142
9533.3543	8.199	-	1.866	1.168	9553.2950	8.077	-	1.782	1.139
9533.4084	8.204	-	1.864	1.170	9554.3074	7.775	-	1.652	1.075
9534.2965	8.140	-	1.816	1.290	9556.2972	8.014	-	1.777	1.144
9534.3444	8.148	-	1.799	1.153	9557.2504	8.230	-	1.862	1.172
9534.4006	8.118	-	1.793	1.145	9559.2233	7.739	-	1.616	1.058
9535.2654	7.920	-	1.715	1.100	9559.3000	7.727	-	1.608	1.059
9535.3318	7.919	-	1.691	1.099	9560.2314	7.824	-	1.689	1.089
9535.4003	7.915	-	1.700	1.105	9560.3365	7.853	-	1.700	1.101
9536.2586	7.929	-	1.713	1.114	9561.3126	8.061	-	1.784	1.148
9536.3799	7.933	-	1.720	1.113	9563.3152	8.036	-	1.759	1.130
9537.2611	7.929	-	1.724	1.111	9564.2392	8.013	-	1.753	1.129
9537.3266	7.930	-	1.732	1.109	9617.0997	7.938	1.575	1.698	1.103
9537.3996	7.931	-	1.728	1.114	9620.2012	7.938	1.320	1.714	1.117
9538.2840	7.930	-	1.727	1.117	9621.1548	8.036	1.497	1.792	1.114
9538.3328	7.928	-	1.725	1.117	9624.1679	7.680	1.373	1.587	1.056
9539.2585	7.949	-	1.738	1.122	9625.1553	7.872	1.367	1.683	1.091
9539.3445	7.949	-	1.749	1.119	9626.2098	8.149	-	1.889	1.154
9539.3826	7.960	-	1.738	1.124	9631.1458	8.047	-	1.786	1.119
9540.2474	8.143	-	1.832	1.162	9632.1564	7.996	1.600	1.761	1.124
9540.3405	8.152	-	1.828	1.159	9633.1592	8.030	1.453	1.745	1.131
9541.2516	8.183	-	1.834	1.156	9634.1468	8.180	-	1.803	1.160
9541.3167	8.172	-	1.807	1.152					

L.N. BERDNIKOV
O.V. VOZIAKOVA
Sternberg Astronomical Institute
13, Universitetskij prosp.
Moscow 119899, Russia

M.A. IBRAGIMOV
Astronomical Institute
33, Astronomicheskaya str.
Tashkent, 700052
Republic of Uzbekistan

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PHOTOMETRIC OBSERVATION OF NS MONOCEROTIS

[BAV Mitteilungen Nr. 76]

NS Mon = CSV 783 = BD+7°1367 (9.5) was discovered by Hoffmeister (1934). He classified the variable as possibly Algol type in the range between $10\overset{\text{m}}{.}5$ and 11^{m}(pg). First investigation of this variable was performed by Kippenhahn (1955) based on 87 plates. He found the maximum brightness not to be constant, suspected β Lyr–type and gave three times of minimum light. Three additional minima timings were submitted by Wasiljanowskaja (1954). She supposed the variable to be of Algol type. Variability of the star between $10\overset{\text{m}}{.}8$ and $11\overset{\text{m}}{.}3$ (pg) was confirmed by Weber (1956). An investigation on 320 photographic plates by Olijnyk (1963) resulted in 15 times of minimum light of NS Mon but the elements could not be found. An even larger set of photographic plates was used by Häussler (1978). He investigated this star on 501 plates of the Sonneberg and Hartha Sky Patrols and derived first elements:

$$\text{Min I} = \text{HJD}\,2441599.600 \; + \; 0\overset{\text{d}}{.}9399163 \times \text{E}. \qquad (1)$$

Using the estimates on the Sonneberg plates together with the above elements a first photographic lightcurve and an O–C diagram were given. Unfortunately two weak stars north and south of NS Mon led to a rather large scatter in the lightcurve. NS Mon was classified as W UMa type in the range between $10\overset{\text{m}}{.}64$ and $11\overset{\text{m}}{.}08$ (ph). With these above data NS Mon is listed in the fourth edition of the GCVS (Kholopov et al. 1985).

For seventeen years the variable had remained obviously unobserved when we put NS Mon on our program, scheduled to look after seldom observed or in some other way problematic eclipsing binaries.

The photoelectric observations were made at the private observatory of one of us (F.A.) with a 0.35 m automatic photoelectric telescope (Agerer 1988). The photometer was equipped with an uncooled EMI 9781A tube and Schott filters for B and V. SAO 114137 (G5) was used as comparison star and SAO 114096 (G0) to check its constancy.

One minimum was observed photographically (P.F.) with a Lichtenknecker Flatfield-Camera f=576mm, f/D=2.0 on hypered KODAK Technical Pan 2415. The exposures were evaluated with a fixed diaphragm photometer. Altogether one new photographic and 10 photoelectric minima in two colours could be collected. All minima times were calculated with the Kwee – van Woerden (1956) method.

In compiling the lightcurve (Figure 1) from our data it became evident that the period published in the GCVS was a spurious one with the relation

$$\frac{1}{\text{P}_{\text{GCVS}}} - \frac{1}{\text{P}} = \frac{1}{2}.$$

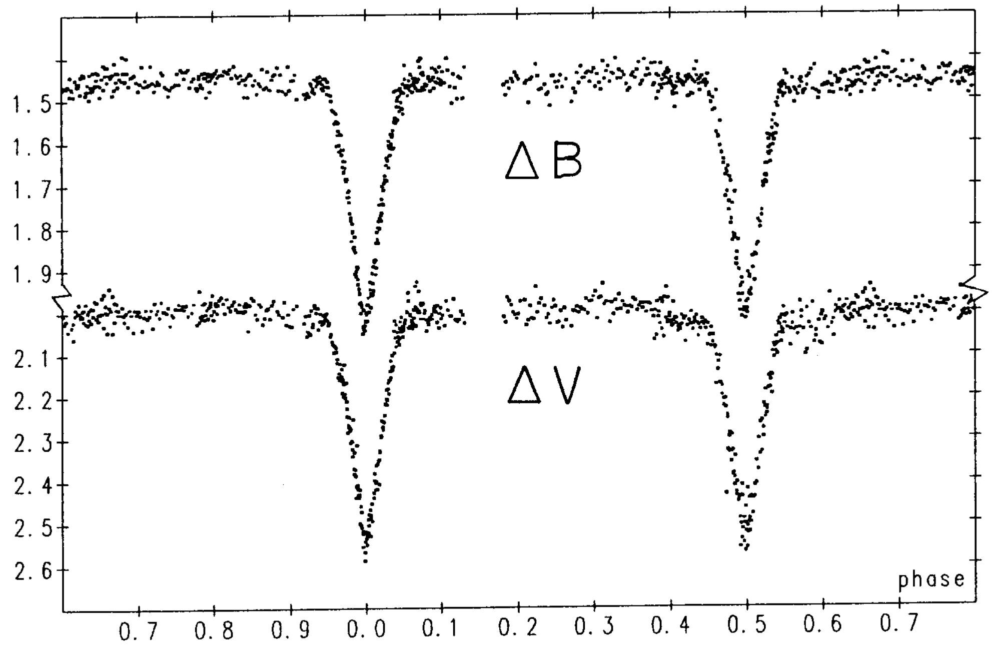

Figure 1: Differential light curves in B and V of NS Mon computed with respect to the new ephemeris (2).

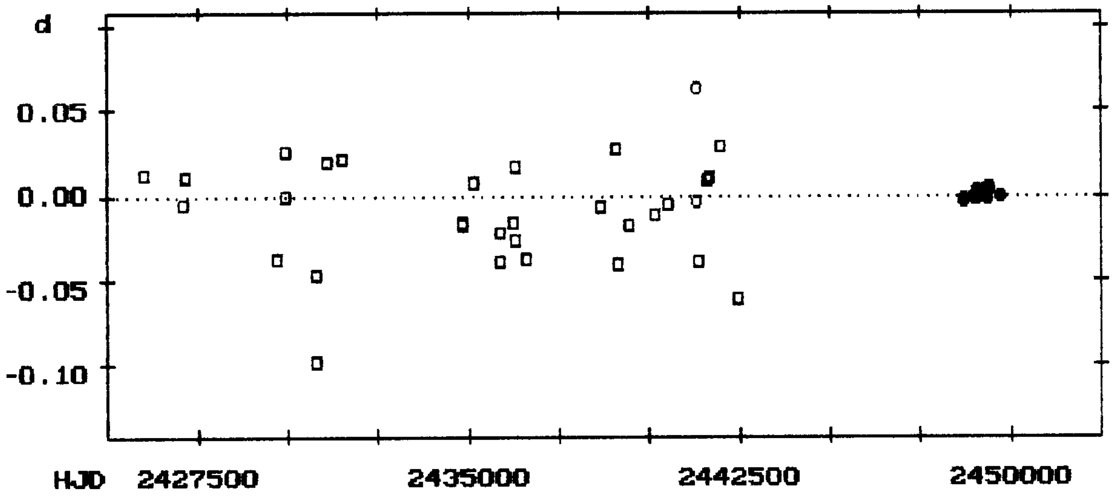

Figure 2: O–C diagram for NS Mon computed with respect to the new ephemeris (2) using all available minimum timings. • represents photoelectric, ○ photographic series and □ photographic plate minima.

Using all published minima found in the 'BAV Database of Minima of Eclipsing Binaries' together with our new observations, a weighted least squares fit yields the following linear ephemeris:

$$\begin{array}{rl} \mathrm{Min\,I} = \mathrm{HJD}\,2449002.4539 + & 1\overset{\mathrm{d}}{.}77761517 \times \mathrm{E} \\ \pm 4 \qquad & \pm 17 \end{array} \qquad (2)$$

Our observations show the primary and secondary minima to be almost equally deep with an amplitude of $0\overset{\mathrm{m}}{.}54$. A distinction between them was not possible. If both minima are primary ones, the period has to be halved. As can be seen from the lightcurve, NS Mon is in any case of the type EA.

Table 1

Observed times of minima for NS Mon, epochs and residuals computed with respect to the ephemeris (2) derived in this paper.

N	JD hel. 2400000+	W	T*	Epoch	O–C	Lit	N	JD hel. 2400000+	W	T*	Epoch	O–C	Lit
1	26030.345	2	P	−12923.0	+0.012	[1]	29	41330.330	20	F	−4316.0	+0.063	[4]
2	27100.452	2	P	−12321.0	–0.005	[1]	30	41385.334	2	P	−4285.0	–0.039	[4]
3	27157.352	2	P	−12289.0	+0.011	[1]	31	41599.585	2	P	−4165.5	+0.009	[4]
4	29700.182	2	P	−10859.5	–0.038	[2]	32	41680.468	2	P	−4119.0	+0.011	[4]
5	29913.533	2	P	−10739.5	–0.000	[3]	33	41983.569	2	P	−3949.5	+0.029	[4]
6	29913.559	2	P	−10739.5	+0.026	[3]	34	42448.326	2	P	−3687.0	–0.061	[4]
7	30762.298	2	P	−10261.0	–0.047	[3]	35	48690.4786	60	V	−176.5	–0.0038	[5]
8	30768.469	2	P	−10258.5	–0.097	[3]	36	48690.4805	60	B	−176.5	–0.0019	[5]
9	31090.335	2	P	−10077.5	+0.020	[3]	37	48985.5648	60	V	−10.5	–0.0018	[5]
10	31531.184	2	P	−9829.5	+0.021	[2]	38	48985.5654	60	B	−10.5	–0.0012	[5]
11	31903.145	0	P::	−9619.0	–0.429	[2]	39	48986.4537	60	B	−9.0	–0.0017	[5]
12	34807.290	2	P	−7986.5	–0.018	[3]	40	48986.4541	60	V	− 9.0	–0.0013	[5]
13	34823.291	2	P	−7977.5	–0.015	[3]	41	49002.4527	60	B	0.0	–0.0012	[5]
14	35135.285	2	P	−7801.0	+0.007	[3]	42	49002.4532	60	V	0.0	–0.0007	[5]
15	35862.283	2	P	−7392.0	–0.040	[3]	43	49018.451	30	B:	9.0	–0.001	[5]
16	35870.300	2	P	−7388.5	–0.022	[3]	44	49018.454	30	V:	9.0	+0.002	[5]
17	36194.329	0	P::	−7205.0	–0.408	[3]	45	49059.3379	60	B	32.0	+0.0003	[5]
18	36230.273	2	P	−7185.0	–0.016	[3]	46	49059.3380	60	V	32.0	+0.0004	[5]
19	36278.301	2	P	−7158.0	+0.016	[3]	47	49067.340	20	F	36.5	+0.003	[6]
20	36286.257	2	P	−7154.5	–0.027	[3]	48	49370.419	30	V:	207.0	–0.001	[5]
21	36613.327	2	P	−6970.5	–0.038	[3]	49	49370.419	30	B:	207.0	–0.001	[5]
22	38673.614	2	P	−5811.5	–0.007	[4]	50	49371.310	30	V:	207.5	+0.001	[5]
23	39057.613	2	P	−5595.5	+0.027	[4]	51	49371.313	30	B:	207.5	+0.004	[5]
24	39146.426	2	P	−5545.5	–0.041	[4]	52	49402.420	30	V:	225.0	+0.003	[5]
25	39441.534	2	P	−5379.5	–0.017	[4]	53	49402.421	30	B:	225.0	+0.004	[5]
26	40152.585	2	P	−4979.5	–0.012	[4]	54	49688.6123	60	V	386.0	–0.0011	[5]
27	40504.560	2	P	−4781.5	–0.005	[4]	55	49688.6126	60	B	386.0	–0.0008	[5]
28	41329.375	20	F	−4317.5	–0.003	[4]							

[1]: Kippenhahn (1955), [2]: Wasiljanowskaja (1955), [3]: Olijnyk (1963), [4]: Häussler (1978), [5]: Agerer: this paper, [6]: Frank: this paper.

*) P denotes pg plate min., V photoelectric min. in visual and B in B Filter and F photographic series. Those marked with ':' got reduced weight while those marked with '::' were discarded.

F. AGERER
P. FRANK
Bundesdeutsche Arbeitsgemeinschaft
für Veränderliche Sterne e.V. (BAV)
Munsterdamm 90,
D-12169 Berlin, Germany

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AW VIRGINIS: PHOTOELECTRIC TIMES OF MINIMUM AND IMPROVED PERIOD

The variable star AW Virginis (α=13$^{\rm h}$25$^{\rm m}_{.}$0, δ=+03°10$'_{.}$0; 1950.0) was discovered by Hoffmeister (1935). Jensch (1935) classified this star as a W UMa type system based on the first photographic light curve. He also obtained fourteen times of minimum light and derived the following ephemeris:

$$\text{Min I=J.D.hel. } 2427871.495+0^{\rm d}_{.}353998\times \text{E} \tag{1}$$

Whitney (1955) and Koch (1961) published photographic times of minimum light and the first author calculated an orbital period of P=0.3539968 days. More recently, Hoffmann (1983) determined two additional photoelectric times of minimum.

Figure 1 shows the BV light curves obtained in April 1988 at Las Campanas (Chile) with the 60 cm telescope of the David Dunlap Observatory and in March 1989 at the Complejo Astronomico El Leoncito –CASLEO– (San Juan, Argentina). An RCA 1P21 photomultiplier refrigerated by dry ice, and a photon-counting system were used in the first case and the Vatican Observatory photo-polarimeter VATPOL (Magalhães et al., 1984) with two dry-ice cooled RCA 31034 Ga-As photomultipliers were employed in the second.

The measurements were made differentially with respect to a comparison star. No variation in the light of this star was detected. All the observations were corrected for first and second order differential extinction. As the comparison is located very near to the variable the corrections were small. Absolute photometry of the comparison star allowed to determine a V_{max}=10.93 for the variable star.

A total of 608 observations in each BV passband were obtained. These observations well cover the orbital period and show minima of approximately the same depth of $\sim$ 0.7 mag (see Figure 1). From these measurements we determined 17 times of minimum light (9 times of primary minimum and 8 times of secondary minimum) using the bisection-of-chords method. A linear least squares fit to our photometric data yields an updated ephemeris:

$$\begin{array}{ll} \text{Min I=J.D.hel. } 2447269.82175 & +\ 0^{\rm d}_{.}35399736\times \text{E} \\ \qquad\qquad\qquad\quad \pm 0.00012 & \pm 0.00000029 \end{array} \tag{2}$$

We compiled all the previously determined times of minimum as well as those reported is this note. Using a linear least squares solution we derived an improved ephemeris:

$$\begin{array}{ll} \text{Min I=J.D.hel. } 2447269.82135 & +\ 0^{\rm d}_{.}353997025\times \text{E} \\ \qquad\qquad\qquad\quad \pm 0.00016 & \pm 0.000000046 \end{array} \tag{3}$$

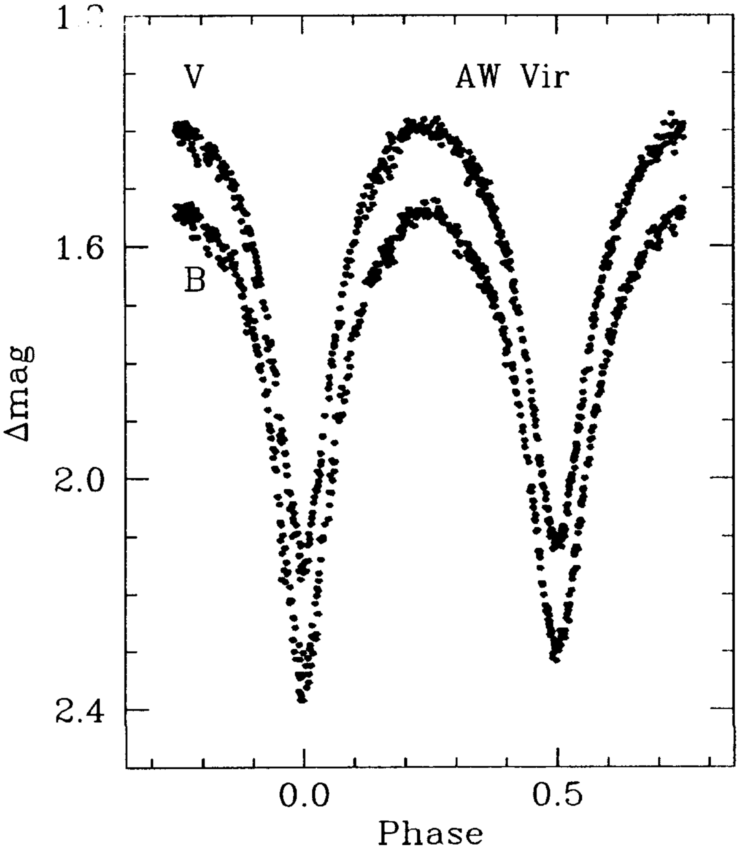

Figure 1

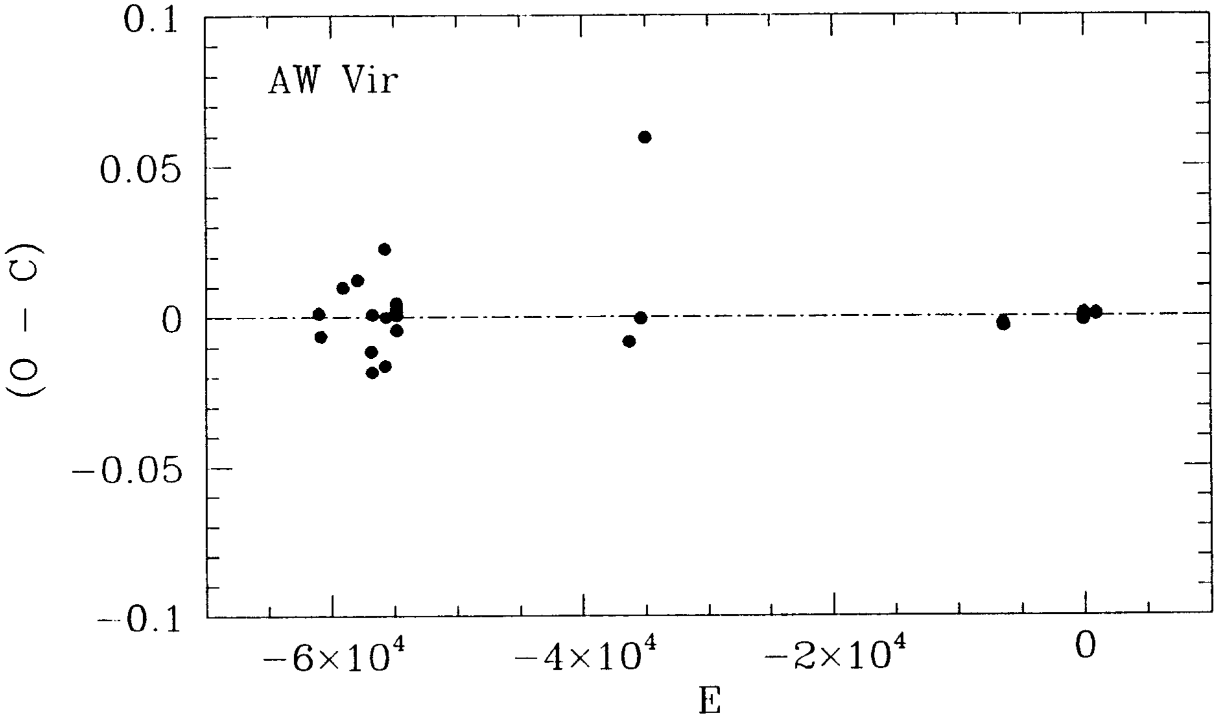

Figure 2

Table 1. Photoelectric times of minimum light of AW Virginis

Min.	JDhel. 2400000.+	E	(O−C)$_{(3)}$	(O−C)$_{(2)}$	reference
II	25680.429	−60987.5	0.001		(1)
I	25735.468	−60832.0	−0.006		(1)
II	26363.652	−59057.5	0.010		(1)
II	26771.459	−57905.5	0.012		(1)
II	27155.522	−56820.5	−0.011		(1)
I	27180.472	−56750.0	−0.018		(1)
I	27191.465	−56719.0	0.001		(1)
I	27539.466	−55736.0	0.023		(1)
II	27543.498	−55724.5	−0.016		(1)
I	27573.427	−55640.0	0.000		(1)
I	27866.541	−54812.0	0.005		(1)
I	27871.493	−54798.0	0.001		(1)
I	27873.619	−54792.0	0.003		(1)
I	27874.674	−54789.0	−0.004		(1)
I	34425.385	−36284.0	−0.008		(2)
I	34750.716	−35365.0	−0.001		(2)
I	34886.711	−34981.0	0.060		(3)
II	45002.645	−6404.5	−0.002		(4)
I	45022.645	−6348.0	−0.003		(4)
I	47257.7843	−34.0	−0.0011	−0.0016	(5)
I	47257.7855	−34.0	0.0001	−0.0003	(5)
II	47259.7330	−28.5	0.0006	0.0001	(5)
II	47259.7331	−28.5	0.0007	0.0003	(5)
II	47259.7332	−28.5	0.0008	0.0004	(5)
I	47268.7593	−3.0	−0.0000	−0.0004	(5)
I	47268.7597	−3.0	0.0004	−0.0000	(5)
II	47269.6447	−0.5	0.0004	−0.0000	(5)
II	47269.6451	−0.5	0.0008	0.0003	(5)
I	47269.8224	0.0	0.0011	0.0006	(5)
I	47269.8224	0.0	0.0011	0.0006	(5)
II	47270.7068	2.5	0.0005	0.0001	(5)
II	47270.7070	2.5	0.0007	0.0003	(5)
II	47270.7064	2.5	0.0001	−0.0003	(5)
I	47615.6770	977.0	0.0006	−0.0002	(5)
I	47615.6773	977.0	0.0009	0.0001	(5)
I	47615.6772	977.0	0.0008	0.0000	(5)

Note: (1) Jensch (1935); (2) Whitney (1955); (3) Koch (1961); (4) Hoffmann; (5) this note.

Table 1 lists all the times of minimum light used to derive equation (3). The columns give: the Julian date corresponding to each minimum, the epoch number, and the (O−C) residuals calculated from equation (3). For the new times of minimum light we included the residuals derived from equation (2). Figure 2 shows the (O−C) vs E diagram corresponding to equation (3). The residuals are, in general, randomly distributed and except for one minimum (Koch, 1961) the amplitude of the dispersion is of ∼0.002 days. According to the precision of the ephemerides the orbital period of the system seems to have remained practically constant over the last ∼50 years. However, additional times of minimum distributed on a longer time base are needed to confirm this preliminary result.

E. LAPASSET and
M. GÓMEZ
Observatorio Astronómico
Universidad Nacional de Córdoba
Laprida 854, 5000 Córdoba
Argentina

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PHOTOELECTRIC UBVR OBSERVATIONS OF THE PECULIAR CEPHEID V473 Lyr

We have observed V473 Lyr at the Mt. Maidanak observatory in September – October 1994. The 60-cm reflector was used and 63 UBVR$_c$ differential measurements were obtained (Table 1); the accuracy of the individual data is near 0.01 mag in all filters. The magnitude of the comparison star HD 180316 in UBVR$_c$ determined by us is: V=6.858, U−B=−0.479, B−V = −0.044, V−R$_c$=−0.037. This star is classified as Cepheid with irregularly variable amplitude in the GCVS. According to our data the amplitude of light curve (Fig.1) is near 0.4 mag. in V.

The phases are calculated with the elements:

$$MaxJDhel = 2428738.767 + 1.490813 \times E.$$

This study was partially supported by the Russian Foundation for Fundamental Research through grants No. 94-02-04344 and No. 94-02-04347.

Table 1

JD hel 2449600+	Phase	ΔV	Δ(U−B)	Δ(B−V)	Δ(V−R$_c$)
19.2499	.105	−.834	-	.662	.385
20.2326	.764	−.750	.766	.696	.392
21.1950	.409	−.625	.825	.794	.444
21.2284	.432	−.622	.869	.771	.422
21.2957	.477	−.581	.867	.760	.453
22.1124	.025	−.919	.788	.630	.387
23.0957	.684	−.633	.842	.721	.419
23.1813	.742	−.708	.789	.709	.394
23.2006	.755	−.730	.776	.686	.398
23.2104	.761	−.735	.782	.678	.392
23.2494	.787	−.791	.777	.669	.375
23.2899	.815	−.832	.787	.661	.386
24.0972	.356	−.654	.857	.755	.434
24.1408	.385	−.615	.833	.753	.445
24.1635	.401	−.618	.847	.763	.421
24.1994	.425	−.605	.848	.763	.432
24.2186	.438	−.608	.871	.763	.430
24.2469	.457	−.585	.858	.757	.431
24.2745	.475	−.583	.845	.758	.445
24.2877	.484	−.590	.852	.764	.427

Table 1 (cont.)

JD hel 2449600+	Phase	ΔV	Δ(U$-$B)	Δ(B$-$V)	Δ(V$-$R$_c$)
24.3259	.510	$-$.593	.869	.760	.428
25.0985	.028	$-$.909	.790	.617	.363
25.1573	.067	$-$.879	.820	.637	.366
25.1784	.081	$-$.856	.799	.661	.378
25.1968	.094	$-$.857	.797	.651	.374
25.2386	.122	$-$.815	.834	.656	.397
25.2608	.137	$-$.813	.787	.680	.385
25.2842	.152	$-$.780	.814	.675	.393
25.3057	.167	$-$.800	.811	.684	.404
25.3219	.178	$-$.783	.812	.701	.393
26.2075	.772	$-$.757	.758	.686	.394
26.2260	.784	$-$.771	-	.641	.389
26.2394	.793	$-$.801	.755	.658	.389
26.2612	.808	$-$.808	.761	.661	.381
31.0968	.051	$-$.893	.799	.643	.365
31.1650	.097	$-$.839	.807	.656	.373
31.1809	.108	$-$.822	.815	.669	.382
31.2086	.126	$-$.822	.821	.671	.384
31.2515	.155	$-$.790	.823	.677	.394
31.2900	.181	$-$.775	.821	.692	.399
32.1085	.730	$-$.678	.784	.699	.404
32.1550	.761	$-$.731	.793	.689	.396
32.1803	.778	$-$.766	.763	.665	.382
32.1968	.789	$-$.792	.764	.665	.376
32.2295	.811	$-$.830	.751	.645	.380
32.2611	.832	$-$.866	.774	.632	.349
32.3033	.861	$-$.913	.786	.636	.317
33.0987	.394	$-$.632	.841	.767	.433
33.1553	.432	$-$.605	.836	.782	.429
33.1807	.449	$-$.604	.818	.787	.439
33.2117	.470	$-$.600	.849	.770	.423
33.2333	.484	$-$.589	.831	.781	.439
33.2799	.516	$-$.578	.866	.772	.445
33.3015	.530	$-$.604	.849	.782	.426
34.1015	.067	$-$.882	.798	.666	.371
34.1330	.088	$-$.875	.816	.644	.373
34.1801	.119	$-$.824	.814	.672	.376
34.2060	.137	$-$.824	.778	.700	.373
34.2470	.164	$-$.793	.813	.703	.392
34.2698	.180	$-$.780	.848	.704	.407
34.2933	.195	$-$.770	.851	.691	.386
35.3079	.876	$-$.930	-	.598	.360

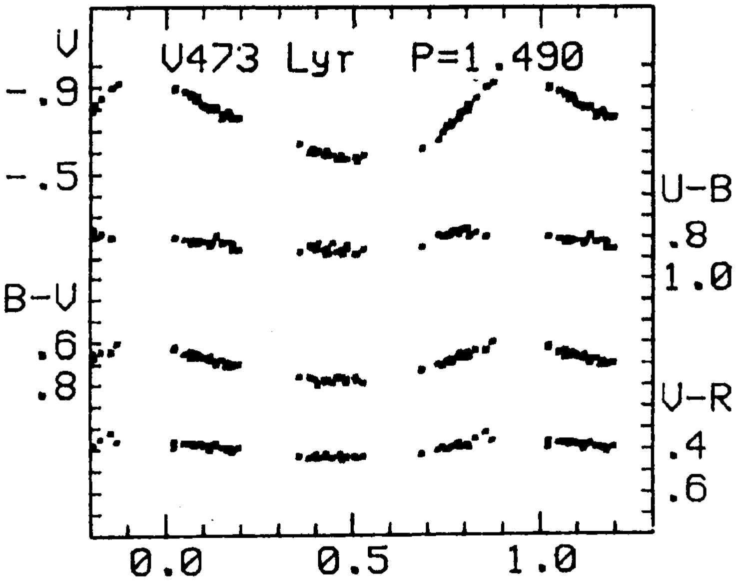

Figure 1

L.N. BERDNIKOV
O.V. VOZIAKOVA
Sternberg Astronomical Institute
13, Universitetskij prosp.
Moscow 119899, Russia

Reference:
Berdnikov L.N., 1992, *Pis'ma Astron. Zh.*, **1**, 654

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OBSERVATIONS OF SN 1993ad

Supernova (SN) 1993ad in IC 1501 was discovered by Pollas (1993) on November 7, 1993. Pollas also reported the brightness estimate $B = 18^m$ at discovery date and the offsets from the nucleus of the parent galaxy $13''$ east and $22''\!.7$ south.

Spectrogram of SN 1993ad was obtained on Nov. 10 by Cappellaro and Della Valle (1993). It showed that SN was of type II at a very early stage. Narrow emission lines of the Balmer series from H_α to H_ε superimposed on a very blue continuum were observed.

It was also noted that spectrum of SN 1983K, obtained ten days before maximum, was similar to that of SN 1993ad. Preliminary photometry gave $B = 16.3$, $B - V = -0.3$, $V - R = 0.0$ on Nov. 10.1 UT.

Four plates of SN 1993ad were obtained with the 40-cm astrograph at Sternberg Astronomical Institute Crimean Station. The brightness estimates are reported in Table I.

Table I.

Date	J.D. 2440000+	B
Nov 14.74	9306.24	16.24
Nov 15.76	9307.26	16.26
Nov 17.75	9309.25	16.45
Nov 18.83	9310.33	16.37

The light curve is shown in Figure 1. We can estimate the date and magnitude of maximum brightness: $B_{max} = 16.1$ on JD 2449303 (November 11).

According to the RC3 the parent galaxy type is Sbc, the radial velocity $v = 5165$ km s^{-1}, and galactic absorption $A_b = 0.12$. As the SN was very blue near maximum, the absorption in the parent galaxy should be negligible and we can estimate the absolute magnitude at maximum $M_B = -18.2$ (with $H_0 = 75$ km s^{-1} Mpc^{-1}). This means that SN 1993ad was fainter than SN 1979C and 1983K ($M_B = -19.6$), but significantly brighter than average type II SNe.

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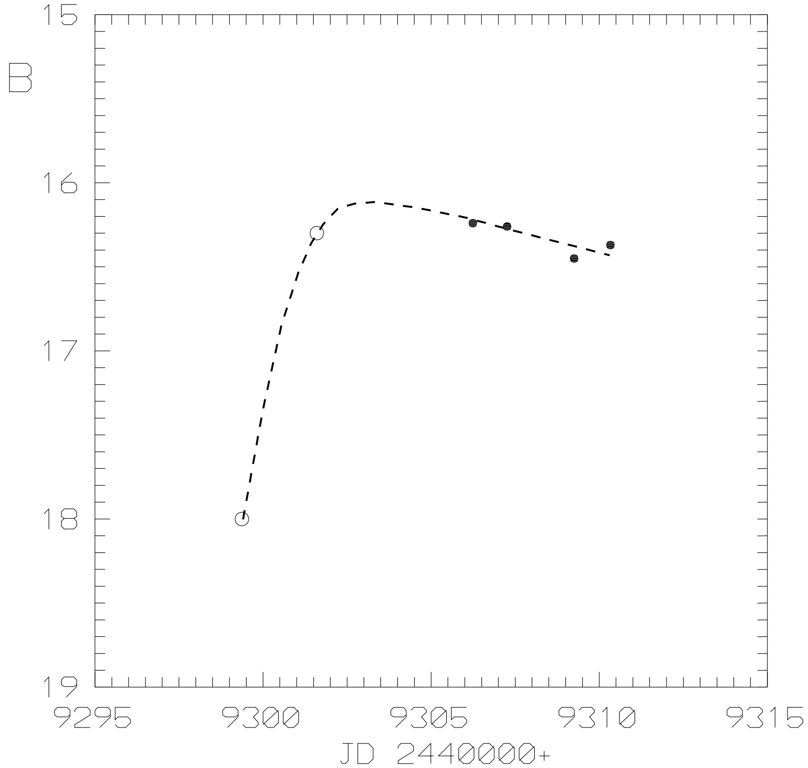

Figure 1. Light curve of SN 1993ad. Dots – our data, circles – data from the literature.

D. YU. TSVETKOV
N. N. PAVLYUK
Sternberg Astronomical Institute
of Moscow University
13, Universitetskij Prosp.
Moscow 119899, Russia
E-mail:
tsvetkov@sai.msu.su
pavlyuk@sai.msu.su

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Pollas, C., 1993, *IAU Circ.*, No. 5887.

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HD 121276: AN ECLIPSING MAGNETIC Ap STAR AT LAST?

Magnetic Ap stars have a peculiar distribution of orbital periods when they belong to binary systems: no magnetic Ap star is known for sure in systems with periods shorter than 3 days (Gerbaldi et al. 1985; see, however, the possible exception found by North 1994a). This is probably why it is so difficult to find a single eclipsing binary among them: indeed, in spite of some early claims (North 1984; Renson & Mathys 1984; Renson 1984, 1990), a close examination tends to make these alleged eclipsing Ap stars normal (North 1994a,b; Ziznovsky 1994).

We present here a new possible candidate: the southern star HD 121276 = CP $-51°6430$ was classified Ap SiCr(pec) by Houk (1978) with a quality 1, i.e. the best. Interestingly, Houk gives a remark saying "He 4026 is fairly strong, with Ca K being even stronger (yld. A1). Magnesium may also be strong; 4471 = 4481". Since Ap stars are helium-poor, the strength of He 4026 appears rather strange and implies that this star is unusual, even among the Ap stars.

The large amplitude photometric variability was noticed in mid-1993 by one of us (CR) during the reduction of early data. These were gathered at the European Southern Observatory, La Silla, Chile, with the double-beam "P7" photometer attached to the 0.7m Swiss telescope in 1989, 1991, 1993 and systematic monitoring took place in June 1993 and July 1994. The resulting lightcurves are shown in Figure 1, for the [U], [B], [V] magnitudes and [U−B], [B−V] colour indices of the Geneva photometric system, according to the ephemeris

$$\mathrm{HJD(Min.I)} = 2\,449\,343.774 + 6.514628 \times \mathrm{E}$$

There is a deep primary minimum, while the secondary minimum is very shallow and a bit ill-defined. In V, there is a large variation (0.08 mag.) outside the eclipses, which is also present in the [B] band but is less definite in the [U] band. This out-of-eclipse variation resembles the effect due to the non-sphericity of a component nearly filling its Roche lobe, but such an effect is not expected to be so wavelength dependent. Moreover, the period is rather long and the primary minimum is short (about 12.5 hours), suggesting that the system is well-detached. Therefore, one is tempted to attribute the out-of-eclipse variations to the intrinsic variability of the primary, which is indeed expected to vary according to its Ap SiCr classification. But the large scatter in the [U] band is much larger than that expected from the measurement errors alone (0.009 mag.) and suggests that some irregular phenomena occur in this system.

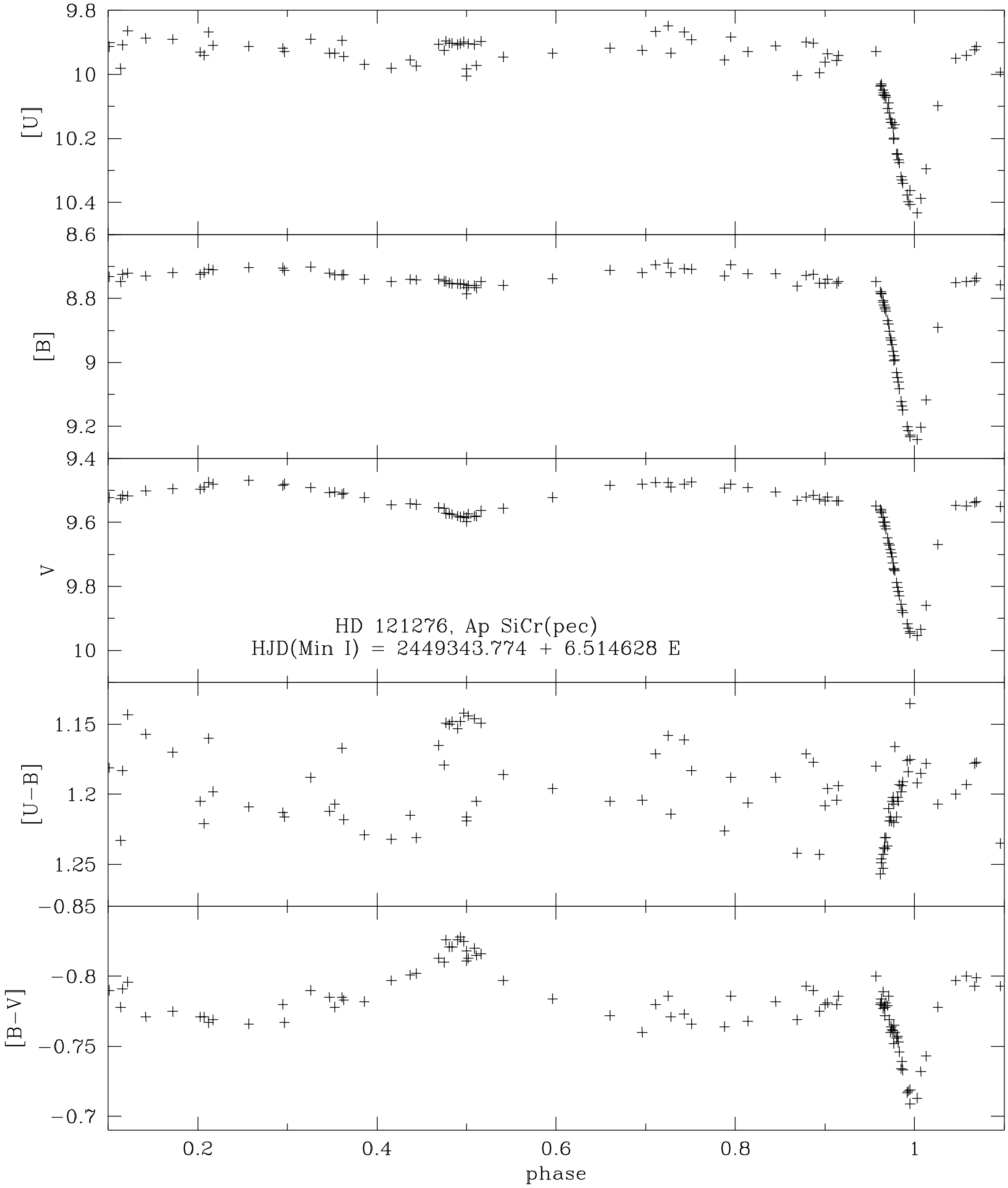

Figure 1. Geneva [U], [B] and V lightcurves of the eclipsing binary HD 121276, phased according to our ephemeris. Notice the large scatter in the[U] passband. The [U−B] and [B−V] indices are shown as well.

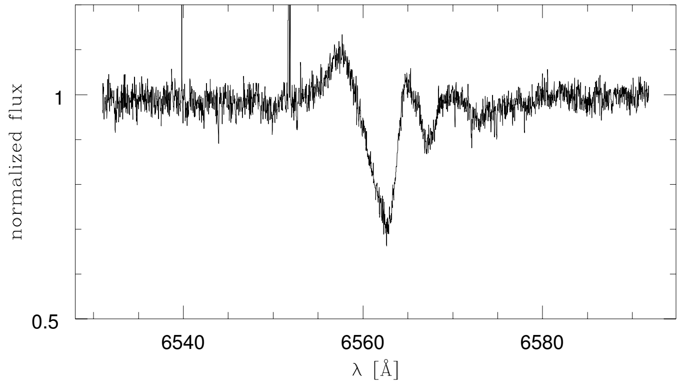

Figure 2. High-resolution spectrum of HD 121276 taken at orbital phase 0.249, i.e. at quadrature, and showing the star as a double-lined system. Notice the asymmetry of the H_α line of the primary and the emission on its blue side, showing the presence of circumstellar gas.

This is confirmed by the [U−B] and [B−V] indices. Both minima are clearly visible, showing the secondary to be redder in [B−V]. The behaviour of [U−B] in the primary minimum is quite unexpected in that the system is becoming *bluer* as the eclipse proceeds, while one would expect the reverse from the secondary eclipse where the system is at minimum [U−B]. Since the mean values of the reddening-free X and Y parameters (Cramer & Maeder 1979) are 1.07 and 0.01 respectively, we probably have a system composed of a mid-B primary and of a late B or early A secondary. The mean value of the reddening-free peculiarity parameter, Z, is −0.020, which suggests that one or both component(s) may have the Si peculiarity type, since this parameter is negative for Bp and Ap stars and null for normal B and A stars. However, the mean value of the $\Delta(V1-G)$ index, which is also a peculiarity parameter (see e.g. Hauck & North 1982), is only about 0.001, indicating a very marginal peculiarity at most.

One of us (PN) has taken a spectrum of this system with the 1.4m CAT telescope of the European Southern Observatory, equipped with the CES spectrograph, the Long Camera and the FA 2048 CCD detector (ESO CCD # 30). The resolving power was R = 60000. The spectrum was taken in the H_α region on the night of May 15-16, 1994 at HJD = 2449488.715, i.e. at phase $\phi = 0.249$ according to our ephemeris. Since this is exactly at quadrature, we can estimate the total mass of the system from the relative velocity at that phase. The spectrum displayed in Figure 2 shows, however, a very peculiar profile of the primary's H_α line: the profile is not only asymmetric, but also shows a blue emission component. Circumstellar gas is therefore certainly present in this system, which may explain the unusual features of the lightcurves.

To estimate the relative velocity, we first fit a gaussian to the core of the H_α line of each component. For the primary, a large uncertainty results from the asymmetry of the H_α line, but some confidence interval can be guessed by fitting a gaussian to the whole profile on the one hand, and to the very core and red side only on the other hand.In the first case we have $\lambda_{p1} = 6562.297$Å, in the second case $\lambda_{p2} = 6562.594$Å. The secondary's line is much more symmetrical, and two fits with a slightly different fitting range give $\lambda_{s1} = 6567.277$Å and $\lambda_{s2} = 6567.288$Å. The range in wavelength difference is thus $\Delta\lambda = 4.683$ to 4.991 Å, corresponding to a relative velocity $\Delta V_r = 213.9$ to 228.0 km s^{-1}.

Since the eclipses are separated by half a period, the assumption of a circular orbit appears realistic, and we obtain then a semi-major axis in the range (the inclination i of the orbital plane being close to 90°, $\sin i$ is approximated by 1):

$$a = 0.128 \ - \ 0.137 \text{ AU}$$

This implies the following range for the total mass:

$$M_p + M_s = 6.6 \ - \ 8.1 \ M_\odot$$

which is consistent with the spectral types estimated above for each component on the basis of the reddening-free X and Y parameters.

This system might well be yet another case of spurious classification due to the peculiar appearance of an unrecognized composite spectrum. The plate used by Houk for her classification of HD 121276 was taken in the night of May 18-19, 1968, i.e. around JD 2439995.6, which corresponds to $\phi \approx 0.049$, just after the primary minimum. But in view of the uncertainty of the period, which is about 0.0002 days at most, the plate could have been taken right in the middle of the primary eclipse, and the apparent spectrum would have been more similar to the intrinsic spectrum of the secondary.

A complete spectroscopic and photometric study would be needed to clarify the true nature of this binary.

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P. NORTH
Institut d'Astronomie de l'Université
de Lausanne
CH-1290 Chavannes-des-Bois,
Switzerland

C. RICHARD
Observatoire de Genève
CH-1290 Sauverny, Switzerland

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A DATABASE OF GALACTIC CLASSICAL CEPHEIDS

We have compiled an electronic database of 505 classical Cepheids in the Galaxy contained in four files.

The first, POS_DATA (27.7 KB), contains the 1950 equatorial and galactic coordinates of each star taken from the 4th edition of the General Catalogue of Variable Stars, as well as the HD and SAO catalogue numbers of each star where available.

The second file, EB−V (55.6 KB), is a compilation of major colour excess determinations published since 1975.

The third, PHYSDATA (49.3 KB), lists period, intensity-mean V magnitude, $\langle \mathrm{B} \rangle_i - \langle \mathrm{V} \rangle_i$, an adopted E(B−V), the V amplitude, $\langle \mathrm{M}_v \rangle$, distance in parsecs, the height from the galactic plane in parsecs, mean radial velocity, radius from a Baade–Wesselink analysis, an indication of binarity, and notes relating to double-mode behaviour, cluster/association membership, etc.

The fourth, AMP_MEAN (34.7 KB), gives the V amplitude, B amplitude, (B−V) amplitude, $\langle \mathrm{V} \rangle_{mag}$, $\langle \mathrm{V} \rangle_{int}$, $\langle \mathrm{B} \rangle_{mag}$, $\langle \mathrm{B} \rangle_{int}$, $\langle (\mathrm{B}-\mathrm{V})_{mag} \rangle$, and $\langle \mathrm{B} \rangle_i - \langle \mathrm{V} \rangle_i$.

A fifth file, having the title of this Bulletin, provides background and additional information on these files. This fifth file is an ascii file, the other four are provided both as ascii files and as dBASE IV binary files.

This material is available on the World Wide Web at the URL

http://ddo.astro.utoronto.ca/cepheids.html

and by anonymous ftp at

perseus.astro.utoronto.ca

in the directory pub/cepheids.

We would appreciate acknowledgment of your use of these data by reference to this IBVS announcement. Please contact fernie@astro.utoronto.ca in the event of queries, suggestions, or difficulties.

J.D. FERNIE
David Dunlap Observatory
University of Toronto
Richmond Hill ON, Canada
L4C 4Y6

Brian BEATTIE
David Dunlap Observatory
University of Toronto
Richmond Hill ON, Canada
L4C 4Y6

Nancy Remage EVANS
Physics & Astronomy Dept.
York University
North York ON, Canada
M3J 1P3

S. SEAGER
Harvard-Smithsonian CfA
60 Garden Street
Cambridge, MA 02138
USA

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SHORT TIME-SCALE VARIATION OF ε Aur Hα BLUE WING EMISSION

ϵ Aur is a peculiar spectroscopic binary system with a long period of 27.1 years. Its primary is an F0Ib star around which there is a slowly moving ring-like (or disk-like) HII radiation cloud accompanying with the rotation of the F star, and this makes Hα wing produce two emission lines with rotating structure. The secondary is a disk-like multi-ring gaseous cloud (Ferluga, 1990). In 1982-84 eclipse, Ferluga and Mangiacapra (1991) observed the shell spectra of the secondary and obtained its multi-ring model.

Our observations on ϵ Aur Hα line outside eclipse were carried out by using the thick CCD system on Coudé spectograph of the 1-meter telescope at Yunnan Observatory. The dispersion of the spectrograph (f=1900) is 4.16Å/mm, and spectral resolution $\lambda/\Delta\lambda$=455000. Read-out noise of the CCD system is 12.3 electrons/sec, the resolution of image cell 0.048Å/pixel, wavelength range for a single exposure about 37Å, and the signal-to-noise ratio 150-250. A line of sight velocity standard star, α Lep, and a spectrophotometric standard star, ζ Leo were observed to confirm the Hα blue wing emission profile. The measurement errors of the equivalent width values in the Hα lines are ±30mÅ for the absorption and ±6mÅ for the blue wing emission.

In Figure 1a and b, the Hα observational profiles are given. No. 1 to No. 15 are out-of-eclipse Hα lines of ϵ Aur and No. 16 is that of the sight line velocity standard star, α Lep. Two significant variations appear at the blue emission peaks on No. 4 and 6 lines; the emission intensity decreases at the line center, and the equivalent widths for these two lines are +193mÅ and +199mÅ (see Table 1), respectively; comparing with Nos.3, 5 and 7, the equivalent width decreases by about 100mÅ in less than 40 minutes. In the time interval of 2.5 hr, the intensity variation from No. 7 to 10 is very small, within ±10mÅ; and on both No. 11 and 14 lines only a small fluctuation appears in 2 hr period. The variations of the equivalent widths for the blue wing emission and absorption in the interval of 7 hr on Oct. 30 are drawn in Figure 2. It is shown from the above description that short time-scale variations from 20 minutes to several hours exist in the blue wing emission; while the red wing and absorption profiles are similar to previously observed profiles, almost no variation can be found (see Figure 1a and b). The average equivalent width of the absorption lines is −545mÅ, only a seventh or eighth of that eclipse; the standard deviation σ_x=11, and the maximum variation is within ±18mÅ, smaller than the error of the measurement.

From the Hα observations in 1955-57 (Wright, 1957) and 1982-84 (Tan, 1985) eclipses, in ingress the secondary first would absorb the Hα red wing emission; and from our model (Cha et al., 1994) the blue wing emission source should be region C, therefore, in the region possibly exists an HII cloud with a short time-scale variation. If our observational Hα continuum is taken as a reference, in the emission over the continuum in 20 minutes

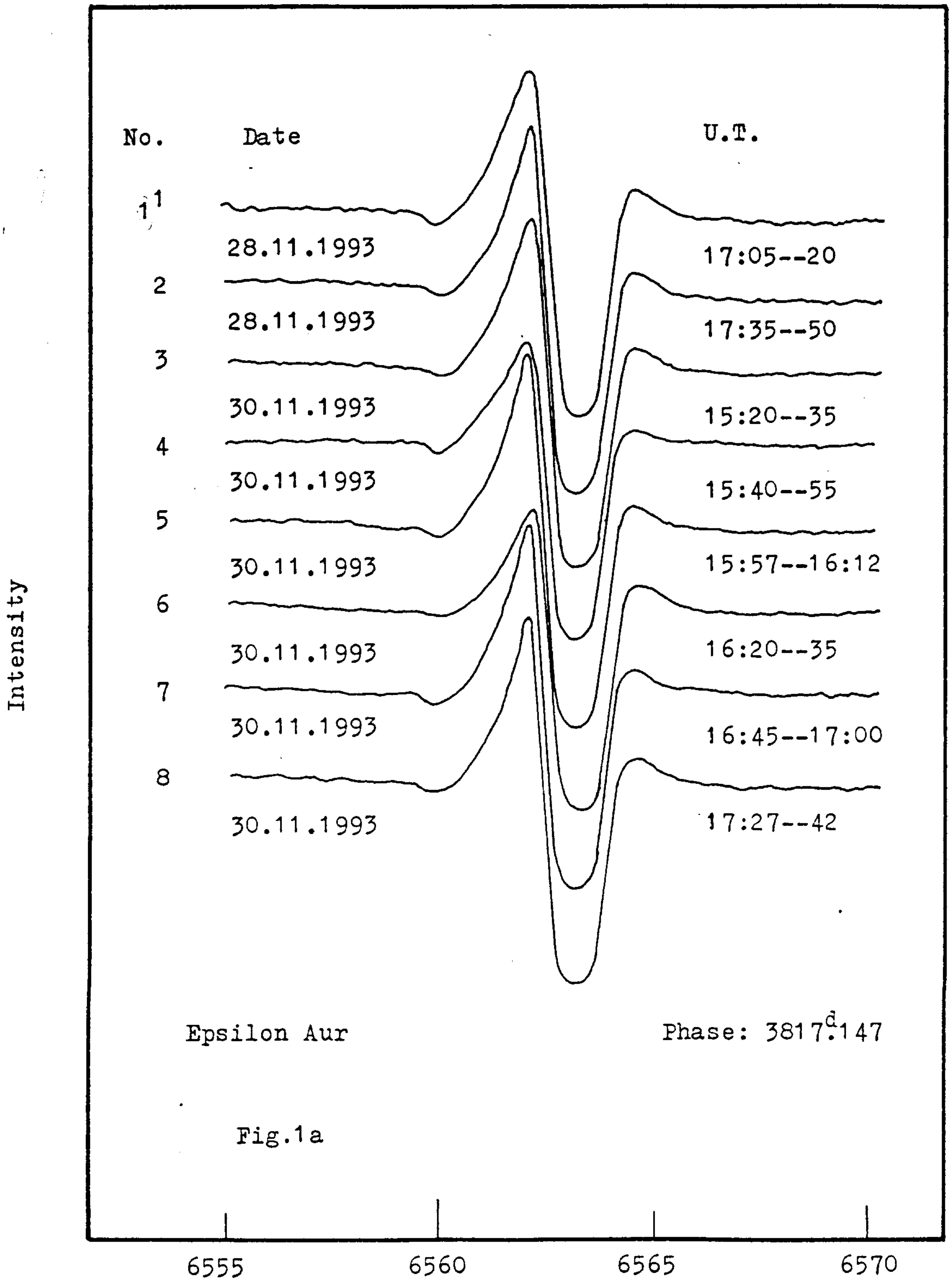

Figure 1a
Figure 1. Short-time variation of ϵ Aur Hα blue wing emission

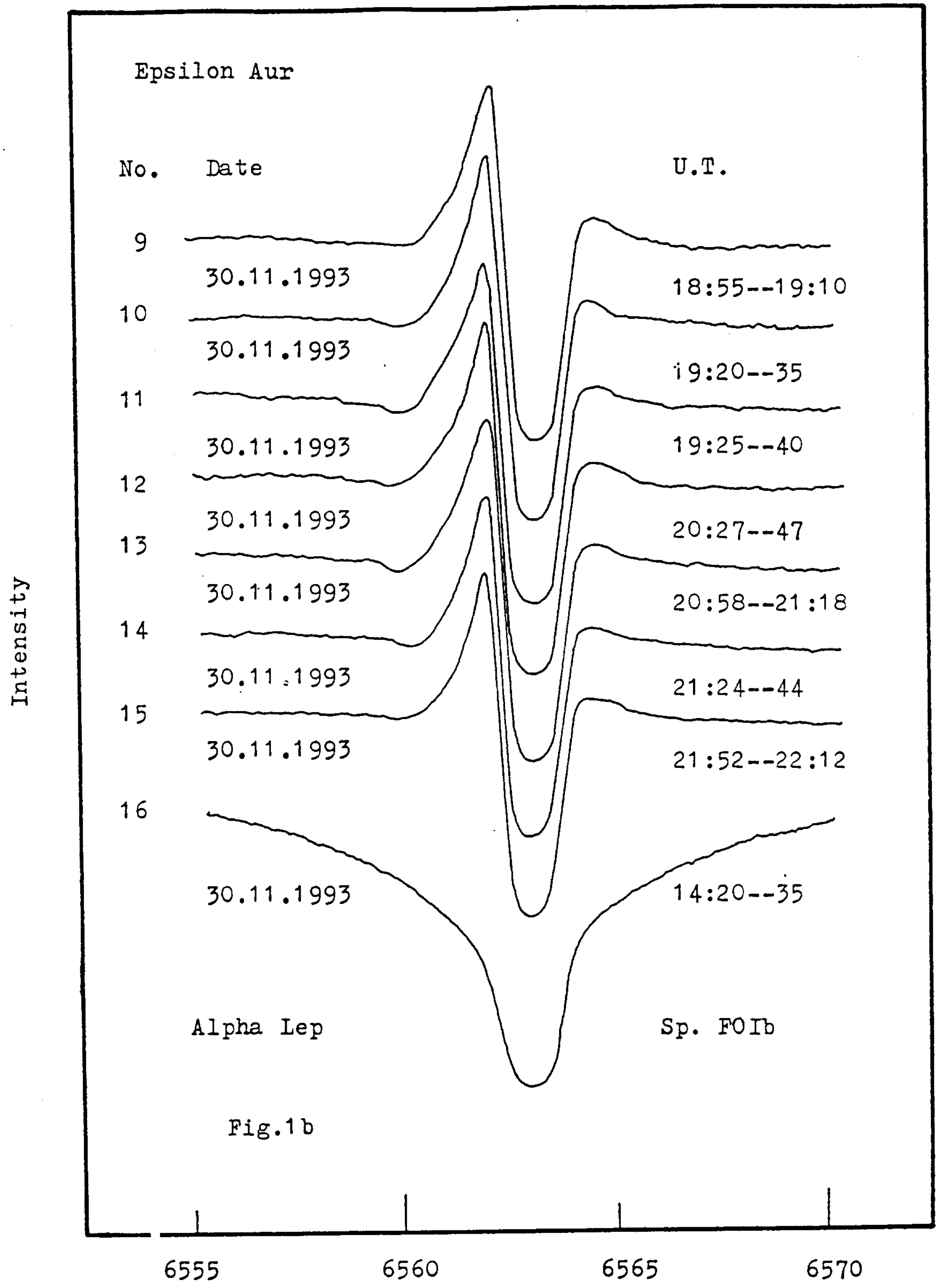

Figure 1b
Figure 1. Short-time variation of ϵ Aur Hα blue wing emission

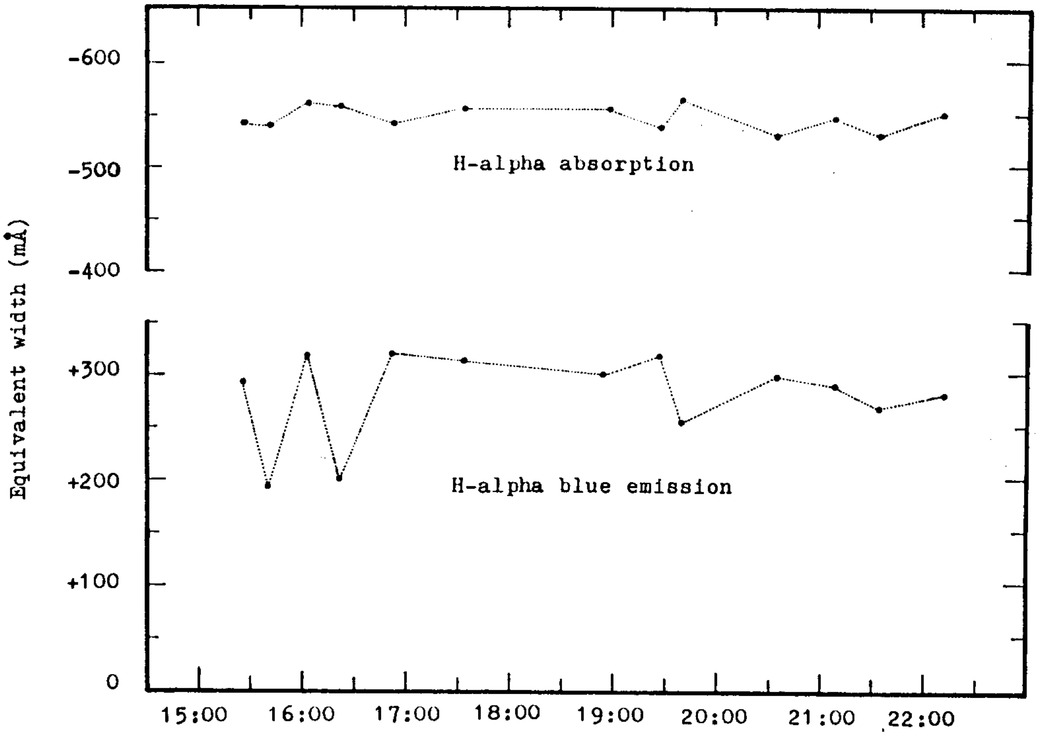

Figure 2. Variation of equivalent widths.

interval appear two fast variations, and the intensity ratio is 2:3 (in No. 4 and 6 to No. 3 and 5), with the intensity decrease by one third. The strong blue wing emission center is close to the Hα absorption profile, and active emission may probably locate in the region slowly appearing from the back of the F0 supergiant. A continuous monitoring on ϵ Aur is of importance to obtain more information about the matter in Hα rotating ring for analysing its motion features, physical characteristics annd emission mechanism.

CHA GUANGWEI
LI YONGSHENG
XU JUN
United Laboratory for Optical
Astronomy,
Chinese Academy of Sciences
Yunnan Observatory
P.O. Box 110
Kunming 650011
People's Republic of China

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IS TX DELPHINI A POPULATION I (CLASSICAL) CEPHEID?

The pulsating variable TX Del (SAO 16272, BD +3°4437) is a well-known, relatively bright ($\langle V \rangle = 9.2$ mag) Cepheid classified as Type II according to the catalogue of Harris (1985). The classification is based on its large distance from the galactic plane: [z] = 450 pc if we assume d = 1.1 kpc distance from the Sun derived from the period–luminosity relation of Type II Cepheids (Harris, 1985). The assumption that TX Del is a classical Cepheid would result in [z] = 1.2 kpc (Harris & Welch, 1989). This latter [z] distance is much larger than the scale height of classical Cepheids (70 pc, Fernie, 1968; Harris, 1985), therefore Harris & Welch (1989) concluded that TX Del is very probably a Type II Cepheid.

There are some other criteria of the classification of Cepheid variables, e.g. metallicity, galactic kinematics, light curve shape, etc. (see Harris, 1985 and the references therein). The classification, however, has large difficulties known for a long time. Up to now the separation based on the [z] distances seems to be the most useful and reliable. It is interesting that none of these criteria support the Type II status of TX Del, because it is a metal-rich star among Type II Cepheids ($[Fe/H] > 0.5$ according to Meakes et al., 1991) and its light curve is very similar to those of classical Cepheids (e.g. Szabados, 1980). Recently TX Del has been discovered to be a member in a spectroscopic binary. Harris & Welch (1989) separated the pulsational and orbital radial velocities and determined the orbital parameters of the system.

A project of computing physical parameters of metal-rich Type II Cepheids via various Baade–Wesselink techniques has been started by the authors. Unfortunately, the number of stars is quite low due to the lack of precise radial velocity measurements but TX Del is one of the best observed objects in this sample. There are many light curves available and the precise pulsational velocity curve determined by Harris & Welch (1989) enabled us to compute the mean radius with acceptable accuracy. The used data are plotted against phase in Figure 1.

We applied two kinds of techniques deriving the radius: the "classical" Baade–Wesselink method based on equal levels of the colour index (B−V) (method #1) and the surface-brightness method based on the Barnes–Evans relation and the $(V-R)_0$ index (method #2). Both methods have lead to very similar results. Figure 2 shows the result of velocity curve integration and the computed radii at certain phases (using method #1). The physical parameters obtained are tabulated in Table I. E(B−V) = 0.1 was adopted from Meakes et al. (1991).

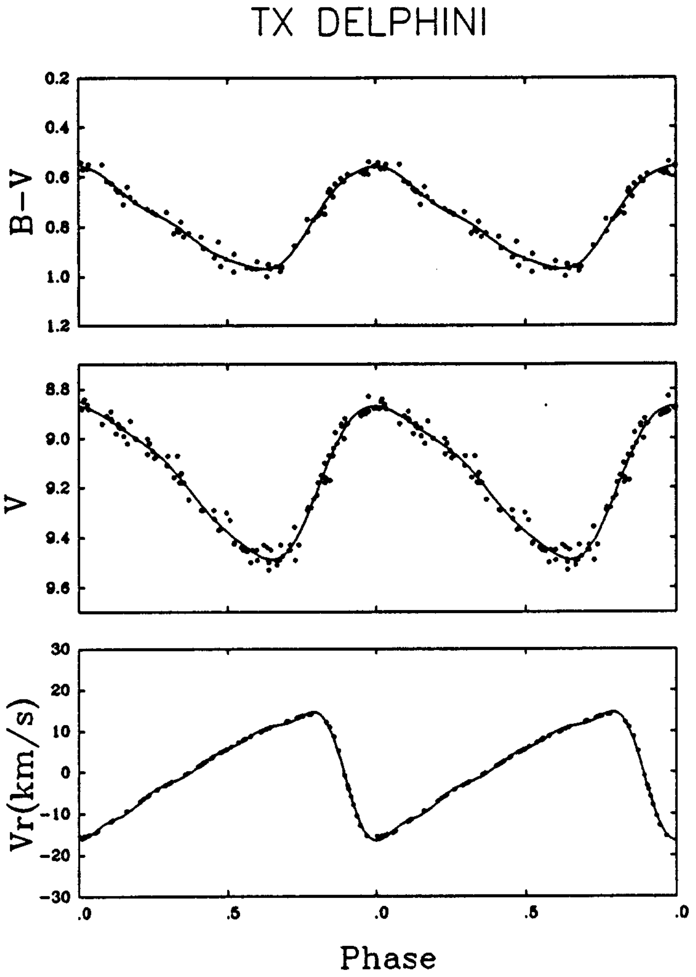

Figure 1 : Light-, color- and radial velocity curve of TX Del

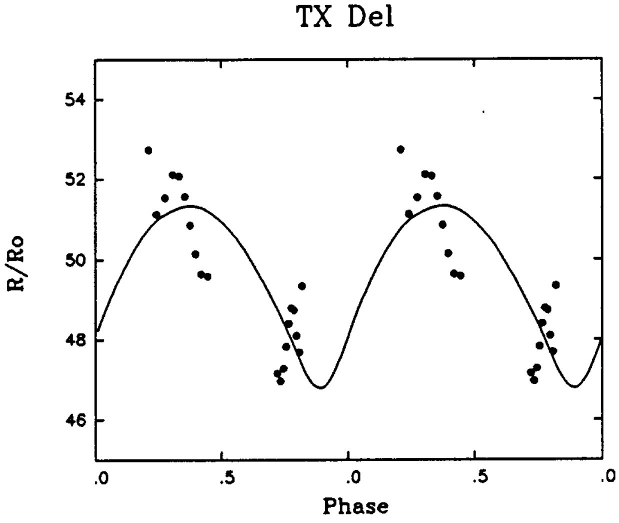

Figure 2 : Radius variation of TX Del during a pulsational cycle. The solid curve is the result of velocity curve integration, the filled circles are the radii obtained from the Baade-Wesselink solution.

Table I

Baade–Wesselink parameters and inferred parameters of TX Del

$R/R_\odot$	$(B-V)_0$	T_{eff}(K)	$L/L_\odot$	$M/M_\odot$	d(pc)	z(pc)
48±2	0.67	5500±200	1940±300	6±0.3	3000	1200

The obtained radius of TX Del ($R/R_\odot = 48$) shows that this star is too large to be a Type II Cepheid. The "normal" radius of an object of this type should be about 16 $R_\odot$ which is considerably smaller. Moreover, the inferred radius is in very good agreement with the period–radius relation for classical Cepheids (Gieren, Barnes & Moffett, 1989). Thus it is probable that TX Del is a Population I (classical) Cepheid. Using this assumption we can estimate the luminosity and the mass of TX Del as well as its distance from the Sun and the galactic plane respectively. These derived parameters are also summarized in Table I.

Since TX Del is a member of a binary system (the orbital period is quite short, $P_{orb} =$ 133 days) it is important to compare its radius with respect to the radius of the Roche-lobe. The mass function of the system is 0.04 $M_\odot$ therefore the minimum mass of the companion is 1.1 $M_\odot$. The Roche-lobe radius thus becomes about 110 $R_\odot$, so the ratio of radii $R_{star}/R_{Roche}\approx 0.44$. This value increases up to 0.5 if the companion is assumed to be as massive as TX Del.

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Z. BALOG and J. VINKÓ
Dept. of Optics
JATE University
Szeged, Dóm tér 9
H-6720 Hungary

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DETECTION OF VARIABILITY IN HD 191850

We obtained two nights of differential photometry of HD 191850 (22/23 and 25/26 July 1994). The observations were done at the ESO 50 cm telescope at La Silla. The observer was E. Paunzen. The measurements are in the Strömgren photometric system and the integration time was 40 seconds. Two comparison stars were observed (C1: HD 191542, m_V=9.6, A5V and C2: HD 191760, m_V=8.9, G3IV/V). Both comparison stars proved to be constant within an upper limit of 0.01 mag in Strömgren b.

The spectral type of HD 191850 is A3 II/III. The following calibrations have been adopted by the Strömgren indices (Moon & Dworetsky, 1985):

$$T_{eff} = 7400 \text{ K}, \; log\, g = 3.7, \; \delta m_0 = 0.057$$

Because of the decreased metallicity and the classification as luminosity-class II/III star, HD 191850 is a candidate for the λ Bootis group (Gray, 1991) which contains metal weak A type stars with broad and shallow hydrogen lines (the properties of this group are described by Weiss et al., 1994). Further observations have to prove the membership in the λ Bootis group.

Two theories exist concerning the evolutionary status of this group. In one case diffusion would be the determining mechanism and the stars are at the end of the ZAMS phase. In the other hypothesis accretion and/or mass-loss would be responsible for the low metallicity and the stars are just arriving at the ZAMS.

The tools of asteroseismology should make it possible to determine the position of stars within the HR-diagram. We started therefore a survey for periodic variability among λ Bootis stars. Up to now we found 8 new pulsating stars. For HD 191850 the maximum peak in the frequency spectrum appears at f=13.53 c/d (P=106 minutes) with a semi-amplitude of 0.034 mag in Strömgren b (see Figure 2). This period is consistent with an expected period of an A type star at the ZAMS (Stellingwerf, 1979). Figure 1 shows the light curve for the first night for all three measured stars. All light curves are in instrumental magnitudes with an offset.

This amplitude spectrum gives some evidence for the presence of more than one pulsation frequency. In spite of the rather poor quality of both nights, the variability of HD 191850 seems to be well established. Further observations have to improve the reported results.

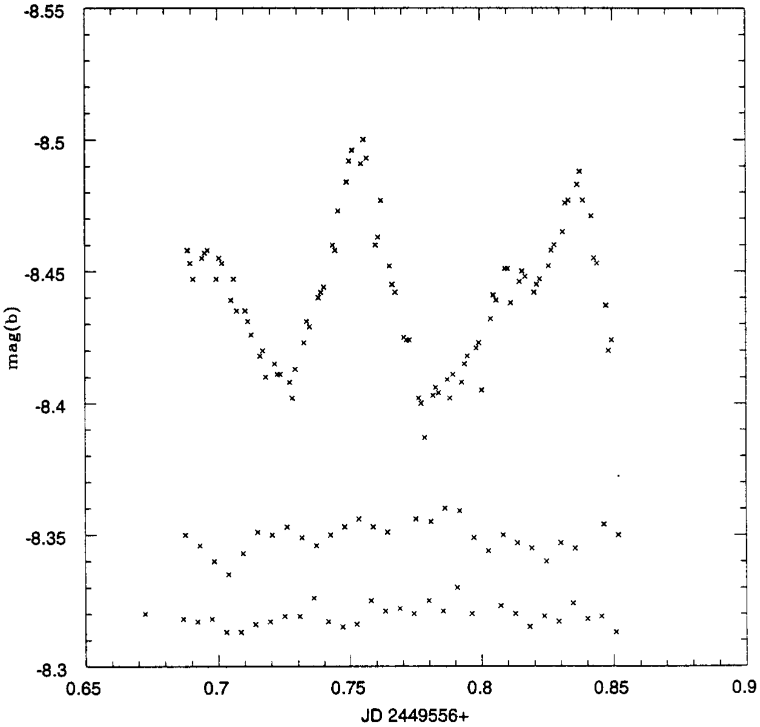

Figure 1. The light curve for HD 191850 (upper panel), C1 (middle panel) and C2 (lower panel) for the first night in Strömgren *b*

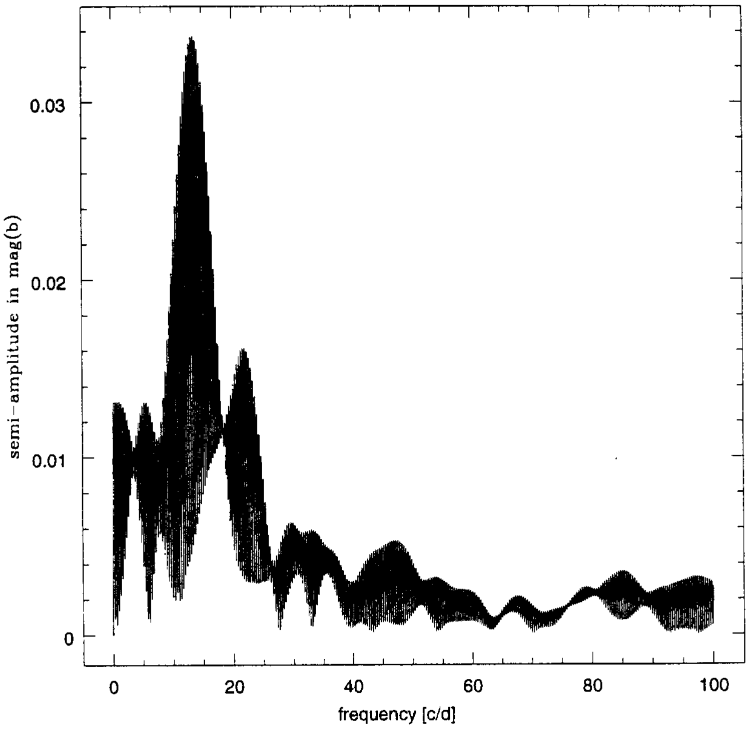

Figure 2. Amplitude spectrum for the differential data of HD 191850 and HD 191542

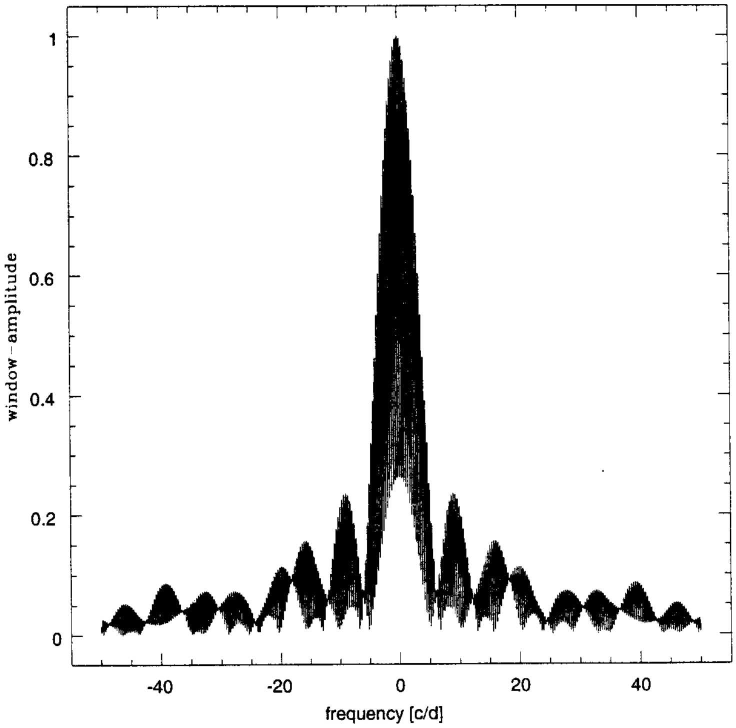

Figure 3. Spectral window for the differential data of HD 191850 and HD 191542

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E. PAUNZEN
U. HEITER
W.W. WEISS
Institut für Astronomie
Türkenschanzstr. 17
A-1180 Wien, Austria
E-mail: PAUNZEN@ASTRO.AST.UNIVIE.AC.AT

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OBSERVATIONS OF SUPERHUMPS IN V1251 Cyg DURING THE 1991 SUPEROUTBURST

Variability V1251 Cyg was discovered by Weber (1966), who reported an outburst occurred in 1963. Rather rapid decline resembles that of a fast nova, but the nature and the identification in quiescent state has remained uncertain for a long time. Systematic visual monitoring of this variable star by amateur astronomers started in the 1980's. After a long series of negative observations, the star was finally caught in its second historical outburst by M. Moriyama on 1991 Oct. 25.54 UT at m_v=12.4 and by P. Schmeer on 1991 Oct. 26.833 UT at m_v=12.7 (Moriyama and Schmeer 1991, Korth 1991). The outburst was subsequently confirmed by CCD observation by the author on Oct. 28. The object was first observed in *BVI* bands. Its conspicuous blue color made the dwarf nova classification most likely.

Following this confirmation, the author obtained a time-resolved *V*-band CCD photometry of this object on eight nights between Oct. 28 and Nov. 15. The observations were carried out using a 60 cm reflector and a Thomson TH7882 chip (576×384 pixels) at Ouda Station, Department of Astronomy, Kyoto University (for a description of the instruments see Ohtani et al. 1992). The exposure time was between 20 and 120 s depending upon the brightness of the variable. The frames were first corrected for standard de-biasing and flat fielding, and were then processed by a microcomputer-based automatic-aperture photometry package developed by the author. The differential magnitudes of the variables were determined using a local standard star ($21^{\rm h}40^{\rm m}58^{\rm s}\!.59 + 48^\circ41'23''\!.1$ (J2000.0), V=10.1; the position and the magnitude from the Guide Star Catalog), whose constancy was confirmed using several check stars in the same field. The estimated error of single observation is 0.01 mag under favorable condition.

The overall light curve for the outburst is given in Figure 1, which shows a smooth slow decline followed by a rapid return to quiescence. From the time-resolved photometry, clear superhumps with a mean amplitude of 0.24 mag were detected on Nov. 3 (see Figure 2); this observation revealed the SU UMa-type nature of this object (Kato 1991). Twelve superhump maxima were observed between Nov. 3 and 6, and by linear regression of the superhump times, we could obtain a superhump period of 0.0759 day. A period analysis using the phase dispersion minimization (PDM) method (Stellingwerf 1978) after removing the steady decline yielded the best estimate of the superhump period of 0.07604 ± 0.00010 day. An examination of a rather fragmentary light curve on Oct. 28 could reveal only 0.05 mag variation (Figure 3), which could not fit the above superhump period. An examination of an image on Nov. 2 taken at the expected superhump maximum again failed to show a large amplitude ($\geq$ 0.1 mag) variation against the rest of the images taken on the same night. From these findings we concluded that the full development of the superhumps in this object took 4 – 7 days from the outburst maximum. This value is much longer than 2 – 3 days in typical SU UMa stars.

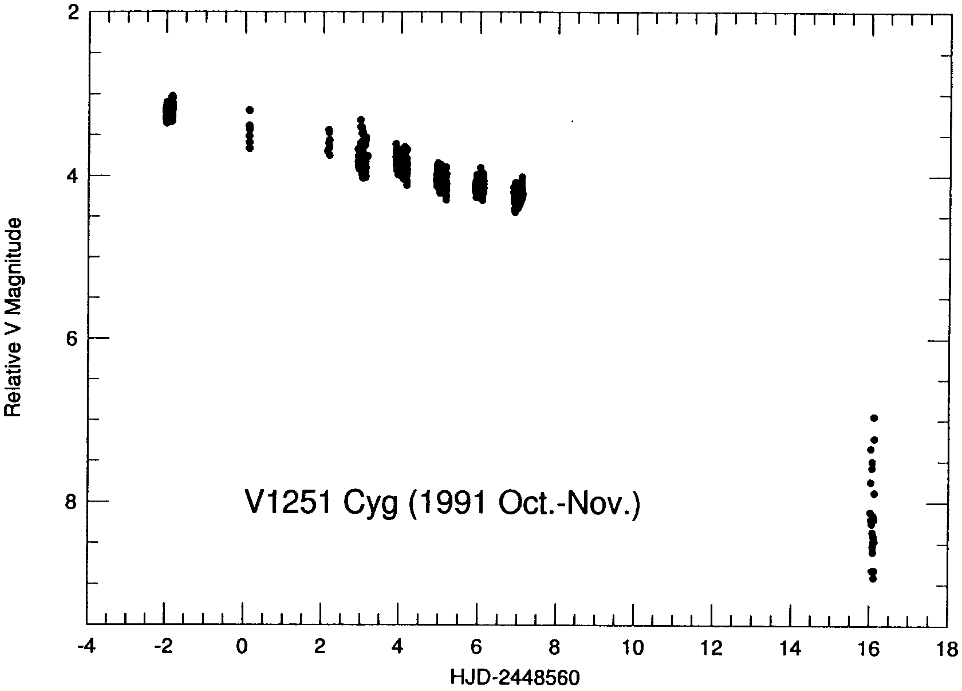

Figure. 1. General *V*-band light curve of V1251 Cyg. The zero point of the relative magnitudes corresponds to *V*=10.1.

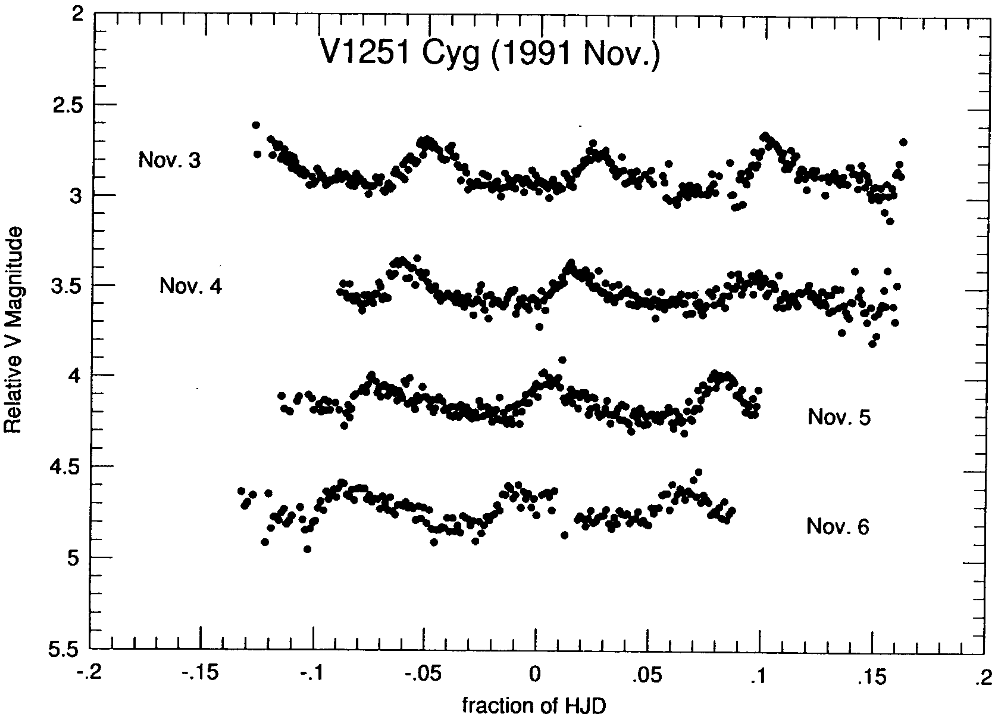

Figure. 2. Light curve for nights from Nov. 3 through Nov. 6. The magnitude is offset by 0.5 mag for each night. Superhumps are clearly seen.

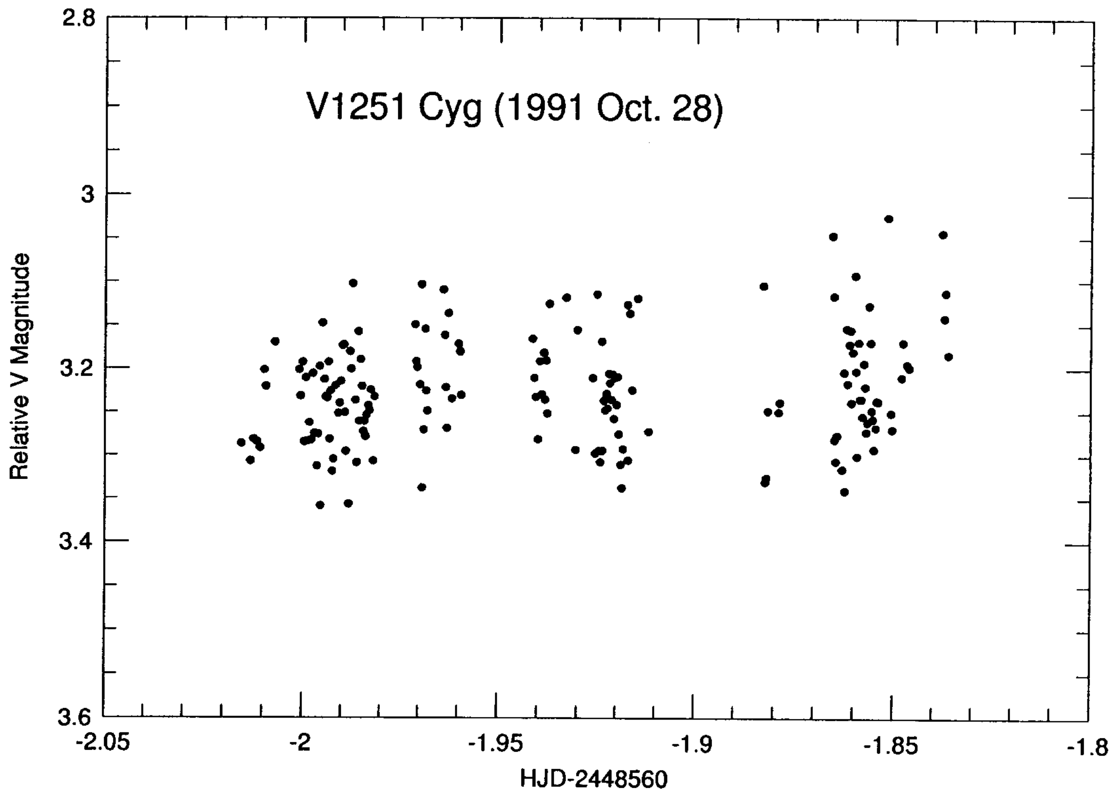

Figure. 3. Light curve on 1991 Oct. 28. Only a small amplitude (~ 0.05 mag) variation was present. The large scatter is due to the unfavorable sky condition.

The star has been monitored since, and was recorded again in superoutburst on 1994 Dec. 30 (Schmeer et al. 1995). Apparent absence of normal outbursts between these two superoutbursts, rarity of outbursts from a search in archival plates (Wenzel 1991), the long interval ($\geq$ 3 years) between the two successive superoutburst, a large outburst amplitude (~ 6.5 mag), and the slow development of superhumps all make V1251 Cyg a close relative of WZ Sge stars (Bailey 1979; Downes 1990) or TOADs (Tremendous Outburst Amplitude Dwarf Novae; Howell 1993). All the characteristics of V1251 Cyg most resemble those of SW UMa, despite the fact that V1251 Cyg has a much longer superhump period.

The author would like to point out one more peculiar feature in the light curve. Although one should be careful in comparing the visual and CCD magnitudes, the available material shows that this dwarf nova showed a rapid initial decline from m_v=12.4 (Oct. 25) to 13.3 (Oct. 28, this study). The similar feature can be also found in the light curve by Weber (1966). This feature would be explained, in the scheme of disk instability model, by the extra mass accumulated in the accretion disk during quiescence in the absence of normal outbursts (Osaki 1994), and would be a clue to understanding the peculiar outburst pattern of WZ Sge stars. A search for normal outbursts and detailed observations of V1251 Cyg both during outburst and quiescence are therefore highly encouraged.

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Taichi KATO
Dept. of Astron., Faculty of Sci.
Kyoto University
Sakyo-ku, Kyoto 606-01 Japan

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PHOTOELECTRIC OBSERVATIONS OF THE ECLIPSING VARIABLE DO Cas

During the 1992 observational season we turned our attention to the eclipsing variable star DO Cas (SAO 12388), in order to check the correctness of the ephemeris reported in the literature and to obtain the entire light curve.

The photoelectric observations were carried out at the station of Capanne di Cosola (AL, Italy) for six nights spanning from August 26 to September 4, collecting a total of 573 points in the instrumental V filter. The adopted photometric device was an OPTEC SSP5 photoelectric photometer (spectral sensitivity S-5) attached to a 200 mm Schmidt-Cassegrain f15 telescope. The integration time was fixed to ten seconds per count. The adopted comparison star was HIC 1228 (SAO 23474), the check one was HD 15963 (SAO 23451). The data of the involved stars are listed in the Table 1.

We obtained 4 heliocentric times of minimum, two primary and two secondary ones, listed in Table 2. These moments of minimum have been obtained processing the data by the Minimum Entropy SOP procedure (MEMSOP, Gaspani, 1993). Table 2 shows the residuals computed with respect to the following ephemeris:

$$\text{Min.I} = \text{J.D.(hel)}\ 2433926.4573 + 0\overset{\text{d}}{.}6846661 \times \text{E}$$

listed by the General Catalogue of Variable Stars (Kholopov et al., 1985). The values of the residuals suggest that the ephemeris listed above is still valid, the phase curve obtained using this ephemeris is shown in Figure 1.

In order to recover a convenient estimate of the true signal from the noisy phased data we processed them by a signal recovery technique based on an artificial neural network implementing a multilayer perceptron according to Haykin (1994), Masters (1994) and others. The restored signal is graphed as a solid line, across the original data points, in Figure 1. The flat secondary minimum is well evident. A further analysis of our observations in view to solving the light curve and determining the orbital parameters of the binary system is in progress.

Table 1. Data of the involved stars

	RA (2000)	Decl. (2000)	V	B−V	Sp.
DO Cas (HIC 12543=BD+59°529 =HD 16506=SAO 12388)	$02^h41^m24^s$	+60°33' 11"	8.39-9.01	0.11	A4V
HIC 1228 (BD+59°521= HD 16088=SAO 23474)	$02^h37^m26^s$	+60°05' 18"	7.407 ±0.031	1.129 ±0.015	F0III
HD 15963 (SAO 23451)	$02^h36^m12^s$	+58°04' 32"	8.03	0.06	A2Ib

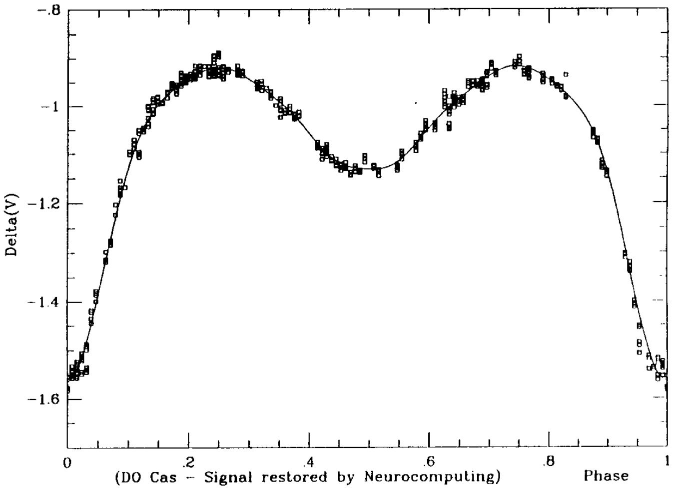

Figure 1. Photoelectric observations of DO Cas (open squares). The solid line is the signal restored by neurocomputing techniques.

Table 2. Observed times of minimum

Date	Epoch E	Times of minimum Heliocentric J.D.	Residual O−C	Type
27 Aug. 1992	21815	2448862.450±0.014	+0.002	I
1 Sep. 1992	21822.5	2448867.572±0.020	−0.011	II
2 Sep. 1992	21824	2448868.620±0.003	+0.010	I
3 Sep. 1992	21825.5	2448869.628±0.003	−0.009	II

Marco ALUIGI
GEOS - 3, Promenade Venezia,
F-78000 Versailles (France)

Gianni GALLI
GEOS - 3, Promenade Venezia,
F-78000 Versailles (France)

Adriano GASPANI
Osservatorio Astronomico di Brera
Via Brera 28, Milano (Italy)
and
GEOS - 3, Promenade Venezia,
F-78000 Versailles (France)
e-mail: gaspani@bach.mi.astro.it

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PHOTOELECTRIC UBVR OBSERVATIONS OF THE PECULIAR CEPHEID RU Cam

It is well known that RU Cam is a Cepheid with irregularly variable amplitude (Kolláth and Szeidl, 1993).

We observed RU Cam at the Mt. Maidanak observatory in September – October 1994. The 60-cm reflector was used and 16 UBVR_c measurements were obtained (Table 1); the accuracy of the individual data is near 0.02 mag in all filters. According to our data the amplitude of light curve (Fig.1) is near 0.03 mag.

The phases are calculated with the elements:

$$MaxJDhel = 2400000 + 22 \times E.$$

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Table 1

JD hel 2440000+	Phase	V	U−B	B−V	V−R_c
9617.3410	.334	8.288	-	1.099	.465
9620.3961	.473	8.434	1.059	1.145	.474
9621.3942	.518	8.505	.992	1.138	.498
9622.4469	.566	8.537	1.046	1.139	.515
9623.4003	.609	8.519	1.006	1.158	.475
9624.3486	.652	8.565	1.151	1.147	.496
9624.4256	.656	8.578	1.039	1.121	.505
9625.3688	.699	8.581	1.170	1.144	.497
9631.3586	.971	8.553	-	1.135	.488
9632.3634	.017	8.525	.993	1.118	.502
9632.4487	.020	8.542	.969	1.115	.496
9633.3309	.060	8.477	1.011	1.122	.505
9633.4283	.065	8.521	1.009	1.103	.479
9634.3447	.107	8.483	1.087	1.127	.500
9635.3970	.154	8.480	-	1.101	.497
9635.4695	.158	8.484	-	1.090	.491

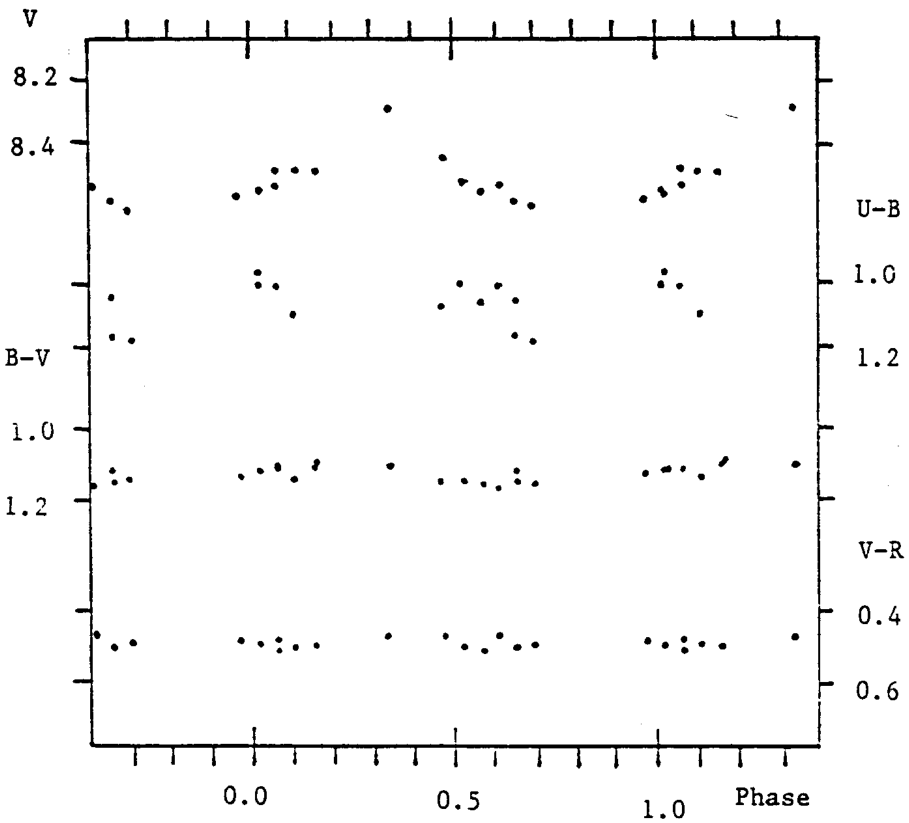

Figure 1

L.N. BERDNIKOV
O.V. VOZIAKOVA
Sternberg Astronomical Institute
13, Universitetskij prosp.
Moscow 119899, Russia

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DISCOVERY OF THE SECOND PG 0943+521-TYPE DWARF NOVA V1159 Ori

This star was discovered to be variable by Wolf and Wolf (1906), called 36.1906, and then suggested by Kippenhahn (1953) to be a possible member of U Gem stars. In the New Catalogue of Suspected Variable Stars (Kukarkin et al. 1982), it was designated as NSV 02011 with a brightness range of $m_{pg} = 13.3 - 14.2$. The subsequent photographic observation by Natsvlishvili (1984) revealed that its magnitude varied from 12.5 at maximum to 16.6 at maximum, and it was finally named V1159 Ori of INS: type in the 68^{th} namelist of variable stars (Kholopov et al. 1987).

Jablonsky and Cieslinski (1992) made spectroscopic and photometric observations and proposed its orbital period of 0.05890 ± 0.00001 days, which suggests that V1159 Ori is a good candidate for an SU UMa star. Their observations, however, could not reveal superoutbursts or superhumps expected for this class of CVs. The peculiar nature of V1159 Ori was already suggested by their estimate of short outburst cycle length of 4.35 days together with its small outburst amplitude. VSOLJ (Variable Star Observers League in Japan) started CCD and visual observations, part of which was published by Kiyota (1993). These observations indicated presence of bright (reaching $m_V \sim 12.1$) outbursts, some of which bore the characteristics of superoutbursts.

The present outburst of V1159 Ori was first detected by the RoboScope, Indiana University Automated Photometric Telescope (Honeycutt and Turner 1992). It was independently discovered on Dec. 23 at m_V=12.9 by M. Yamada (VSOLJ; private communication). We made photometric observations on 1994 Dec. 23 and 24 using CCD camera (Thomson, TH7882CDA, 576 × 384 pixels with 23 μm square pixel size) attached to the Cassegrain focus of 0.6-m reflector with Johnson V-band filter at the Ouda Station, Kyoto University (Ohtani et al. 1992). The mode of 2 × 2 on-chip summation was employed. A total of 225 frames were taken between 23.154 and 23.270 UT under clear sky, and 57 frames between 24.144 and 24.264 UT interrupted for 82 minutes by clouds. The exposure time was 30 seconds on Dec. 23 and varied between 60 and 180 seconds on Dec. 24.

We reduced the data using the personal-computer-based aperture photometry package developed by one of the authors (T.K.). This package automatically subtracts bias-frames, applies flat fielding and enables us to estimate the instrumental magnitudes. The aperture size was 9" in radius. The sky level was determined from pixels whose distance from the individual objects are between 24" to 48".

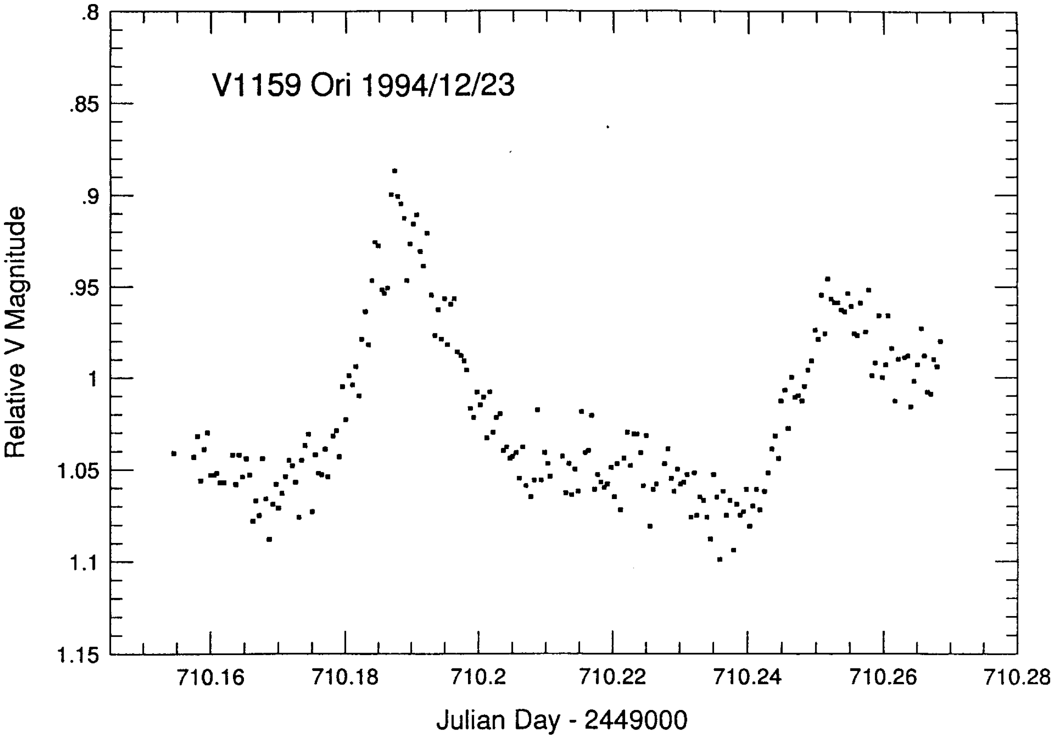

Figure. 1. V-band light curve of V1159 Ori on 1994 Dec. 23. The zero point of the relative magnitudes corresponds to V=11.99.

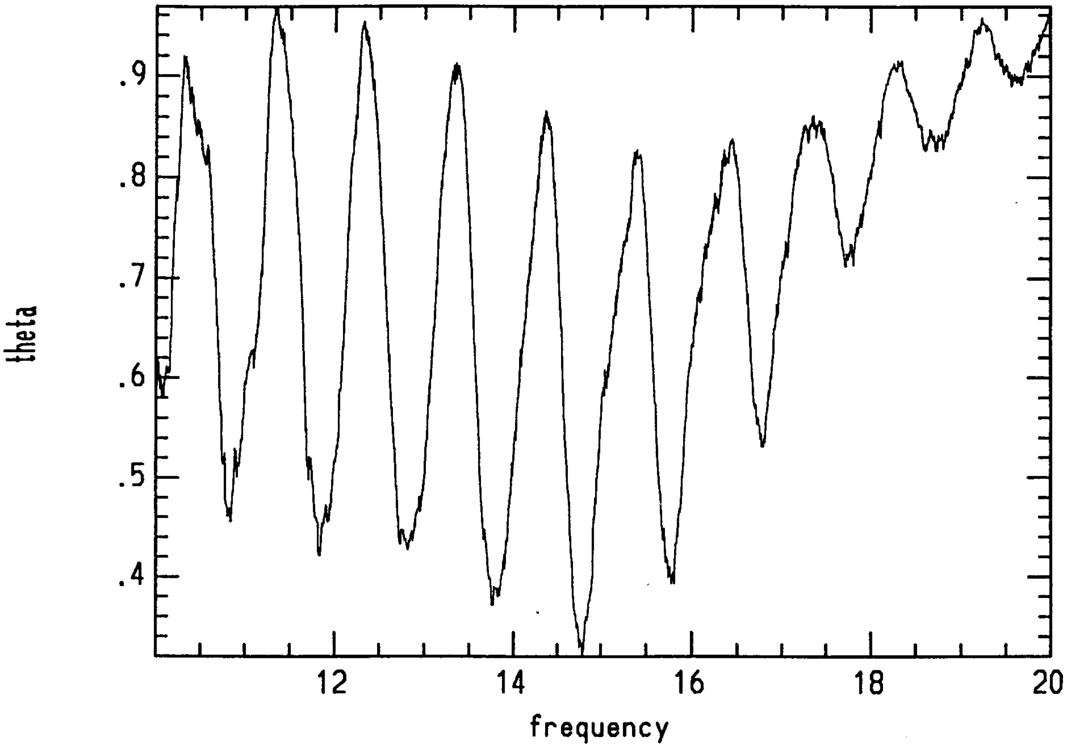

Figure. 2. The theta diagram by PDM on the data of V1159 Ori on 1994 Dec. 23 and 24.

Figure 1 shows the light curve of differential magnitude between V1159 Ori and a comparison star on Dec. 23. The comparison star is "c" in Jablonsky and Cieslinski (1992), whose V magnitude is given as 11.99 in thier Table 1. A decay of amplitude of humps is seen in the figure and the similar modulation was also observed in PG 0943+521 (Nogami et al. 1995). We analysed the light curve, using phase dispersion minimization (PDM) method (Stellingwerf 1978) implemented in IRAF package (IRAF is distributed by National Optical Astronomy Observatories, U. S. A.). Figure 2 shows the Θ diagram, whose abscissa is frequency (day^{-1}). The lowest minimum point in Θ corresponds to 0.06764 days. Robertson et al. (1995) independently detected the same hump features and reported that they are repeated with a period of 0.067 ± 0.001 days.

The difference in the photometric and spectroscopic periods confirmed the superhump nature of these humps. The outburst observed by Jablonsky and Cieslinski (1992) did not show superhump-like modulation and corresponds to normal outburst of usual SU UMa-stars. Thus, V1159 Ori was unambiguously identified to be an SU UMa-type dwarf nova with a superhump period of 0.06764 ± 0.0001 days. The present discovery of superhumps in V1159 Ori, together with its extreme shortness of its outburst recurrence time, its long duty cycle (Jablonsky and Cieslinski 1992, Kiyota 1993), and its extremely short supercycle (recurrence time of superoutbursts) (Robertson et al. 1995), has established a new subgroup of peculiar dwarf novae whose prototype is PG 0943+521 (Kato and Kunjaya 1995, Misselt and Shafter 1995, Osaki 1995).

The fact that the supercycle of V1159 Ori (44.5 days, Robertson et al. 1995) is almost equal to that of PG 0943+521 (43 days) is possibly not accidental. According to Osaki (1995), the shortest supercycle predicted by disk-instability theory under a given strength of the tidal torques is about 40 days and the supercycle is insensitive to the mass transfer rate from the secondary around this minimum value. However, as first pointed out in the case of PG 0943+521 by Kato and Kunjaya (1995) and later confirmed by numerical simulation by Osaki (1995), a dwarf nova with minimum supercycle length should have much ($\sim$ ten times) larger mass transfer rate than those of usual SU UMa-type dwarf novae, near the borderline between nova-like stars and SU UMa-type dwarf novae. For a dwarf nova with an orbital period below the period gap, it is generally believed that its mass transfer is powered by the gravitational-wave radiation, that is, its rate is mainly dependent on the orbital period. The shortness of the orbital period of V1159 Ori (0.05890 days, Jablonsky and Cieslinski 1992) and the superhump period of PG 0943+521 (0.06549 days, Kato and Kunjaya 1995) implies small mass transfer rates in the present scheme of CVs, which are clearly in conflict with such large mass-transfer rate expected from their outburst behavior.

The present discovery of "another" PG 0943+521 star suggests that this type of CVs may not considered to be unique but form a larger population in CVs than ever expected. In this case, the present picture of the mechanism of mass transfer and the evolution of CVs below the period gap would unavoidably be modified.

The authors are grateful to the VSOLJ (Variable Stars Observers League in Japan) members for supplying us of visual and CCD estimates, and especially M. Yamada for notifying us of the outburst. Thanks also to Y. Osaki, K. A. Misselt and R. K. Honeycutt for sending us their preprints. We acknowledge R. K. Honeycutt for opening the real-time light curve by RoboScope to public through the World-Wide Web. This research has been partly supported by Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists (T.K.).

Daisaku NOGAMI
Taichi KATO
Seiji MASUDA
Ryuko HIRATA
Dept. Astron., Faculty of Sci.
Kyoto University
Oiwake-cho, Kitashirakawa
Sakyo-ku, Kyto 606-01 Japan

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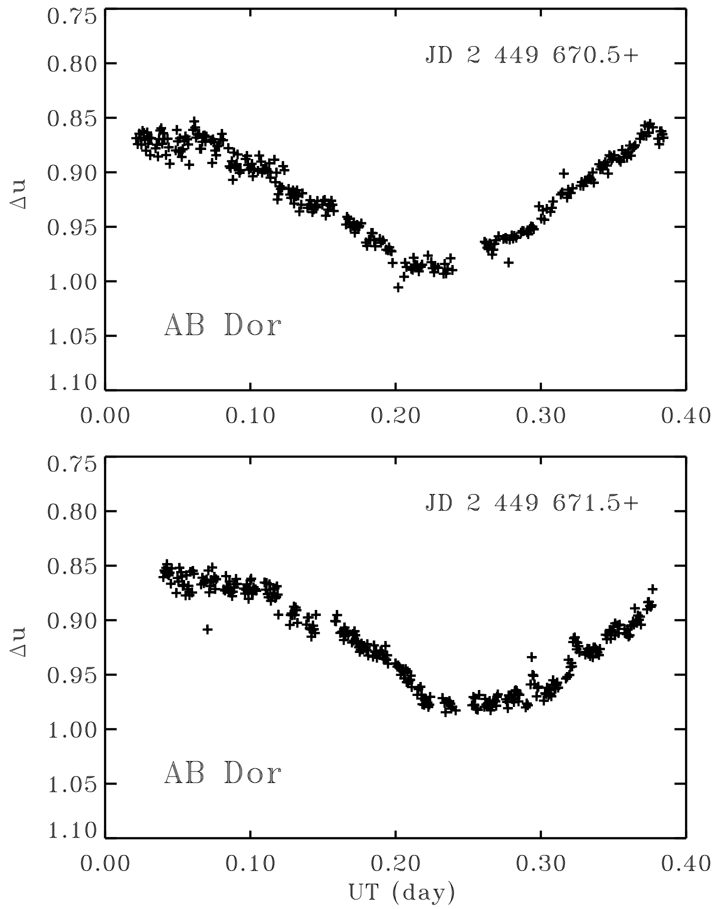
U-FILTER PHOTOMETRY OF AB DORADUS

AB Doradus (HD 36705) is a rapidly-rotating (0.515 day), late-type star (K0-2 IV-V) in the solar neighborhood, at a distance of about 25 pc. The rapid rotation is due to its youth, as indicated by the presence of strong lithium absorption (Rucinski 1985). The star apparently belongs to the Pleiades moving group (Innis et al. 1986). It is a very active star, one of the most active presently known. Several investigations of different aspects of its activity have been cited in papers by Vilhu et al. (1987, 1993) and by Lim et al. (1992)

The great importance of this star resulted in the award of a substantial amount of observing time of the Space Telescope for spectral monitoring of selected UV spectral regions with the Goddard High Resolution Spectrograph. The two adjacent HST programs, conducted on 14 – 15 November 1994 were led by the Principal Investigators F. Walter and O. Vilhu. In addition, simultaneous optical spectroscopy was obtained from CTIO, as were simultaneous observations with the EUVE and ROSAT. The present note describes photometric support monitoring of AB Dor performed on two nights, 13/14 and 14/15 November 1994 with the Helen Sawyer Hogg 61 cm telescope of the University of Toronto at Las Campanas. These observations were meant as a check of the star's flaring activity. Also, since X-ray and EUV satellites have relatively low spatial resolution, possible flares of the optical companion of AB Dor, Rst 137B, could contaminate the high-energy data. Our observations could be used to monitor and detect strong flares of Rst 137B.

The photometric monitoring was done with a CCD camera (Photometrics, 512 × 512 pixels, $0\farcs45$ per pixel) and with a fixed U-band filter of the UBV set. The exposures of the variable were 15 seconds long and they were done in as rapid succession as was practicable given the relatively long readout time. The effective sampling was thus typically one frame per minute. The UT time was recorded manually with an uncertainty of about 2 – 3 seconds. Every 15 minutes the comparison star HD 37297 was observed. The photometric data have been extracted from the CCD images using simple aperture photometry. The final results are in instrumental magnitude differences Δu, in the sense AB Dor *minus* HD 37297. In addition to AB Dor, several observations of the second comparison, HD 35474, were obtained each night. They gave the mean differences Δu between the two comparison stars, HD 35474 − HD 37297, equal to 0.764 ± 0.012 and 0.783 ± 0.008 for each night, respectively.

The results for AB Dor are displayed in graphical form as a function of the heliocentric Universal Time (expressed in fraction of Julian Day) in the accompanying figure. The basic results are:



The U-filter differential light curves of AB Dor obtained
on nights 13/14 and 14/15 November 1994 at Las Campanas.

1. A well defined spot modulation with $\Delta U \simeq 0.12$ was observed over basically the same rotation-phase window (about 3/4 of full rotation) on both nights. The wave minima were located approximately at JD 2 449 670.72 and JD 2 449 671.76.

2. The minima correspond to phase 0.5 of the ephemeris given by Innis et al. (1988): JD(min) = 2444296.575 + 0.51479×E. Minima placed at that phase could be explained by a feature designated Spot B by Innis et al.

3. Assuming that $U = 7.22$ for HD 37297 (Cutispoto & Rodonó 1988), and that our instrumental system U is the same as the standard one (which we cannot confirm), we observed variability of AB Dor between approximately $8.08 < U < 8.20$. Assuming further that AB Dor has typically $U - V \simeq 1.20$, the corresponding visual range was $6.88 < V < 7.00$. This would indicate that the star is still faint and that a brightening trend of the spot cycle, whose first signs were reported by Anders (1994), has not yet fully taken place.

4. No flare activity of any importance was noted. During the second night, low-level activity might have been present during the ascending branch of the spot wave.
5. The visual companion of AB Dor was not observed in any of the CCD images. Because our system had low sensitivity in U and exposures were short, the detection limit for Rst 137B was at relatively high brightness, about 5 – 6 magnitudes below that of AB Dor, i.e. at about $U \simeq 13 - 14$. Rst 137B is a faint ($V \simeq 13$) M2–4 dwarf (Vilhu et al. 1989) with unknown, probably very low brightness in ultraviolet. Thus, we could detect only the largest flares from this star.

The tabular data with our observations of AB Dor is available from the authors at the following e-mail addresses: *rucinski@astro.utoronto.ca* or *garrison@astro.utoronto.ca*.

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Slavek RUCINSKI
R. F. GARRISON
Boyd DUFFEE
David Dunlap Observatory
P.O.Box 360
Richmond Hill, Ontario
Canada L4C 4Y6

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PHOTOMETRIC OBSERVATIONS OF ECLIPSES IN THE SYMBIOTIC TRIPLE SYSTEM CH CYGNI

CH Cygni is probably the most peculiar object among all known symbiotic stars. The complex behaviour of the spectrophotometric parameters and the light curve observed during the outbursts (1963, 1967–1970, 1977–1986) led, at first, to a single star model (e.g. Faraggiana & Hack 1971). The binary nature of CH Cyg was suggested by radial velocity measurements in the *optical* spectrum for both components (e.g. Yamashita & Maehara 1979, Tomov & Luud 1984) and by the eclipse of the hot component by the red giant observed during 1985 May – October (e.g. Mikołajewski et al. 1987). CH Cyg then was accepted as the symbiotic binary with the long 5700-day period orbit. Recently Hinkle et al. (1993) analysing a 13-year time series of high-resolution 2μm *infrared* spectra of CH Cyg, found a very regular variation in the red giant radial velocities with a 756-day period. They suggested that CH Cyg is a triple system with the symbiotic pair being the short 756-day period system, while the unseen G-K dwarf revolves around the symbiotic binary in the long 14.5-year period orbit. However they state that CH Cyg cannot be an eclipsing system, and the orbital inclination must be $\sim 70°$. The aim of this contribution is to present our new photometry showing that CH Cyg really is an *eclipsing* symbiotic triple system.

CH Cyg has been regularly monitored at the Skalnaté Pleso (1750 m above the sea level) and Stará Lesná (890, our down station near Tatranská Lomnica) observatories. The observations have been made in the standard UBV system using a one-channel photoelectric photometer installed in the Cassegrain focus of the 0.6/7.5 m reflectors. The stars HD 182 691 (V=6.525, B−V=−0.078, U−B=−0.24) and SAO 048 428 (m_v=8.0, m_{pg}=8.6, spectrum F8) were used as the comparison and the check stars, respectively.

In Figure 1 we show the historical U-light curve as this represents best behaviour in the blue continuum of CH Cyg during outbursts, quiescence as well as eclipses. Our new data observed up to 1995 January 31 are displayed in more detail in Figure 2 together with those published by Panov & Ivanova (1992) and Leedjärv (1993). It covers the period of the current outburst which began at the beginning of 1992 (Skopal et al., 1992). During this active phase photometric observations indicate the two deep minima of about 2 and 3 mag in the U band, respectively, and times of their centres at JD 2 448 922 and JD 2 449 685±5. Other such minima occurred during the 1967–1970 active phase at ≈JD 2 439 810 and JD 2 440 543. Positions of these four minima agree well with times of the spectroscopic conjunction of the symbiotic pair (cool component in front) in the triple-star model of CH Cyg – T_{conj} = JD 2 445 888, P_{orb} = 756±4 day, circular orbit – derived by Hinkle et al. (1993). Thus we can conclude that these minima are caused by the eclipse of the active component by the cool component in the *short-period* symbiotic pair.

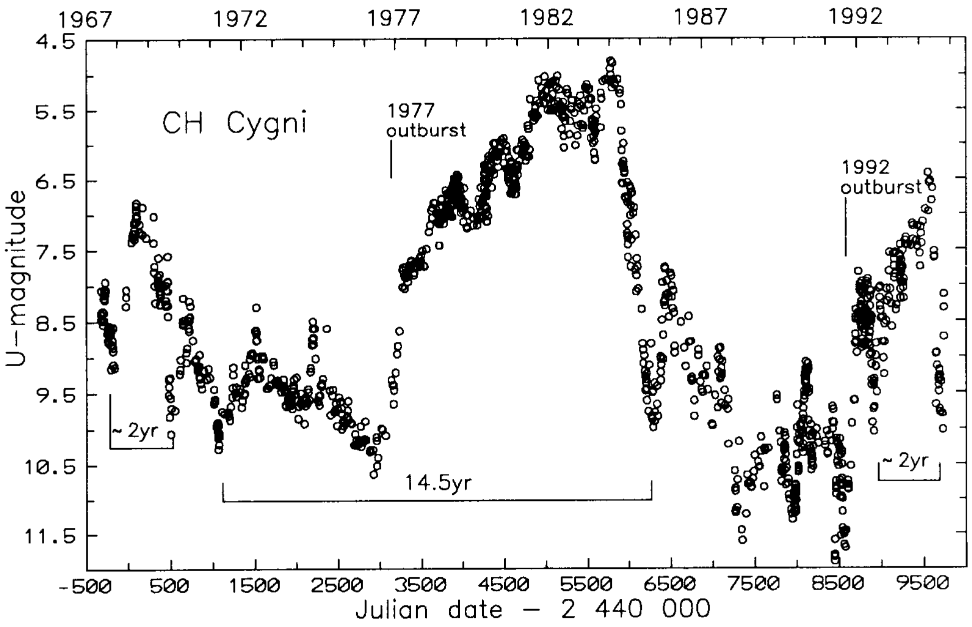

Figure 1. Historical U-light curve for CH Cyg. Eclipses
in both the long- and short-period orbit are marked.

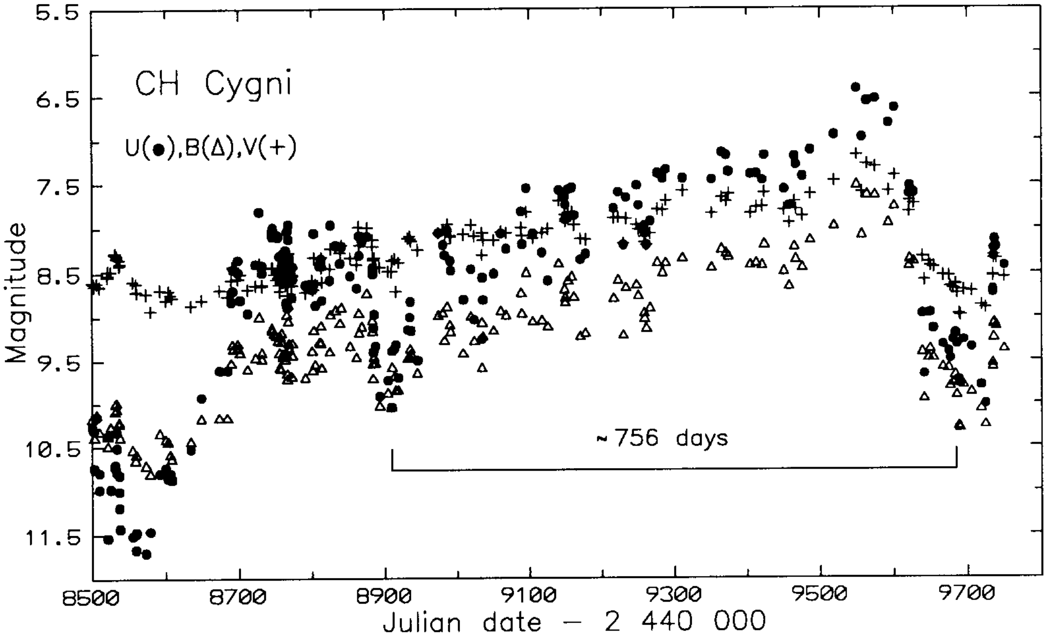

Figure 2. The UBV light curves of CH Cyg covering the current outburst.
The minima correspond to the eclipses of the active component
by the cool component in the 756-day period symbiotic pair.

During the 1970–1977 and 1986–1991 quiescent periods, due to a very low level of the blue continuum, the eclipses could not be detected. Nor were they present in the light curve during the last, 1977–1986, active phase. Due to a very high level of activity during that period, the circumstellar matter in the symbiotic pair was probably located within the common potentials of the binary, and that way, instead of deep and relatively narrow minima, we observed a rather complex wave-like variation in the light curve (cf. Figure 1).

On the other hand the periodic ~756-day variation in the U, B, V light curves (cf. Skopal 1989) at a level of about 1.5 mag and with minima at the spectroscopic conjunction observed during the quiescent periods, resembles that present in light curves of the other classical symbiotic stars (e.g. AG Peg, V443 Her, AG Dra, EG And).

In addition, the historical light curve exhibits two more minima in the U-band at ~JD 2441130 and JD 2446275±75. Their positions agree perfectly with times of the spectroscopic conjunction in the *long-period* orbit – $T_{\rm conj}$ = JD 2446346±340, $P_{\rm orb}$=5298 ±98 days, $e = 0.067$, $\omega = 207°$ (Hinkle et al. 1993). Bearing in mind the very large separation of the components in the long-period orbit, approximately of 1700 $R_{\odot}$, and the radius of the giant to be of 180 to 200 $R_{\odot}$, the orbit inclination must be very high to produce the observed shape of the minima – mainly that in 1985. A rough estimation gives $i > 83°$.

The agreement between the positions of the minima observed in the U-light curve and times of the spectroscopic conjunctions for both orbits allow us to conclude that CH Cyg is an *eclipsing* symbiotic triple system.

A. SKOPAL
Astronomical Institute,
Slovak Academy of Sciences,
059 60 Tatranská Lomnica
Slovakia

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THE DISCOVERY OF Hα EMISSION IN V373 Cas

The eclipsing binary star V373 Cas (HD 224151; V=5.9, ΔV=0.1; P=$13\overset{d}{.}41921$; B0.5II +B4III) is a relatively poorly investigated object. Hill and Fisher (1987) studied the orbit and physical parameters of V373 Cas. They used their high S/N ratio spectroscopic observations in the blue spectral region and incomplete light curve showing large distortion obtained by Lynds (1959). We included V373 Cas in our program of the double B stars with purpose to determine its evolutionary status, atmospheric parameters, helium abundance and matter flows. The results of these complex investigations will be published later and now we report the discovery of emission in Hα and HeI λ6678 lines and its variability during the orbital period.

Our spectral, photometric and polarimetric observations were carried out during 1994. The spectral data were obtained using coudé spectrograph with GEC CCD of the 2.6 m telescope of Crimean Astrophysical Observatory. The spectral resolution were 25000 and 30000 for Hα and HeI, respectively. The S/N ratio was 100–200. The photometric and polarimetric data were obtained at the 1.25 m telescope with the UBVRI five channel photometer–polarimeter.

Figures 1 and 2 illustrate some of typical profiles of HeI and Hα lines for the different orbital phases. The phases φ have been calculated according to the ephemeris of Hill and Fisher (1987). From Fig. 1 one can see that the primary (the more massive star–A) and the secondary (the less massive star–B) HeI components were observed near the elongations ($\varphi = 0.07$ and $\varphi = 0.35$). One should pay attention to the weak red emission component in HeI profile at the phase 0.07 (Fig. 1). From Fig. 2 one can see that the Hα profile has a more composite structure; there are absorption and emission components and they are variable during the orbital period. The Hβ profile has been observed by us and by Hill and Fisher (1987), but no emission was found in this line. The presence of the emission may be considered as an evidence of the mass exchange between the components, and it is more probably that the matter outflows from the primary. Our considerations are similar to those of Hill and Fisher (1987), namely, the primary component is close to, or at, the Roche lobe at periastron, and there is non–synchronism for both components.

Our photometric observations have shown the low amplitude variability ($0\overset{m}{.}10$) in all five passbands. We also found the unexpectedly large (0.5%) phase–locked polarimetric variability which may be considered as an additional evidence for the existence of the circumstellar gas.

We hope that our complex observations of V373 Cas together with the earlier results of the other authors will allow us to understand better the nature of the binaries which are on the short duration stage of the mass loss from more massive primary.

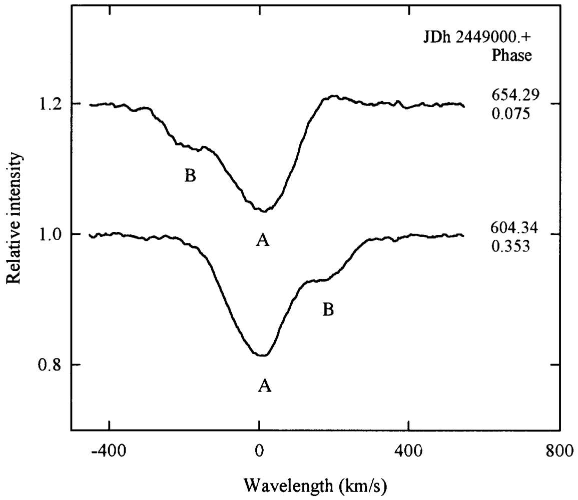

Figure 1. HeI λ 6678 line profiles.

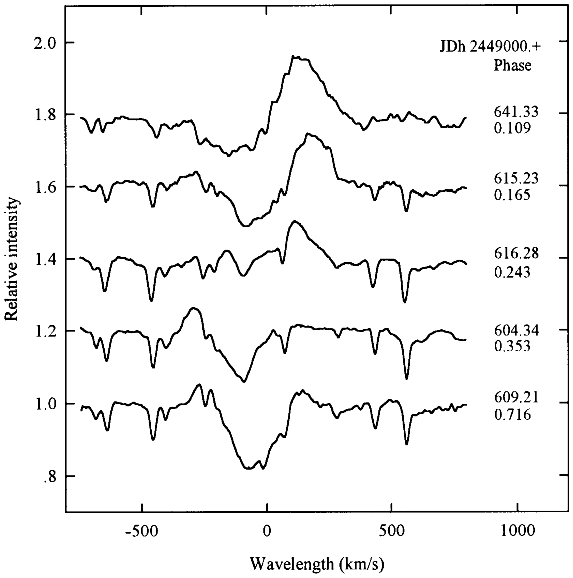

Figure 2. Hα line profiles. The sharp absorptions are the telluric H_2O lines.

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A.V. BERDYUGIN
T.M. RACHKOVSKAJA
S.I. ROSTOPCHIN
A.E. TARASOV
Crimean Astrophysical Observatory
334413 p.Nauchny, Crimea, Ukraine
e–mail: rtm@crao.crimea.ua

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A POSSIBLE VARIABLE STAR RECLASSIFICATION FOR TX PISCIUM

From 1990 through 1995 the Lb (Kholopov, 1985) carbon star TX Piscium has been observed via photoelectric photometry as part of the AAVSO Small Amplitude Red Variable (SARV) program. The objective was to discover periodicity, if any, and refine existing measured amplitudes. Wasatonic (1993) reported the first evidence of semi-regularity in visual light with well defined amplitudes. This paper presents observations taken since 1992 to show further evidence of semi-regularity, which is used as the basis for variable star reclassification; no existing light curves have been found to back up the Lb classification.

A SIMBAD database search yielded 234 references of this highly observed star, most of them describing spectroscopic work. Various spectral types have been published: C6,2 (Judge and Stencel, 1991), N0 C7,2 (Barnbaum, 1992), or C5 II (Hoffleit, 1982) and (Richer, 1971). In general, carbon stars are peculiar red giants; their spectra are characterized by bands of carbon-containing molecules in contrast to normal K and M spectra, where oxides predominate (Faulkner et al., 1988). A more thorough discussion of carbon star spectral characteristics is beyond the scope of this paper and will not be addressed further.

All observations were made with a 8-inch f/10 Schmidt-Cassegrain and a silicon PIN photodiode SSP-3 photoelectric photometer using a Schott visual filter. Standard photometric observations and data reduction techniques were used, as described in the earlier paper by the author. The observations were made on 118 separate nights from JD 2448180 to JD 2449726. The maximum internal standard error calculated for each night was 15 millimags; the internal standard average error over all 118 nights was only 4.4 millimags.

It is proposed that the variable star classification for TX Piscium be changed from its current Lb type to that of a semi-regular variable of type SRa or SRb. The scientific justification of this reclassification is as follows:

- From SiO and H2O maser observations it is speculated that the circumstellar envelope surrounding the star is clumpy in nature, and is not confined to a region close to the star (Heske et al., 1989). This theory is supported to some degree by Judge and Stencel (1991) in which they state that TX Piscium, as an optically visible carbon star, is thought to be in a post-Mira evolutionary phase; in this phase there exists a circumstellar shell which has become "detached" from the star. Heske also states that since the detached circumstellar shell is irregular (clumpy), mass loss is asymmetric, which can be caused by pulsational properties of SR variables. Heske also states that TX Piscium is classified as an SR variable by referencing Kukarkin et al. (1969).

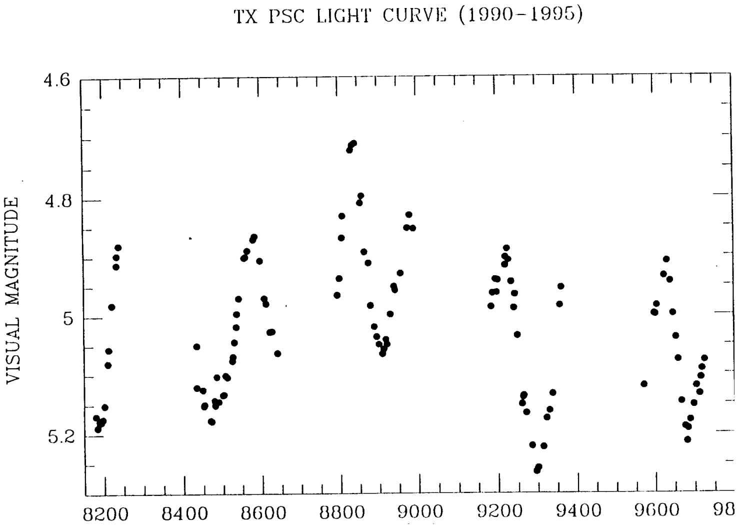

Figure 1

- Alksne et al. (1991) classify the spectrum as C7,2; according to this data distribution TX Piscium would be an Lb variable. However, most literature references classify the spectrum as either C6,2 or C5 II. This would indicate an SR type variability according to Alksne's data distribution, and again matches the proposed reclassification type.
- An examination of the light curve itself reveals semiregularity (see Figure 1). Table I lists the observed times of minima and the intervals between them. The last three intervals are actually times separated by two non-consecutive minima, as the missing minima are due to seasonal gaps. Hence the average time between all minima is about 222 ± 46 days.

Table I: TX Piscium Minima Data

Times of Minima	Intervals Between Minima (Days)
JD 2448190	
	290
JD 2448480	
	430
JD 2448910	
	390
JD 2449300	
	380
JD 2449680	

Table II: TX Piscium Maxima Data

Times of Maxima	Intervals Between Maxima (Days)
JD 2448580	
	260
JD 2448840	
	390
JD 2449230	
	410
JD 2449640	

Table III: TX Piscium Visual Light Curve Data

JD 244+	MAG	JD 244+	MAG	JD 244+	MAG	JD 244+	MAG
8180.547	5.17	8531.616	5.04	8909.564	5.06	9300.487	5.26
8184.536	5.19	8536.586	5.02	8913.558	5.06	9313.464	5.22
8189.514	5.18	8538.590	5.00	8918.529	5.04	9322.472	5.17
8191.563	5.18	8543.565	4.97	8921.525	5.05	9330.456	5.16
8193.550	5.18	8558.583	4.90	8930.521	5.00	9338.479	5.13
8197.539	5.17	8560.516	4.90	8940.484	4.95	9358.460	4.98
8202.495	5.15	8566.527	4.89	8943.484	4.96	9362.465	4.95
8211.506	5.08	8581.552	4.87	8957.483	4.93	9571.725	5.12
8213.533	5.06	8585.505	4.86	8975.528	4.85	9598.678	5.00
8222.473	4.98	8598.464	4.91	8981.478	4.83	9601.671	5.00
8234.461	4.91	8608.463	4.97	8990.482	4.85	9606.640	4.98
8235.471	4.90	8613.464	4.98	9185.840	4.99	9625.621	4.93
8240.475	4.88	8622.469	5.03	9189.496	4.96	9633.612	4.91
8434.860	5.12	8628.480	5.03	9196.756	4.94	9641.542	4.94
8435.817	5.05	8641.471	5.06	9199.824	4.96	9647.548	5.00
8449.816	5.12	8795.851	4.96	9202.740	4.94	9654.513	5.04
8452.810	5.15	8801.817	4.94	9221.830	4.92	9659.572	5.08
8454.813	5.15	8808.820	4.87	9222.759	4.90	9667.568	5.15
8469.804	5.18	8819.836	4.83	9226.708	4.89	9676.480	5.19
8471.756	5.18	8832.752	4.72	9229.664	4.91	9681.478	5.21
8479.750	5.14	8836.749	4.71	9236.641	4.94	9683.473	5.19
8481.806	5.15	8842.723	4.71	9242.627	4.99	9689.472	5.18
8485.724	5.10	8855.696	4.81	9245.628	4.96	9698.476	5.15
8490.733	5.14	8859.706	4.80	9250.636	5.03	9705.460	5.12
8501.683	5.13	8865.664	4.89	9261.620	5.15	9713.463	5.13
8503.690	5.13	8875.642	4.91	9264.604	5.14	9716.464	5.11
8508.667	5.10	8880.624	4.98	9265.598	5.14	9719.466	5.09
8512.641	5.10	8889.665	5.02	9271.566	5.17	9726.463	5.08
8526.595	5.08	8895.590	5.04	9285.625	5.22		
8527.611	5.07	8901.595	5.05	9295.595	5.26		

Table II lists the observed time of maxima and the intervals between them. Again, the last two intervals are actually times between two non-consecutive maxima, missing again due to seasonal gaps. Hence the average time between all maxima is about 220 ± 35 days, which nearly matches the minima interval. Therefore, one can deduce a semi-regular period averaging 221 ± 40 days.

Since SRa variables have relatively constant periods, smaller amplitudes than Miras ($<$ 2.5 mag), and strong cycle-to-cycle amplitude variations (Querci and Querci, 1988), it is apparent that the published light curve fits these characteristics to some degree. Hence these features lend credence to re-classifying TX Piscium as an SRa variable star.

- A distribution of semi-regular periods was done by Petit (1982), and for SRb stars of spectral type C and S there is a modal value at periods between 200 and 250 days; the apparent 221 day period falls within this range. Additionally the light curve asymmetry is 0.46, typical for SRa stars with possible extensions to SRb stars.

Hence, these features support a SRb classification.

- One can also see the superposition of a cycle on top of the 221 day principle cycle by noting the gradual rise and decline of each seasonal variation, with the peak occurring from JD 2448750 to JD 2449000. This second cycle is a characteristic feature of SRb stars (Petit, 1982). A preliminary cycle of 1490 days can be measured from the minimum at JD 2448190 to the minimum at JD 2449680. This is about 6.7 times the principle cycle but still less than the normal modulation of 8 to 15 years for SRb stars. Further observations are required to characterize this phenomenon.

In researching published amplitude ranges, Drake et al. (1991) and Judge and Stencel (1991) reported an amplitude range of 0.8 mag, somewhat more than the maximum observed amplitude of 0.55 mag. Mitton and MacRobert (1989) also reported a total amplitude of 0.50 mag. Because the total amplitude for the seasonal cycles averaged 0.33 mag, perhaps the Mitton and MacRobert amplitude is a feature of the superposition cycle. It now appears that the reported 0.8 mag amplitude is erroneous, and could be due mainly to scattered results.

Concluding, based on the visual light curve and supporting arguments, the classification of TX Piscium should be changed from an irregular Lb giant to an SRa or SRb giant. Due to the nature of red giants more observations could reveal a presumed resumption of irregularity; for this reason and to further define the superposition cycle observations will continue indefinitely. Nevertheless, in visual light TX Piscium is now pulsating with characteristics of a semi-regular star, and thus its classification should be made accordingly so.

Rick WASATONIC
Computer Sciences Corporation
IUE Observatory
10,000-A Aerospace Road
Lanham-Seabrook,
Maryland 20706 USA

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SOLAR MAGNETIC FIELD MODULATION OF THE NEUTRINO FLUX

Soon after the first neutrino observations had been published it became clear that the solar neutrino flux was not only much smaller than expected from the solar standard model (the first neutrino problem). It also proved to be variable in time (the second neutrino problem), which implied that the Sun was a variable neutrino star. (For more detail see Bahcall (1993), Rivin (1993) and references therein).

Time fluctuations of the solar neutrino are not quite understood. Some authors believe them associated with solar activity whose growth results in a decreased neutrino flux ν (^{37}Ar measurements at South Dakota), i.e. a negative correlation with the solar activity indices is supposed (Voloshin *et al.*, 1986, Rivin, 1993) According to this hypothesis, the neutrino flux passing through a strong magnetic field is modulated, as part of the left–hand neutrino are transformed into the right–hand neutrino. The modulation mainly depends on two factors: the magnetic moment of the neutrino and the absolute value of the transverse magnetic field component. This modulation is difficult to obtain in laboratory. However there is evidence indicating that it occurs in the Sun, as the high–energy neutrino flux from the core passes through the magnetic field in the solar convection zone.

To verify this hypothesis, it is essential to choose an index that would characterize most adequately the magnetic field in the solar interior along the neutrino propagation line. Such indices used in early work are the Wolf number or the mean photospheric field. However both of them are dissatisfactory, as they are global indices. We have used magnetic field measured every day from the Zeeman effect at intersection of the "solar center – Earth" line with the photosphere. The data were obtained at the John Wilcox Observatory of the Stanford University (WSO). These observations started in May 1976 (Carrington rotation 1641) and the data are available up to 1992 inclusive (Hoeksema and Scherrer, 1986; Hoeksema, 1991). The earlier period since 1970 is covered by the data obtained at the Mount Wilson Observatory (MWO) by Robert Howard's group and kindly placed at our disposal by J. Stenflo. Both data series are used in our analysis in spite of some nonuniformity.

These measurements based on potential approximation can be used to calculate the daily and, then, the annual mean values of the three magnetic field components (B_r, B_θ, and B_φ — the radial, meridional and azimuthal components, respectively). The error is shown to be no more than $\sim 10\%$. Since the neutrino flux propagates radially from the solar interior to the Earth, the absolute values of the two latter components must play a decisive role in its modulation.

The high–energy boron neutrino flux ($E \simeq 0.1$ MeV) from the solar core has been measured at South Dakota (USA) since 1970. The data of several observation runs with their errors are given in (Bahcall, 1993). As the runs are different in length, the scale of data is nonuniform. We have applied linear interpolation to obtain a uniform scale as a series of monthly mean values covering the whole observation interval. These have been used in turn to yield the annual mean values, as well as the mean square root error.

The data from individual runs have been analyzed to give an average signal–to–noise ratio equal to $\simeq 0.5$. This ratio however grows to $\simeq 2 - 2.5$ when the annual mean values are considered.

These facts allow us to compare the neutrino flux variations and the absolute values of the magnetic field components along the flux propagation line over a time interval of 22 years. The correlation coefficient between the neutrino flux and $<\mid B_\theta \mid>$, $<\mid B_\varphi \mid>$, and $<\mid R_r \mid>$ was found to be -0.66, -059, and -0.62, respectively. Note that correlation coefficient with the Wolf number is as small as -0.37. On the other hand, the correlation coefficient reaches -0.84 if only the uniform data series from Stanford is used.

The high correlation coefficient indicates a possible relationship between both phenomena. As should be expected, it is most pronounced when direct physical parameters of magnetic fields are considered. Relationship between the neutrino flux and the average field components ($< B_\theta >$, $< B_\varphi >$, $< B_r >$) is practically absent (correlation coefficient from -0.35 to -0.15).

Besides South Dakota, neutrino measurements (though much shorter series) were also obtained with the Japanese neutrino detector Kamiokande–II. The annual mean values of the neutrino flux from both detectors show a good agreement over the time interval of 1988–1991. It should be noted that neutrino flux variations over this interval are relatively small compared to the Wolf numbers, so that dependence on the solar cycle may not exist. This inconsistency can be avoided by using direct physical parameters. In fact, the heights of the solar maxima in Wolf numbers in 1979 and 1989 are practically equal, whereas the amplitude of magnetic field components in 1989 are much lower than in 1979.

Besides the 11–year cycle, the ^{37}Ar curve displays a significant quasi–biennial fluctuation (Sakurai, 1979; Rivin, 1993). In time variations of the absolute magnetic field values, this fluctuation is absent. Therefore it should be suppressed to obtain adequate correlation coefficients.

Suppression has been realized by smoothing the original data series over 3–year intervals. For the smoothed data, the correlation coefficients of the neutrino flux with $<\mid B_\theta \mid>$, $<\mid B_\varphi \mid>$, and $<\mid B_r \mid>$ increases to make -0.79, -0.79, and -0.85, respectively. The correlation coefficient with the Wolf number also increases (-0.60), but it still remains lower than correlation between ^{37}Ar and the field components. And finally, comparison of the smoothed neutrino data with a uniform series of magnetic field data from WSO yields a correlation coefficient as high as -0.90.

Our conclusions are as follows:

1. The fact that linear correlation between the neutrino flux and the solar magnetic field increases significantly when absolute values of the magnetic field components along the "solar center — Earth" line are considered, as well as high correlation coefficients themselves suggest that solar magnetic fields are responsible for variations of the high–energy neutrino flux from the solar interior detected at South Dakota.

2. As the absolute values of the magnetic field components display mainly an 11–year variation, the neutrino flux is modulated by the fields in the convection (or maybe even radiative) zones in the Sun. These are the fields that determine the basic solar activity cycle with a period of $\simeq 22$ years.

3. The fact that magnetic field curves do not display significant quasi–biennial fluctuation that is present in the curve of the neutrino flux shows that generation of quasi–biennial fluctuations has nothing to do with the fields of the basic solar cycle, but is rather due to the thermal processes in the solar core, as suggested by Sakurai (1979).

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V.N. OBRIDKO
Yu.R. RIVIN
Institute of Terrestrial Magnetism,
Ionosphere and Radio Wave
Propagation
of Russian Academy of Sciences
Troitsk
Moscow Region 142092
Russia

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POSSIBLE LOW AMPLITUDE LIGHT VARIATIONS OF DI Her

The eccentric eclipsing binary DI Herculis (B4 V and B5 V; $P = 10\overset{\mathrm{d}}{.}55$; $e = 0.49$) is an important test case of general relativity for stars composed of non-degenerate matter because it is expected to have a large relativistic contribution to its apsidal motion (Rudjkøbing, 1959; Guinan and Maloney, 1985). DI Her has well determined orbital and physical properties and an accurately measured apsidal motion rate of $\dot{\omega}_{obs} = 1\overset{\circ}{.}04/100\mathrm{yr}$ $\pm 0\overset{\circ}{.}15/100\mathrm{yr}$ determined from the recent analysis of numerous times of primary and secondary eclipses (Guinan et al., 1994). The most remarkable feature of DI Her is that its observed apsidal motion rate is significantly smaller than that predicted by general relativity and classical effects. The total predicted rate of apsidal motion is $\dot{\omega}_{gr+cl} = 4\overset{\circ}{.}27/100\mathrm{yr}$ $\pm 0\overset{\circ}{.}30/100\mathrm{yr}$ where the general relativistic term is the major contribution.

We are currently carrying out an intensive study of DI Her to search for the reason(s) for the large discrepancy between the observed and predicted apsidal motion rates. In a previous paper, we have refined the value of the apsidal motion rate and have also searched for evidence of variations in the O−C's of the photoelectric eclipse timings, obtained over the last 30 years, that could arise from the light time effects of a possible third body (Guinan et al., 1994). No evidence of the presence of a third body was uncovered from this analysis.

Another possible solution for the smaller than expected apsidal motion rate is tidal dissipation of the system's angular momentum arising from induced pulsations in the stars as they move in their eccentric orbit (see Papaloizou and Pringle, 1980; Savoniji and Papaloizou, 1983). In this case the discrepancy in apparent apsidal motion is produced by a decrease in the orbital eccentricity as the orbit circularizes. However, as discussed by Guinan and Maloney (1985) the rate of change of the eccentricity needed to explain the observed discrepancy is large ($\dot{e} \simeq -0\overset{\circ}{.}01/100\mathrm{yr}$) and the induced pulsations in the stars, if present, must be significant and should be observable. With this in mind, we carried out intensive UBV photoelectric photometry of DI Her using the Fairborn-Villanova 0.8m Automatic Photoelectric Telescope (APT) on Mt. Hopkins, Arizona.

Many eclipse timings have been obtained for DI Her, but there have been few attempts to observe the system for a significant amount of time outside of eclipses. During the springs of 1993 and 1994, DI Her was observed continuously (with comparison and check stars) for up to 4 – 5 hours on several nights outside of eclipses. A description of the equipment, filters, comparison and check stars, and reduction technique is found in Guinan et al. (1994). In Figure 1 we present the U and V light curves obtained during 1993/94. From this figure it is apparent that there are small light variations outside the eclipses on time scales significantly shorter than the 10.55 day orbital period. The variations are largest in the U bandpass and barely noticeable in the V bandpass. In Figure 2 we plot two long runs on an expanded magnitude and time scale to show examples of the light variations in the U bandpass. To search for possible periodicities, all of the data were

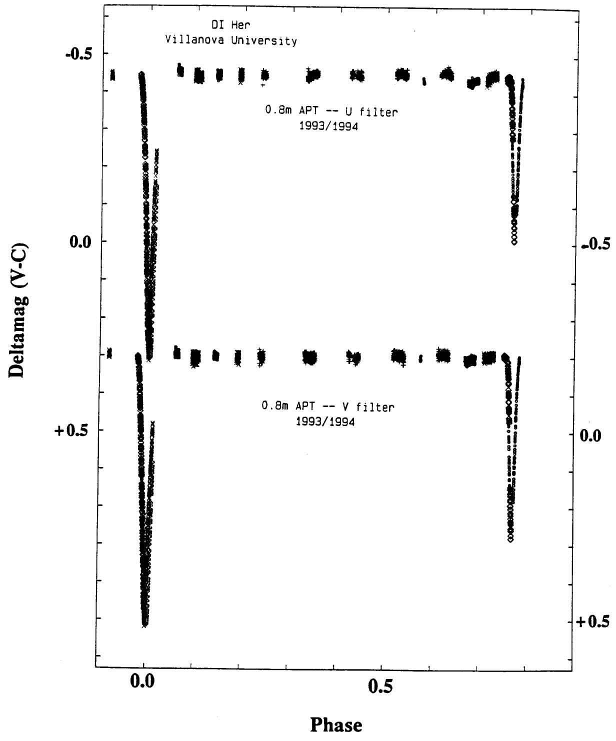

Figure 1. The U and V band light curves of DI Her obtained in 1993/94 are plotted. The magnitudes are differential measured relative to a nearby comparison star HD 174932. Note the small light variations in the U observations outside the eclipses.

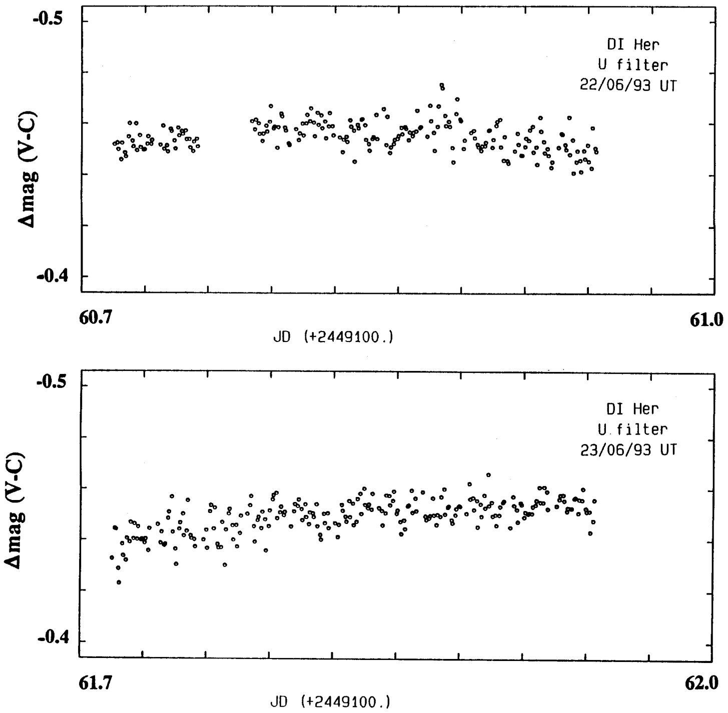

Figure 2. The delta U mags of DI Her for the nights of 21 and 22 June 1993 are shown. Small systematic variations are noticeable on time scales of several hours.

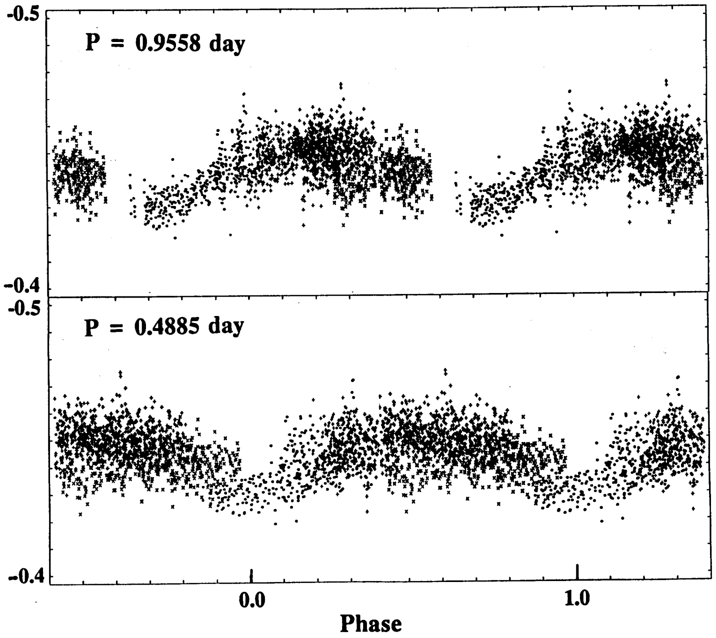

Figure 3. The results of period searches of the U observations outside of eclpises using the Lomb–Scargle method are shown. The two most prominent periods found are 0.4885 days and 0.9558 days and are indicated along with several other possible periods.

analyzed using the Lomb–Scargle algorithm (Press and Teukolsky, 1988).
We narrowed down the possible range of periods to 0.4 to 2.0 days by trial and error and then analyzed the data in this restricted period range. The results are difficult to interpret because there is no single highly prominent peak in the periodogram. This is in most part caused by the low amplitude nature of the light variations (0.01 – 0.02 mag) and gaps in the data set. Our analysis reveals two prominent periods of 0.4885 day and 0.9558 day having relative powers of 201.0 and 197.6 on the periodogram. However, there are other possible periods including 1.2165 days with a lower relative power of 155; it is possible that the 0.4885 day and 0.9558 day periods are aliases of each other. It may also be possible, however, to have multiple periods. In Figure 3, we plot the U light curves computed with the 0.4885 day and 0.9558 day periods, respectively. As shown in the figure, both periods result in a low amplitude sinusoidal light curve. It is difficult to discern which one of the two periods is better. The amplitudes of the U, B, V light variations are 0.020 mag, 0.013 mag, and 0.010 mag, respectively.

We are confident that the light variations discussed above are real. However, there is an uncertainty in the source of the variability because all measurements were made with respect to a nearby comparison star (HD 174932; B9; V=+8.9) which itself could be the source of the observed light variations. Although this is unlikely, we cannot be certain that the comparison is constant in light because the check star (HD 343238; A2; V=+9.7) observations show considerable scatter. The scatter in the check star data is probably due to centering problems with the APT acquiring this faint star (the limiting magnitude for acquisition is +9.6 – +9.7 mag); it is also possible that the check star may be intrinsically variable. We plan further observations next season to resolve this dilemma using additional comparison stars.

The characteristics of the light variations reported here (whether from DI Her or the comparison star HD 174932) are very similar to those found by Waelkens and Rufener

(1985) and Waelkens (1987, 1991) for a proposed new class of stars called slowly pulsating B stars (SPB stars). These stars generally have spectral types ranging from B3 to B8 (with luminosity classes of IV – V) and have light amplitudes of a few thousandths or hundredths of a magnitude that increase with decreasing wavelength; multiple periods are typically seen in the range of about 1.0 – 3.0 days. All the SPB stars seem to show the same dependence of the amplitude on wavelength, with amplitudes in the U bands about twice as large as in the V bands. Furthermore, North and Paltani (1994) have found that the ratio of the amplitude in the (U−B) index and V magnitude is very well correlated with the effective temperatures of the SPB stars. Waelkens (1991) explains the light variations from the SPB stars as arising from non-radial oscillations in the g modes with large radial wave numbers k and low orders l. The ratio of the amplitude of the (U−B) to the amplitude in V for our differential magnitude measures of DI Her is $A_{(U-B)}/A_V = 0.70$. This ratio is similar to that found for SPB stars with spectral types of B4 – B6 which is close the spectral type of the components of DI Her. On the other hand, the comparison star has a spectral type of B9 which is near the observed upper limit for SPB stars. Furthermore, B8 – B9 SPB stars have an amplitude ratio of $A_{(U-B)}/A_V = 0.9 - 1.1$ which is not consistent with our observed value. This evidence lends some support to the hypothesis that the light variations are coming from one or both of DI Her's components and not the comparison star. Observations planned for the future should resolve this issue.

If future photometry confirms that the light arise from DI Her rather than the comparison star, these low amplitude non-radial pulsations would not be sufficient to explain the discrepancy in DI Her's apsidal motion rate from tidal dissipation. It would appear more likely that the light variations may be quite common for stars of their spectral class and is not related to them being members of an eccentric binary system. It is possible that many more B-type stars will show low amplitude light variations and have not yet been discovered because they have not been adequately sampled.

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James J. MARSHALL
Edward F. GUINAN
George P. McCOOK

Department of Astronomy
and Astrophysics
Villanova University
Villanova, PA 19085

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ON THE AGE OF FLARE STAR FS2 AND THE CLUSTER OF α PERSEI

As has been shown earlier, there is a correlation between the maximum flare energy (amplitude) which is likely to be emitted by star of particular magnitude (mass) and its age (Parsamian, 1976, 1995). This relationship depends upon the evolutionary stage of the flare stars, and of the clusters in which they have been observed. It follows therefore, that the age of any flare star may be estimated if large flare – sufficiently intense to be regarded as maximal – is observed.

During flare star searches in the α Persei cluster, a large flare of amplitude $\Delta \mathrm{U} \approx 9^{\mathrm{m}}$ was observed for the star FS2 (Semkov et al., 1993). According to these authors, the (V, V−I) photometry of FS2 makes it acceptable for membership in the cluster. Flares of such large amplitudes occur very seldom; it is therefore likely that the energy emitted in this particular event is close to the upper limit described above. If star FS2 is a member of the α Persei cluster, we can then estimate the age of the star and of the cluster in which it resides.

According to Semkov et al., FS2 is a faint star of magnitude $\mathrm{U} \approx 21.7$ and of spectral class $\geq$ M5. Given a distance of r= 166pc for the α Persei cluster, the absolute magnitude of FS2 is then $\mathrm{M(U)} = 15.6$, and the absolute magnitude of the flare is $\mathrm{M}_f = 6.6$. According to Table 3 in Parsamian (1995) the age of the star would then be $3{\times}10^7$ yr, and the age of the cluster at least as large. For comparison, other independent estimates of the age of this cluster vary from $5{\times}10^7$ yr to $8{\times}10^7$ yr (Mermilliod, 1981, Prosser, 1992). On the other hand if FS2 is a field star, then $\mathrm{M(U)} = 15.1$ (Mampaso, 1991), $\mathrm{M}_f = 6.1$ and the age would be $\sim 2{\times}10^7$ yr.

Elma S. PARSAMIAN
INAOE, Mexico,
E-mail: parsam@tonali.inaoep.mx
Byurakan Astrophysical
Observatory, Armenia

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OBSERVATIONS OF A NEWLY DISCOVERED SU UMa-TYPE STAR HV AURIGAE

HV Aurigae was discovered to be a dwarf nova by Hoffmeister (1964) in Dec. 1963. He also found two outbursts on the Palomar charts occurred in March 1940 and March 1941 on the Palomar charts. After the discovery, the object has been little studied except the additional observations of two outbursts and a finding chart given by Bruch et al. (1987). The quiescent identification was made by Downes and Shara (1993).

Many of the outbursts of HV Aur have probably been overlooked because of its faintness, because the maximum visual magnitude in outburst is only about 15. However, an outburst was recently noticed by M. Iida (Variable Star Observers League in Japan) on Nov. 8, 1994, and announced a brightness variation which was regarded to be superhumps (M. Iida 1995, in preparation).

In order to confirm the superhumps and to determine the superhump period, we made observations on Nov. 11 and 13, 1994 using a CCD camera (Thomson, TH 7882CDA, 576 × 384 pixels with 23 μm square pixel size) attached to the Cassegrain focus of 0.6-m reflector (focal length=4.8m) at Ouda Station, Kyoto University (Ohtani et al.,1992). An interference filter was used which had been designed to reproduce the Johnson V band. The mode of 2×2 on-chip summation was employed. The observation lasted about six and eight hours on Nov. 11 and 13, respectively, occasionally interrupted by clouds. The exposure time was 120 sec with a read-out and saving dead time of 13 sec throughout observations.

We reduced the data using the personal-computer-based aperture photometry package developed by one of the authors (T.K.). This package automatically subtracts bias-flames, applies flat fielding and enables us to estimate the instrumental magnitudes. The aperture size was $8''$ in radius. The sky level was determined from pixels whose distance from the individual objects are between $16''$ to $30''$.

Figures 1 and 2 show short-term light curves of differential magnitude between HV Aur and a comparison star (Table 1). The zero point of the ordinate of figures corresponds to $V = 13.6$. The abscissa is Julian Day minus 2449660.

Table 1. The coordinates and magnitudes of the comparison and check stars taken from Guide Star Catalog (GSC).

	R. A.(J2000)	Dec.(J2000)	m_V
comparison	$04^{\rm h}53^{\rm m}02\overset{\rm s}{.}97$	$+38^{\circ}18'10\overset{''}{.}0$	13.6
check 1	$04^{\rm h}53^{\rm m}00\overset{\rm s}{.}06$	$+38^{\circ}14'22\overset{''}{.}0$	13.4
check 2	$04^{\rm h}53^{\rm m}06\overset{\rm s}{.}31$	$+38^{\circ}13'50\overset{''}{.}9$	14.3
check 3	$04^{\rm h}53^{\rm m}13\overset{\rm s}{.}20$	$+38^{\circ}18'20\overset{''}{.}9$	14.5

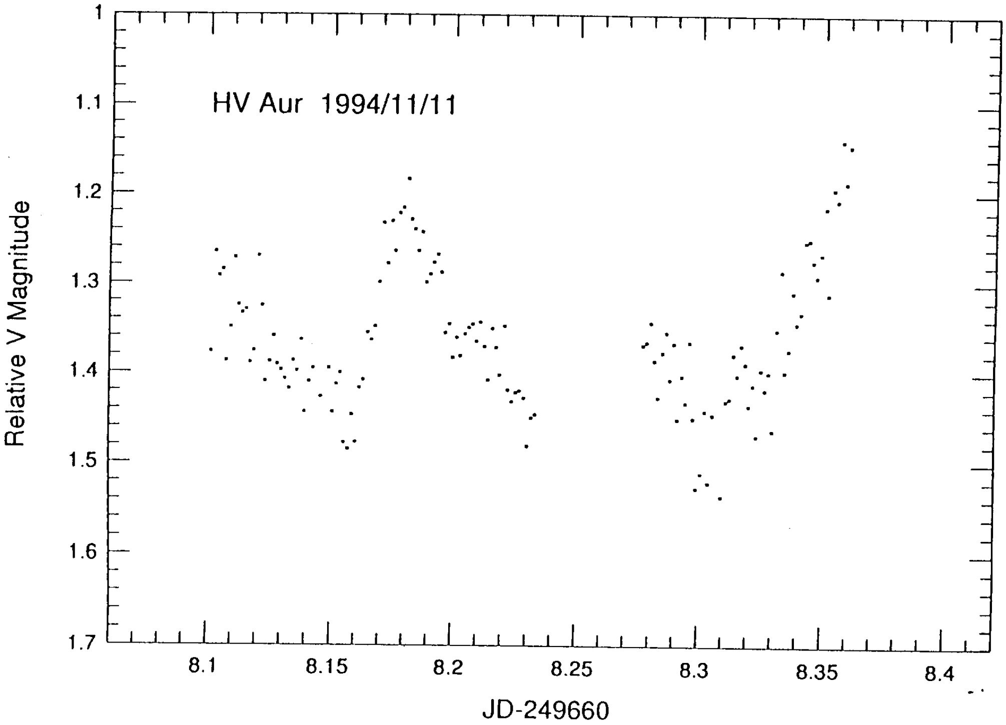

Figure 1: The short term light curve of HV Aur on Nov. 11 1994

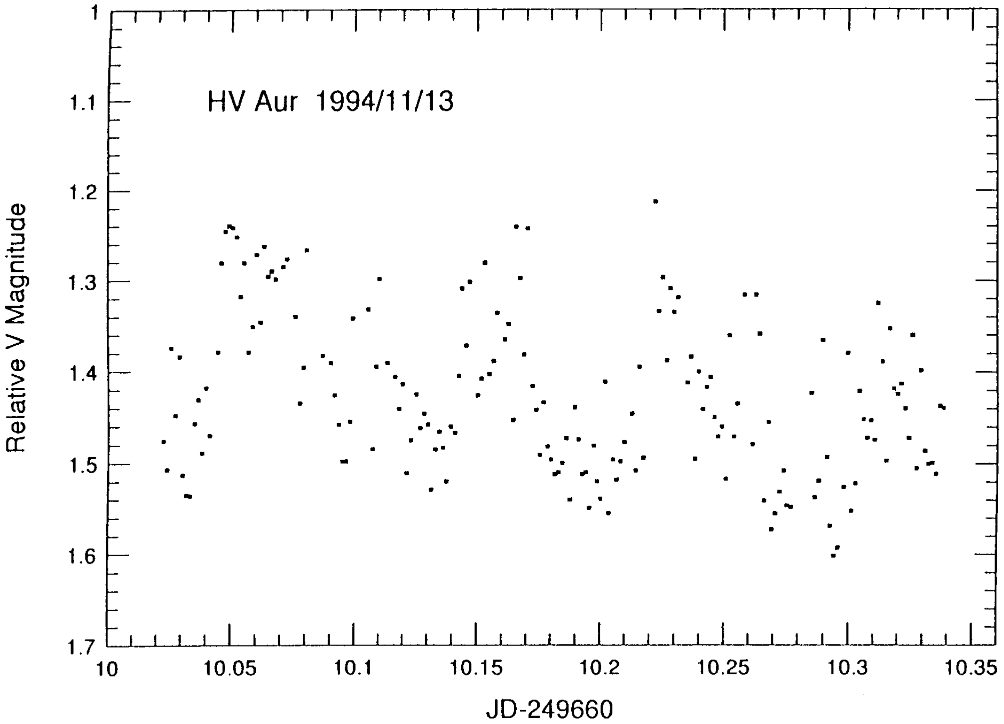

Figure 2: The short term light curve of HV Aur on Nov. 13 1994

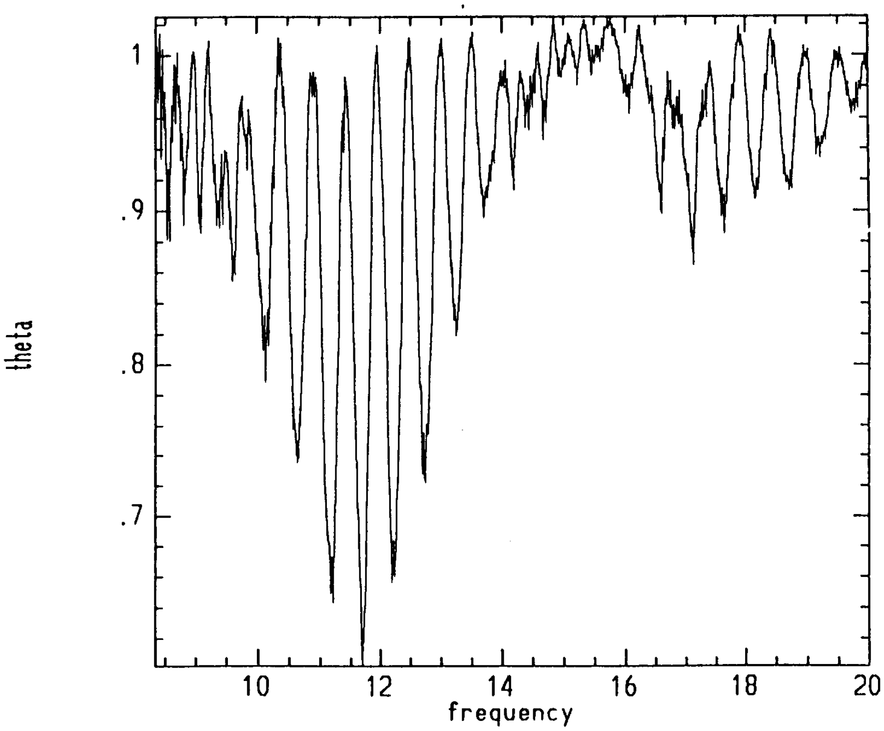

Figure 3: Theta diagram by PDM; the minimum point corresponds to 0.0855 day

Using three nearby check stars selected from GSC, we confirmed the constancy of the comparison star (Table 1) within $0\overset{m}{.}02$, and the r.m.s. error for a single measurement of the differential magnitude is $0\overset{m}{.}02$. Although the error is a little bit large because of clouds, the hump-like feature is considered to be real because its amplitude is about 0.2 mag, being much larger than the estimated error.

By analyzing the light curve using PDM (Stellingwerf 1978) program within IRAF package (IRAF is distributed by the National Optical Astronomy Observatories, U.S.A.), after removing the trend of linear decline, we obtained 0.0855 ± 0.0001 day as the best estimate of the period. Figure 3 shows the Θ diagram, whose abscissa is frequency (day^{-1}). We regarded the feature as superhumps, because the shape of the modulation, rather rapid rise and following gradual decline, is characteristic of a superhump of SU UMa-stars in superoutburst and only a superhump can explain such large amplitude modulation in a dwarf nova in outburst. We thus confirmed Iida's identification of HV Aur as a new member of SU UMa-type dwarf novae, and obtained a superhump period of 0.0855 day.

The decline rate is 0.035 mag day^{-1}, which is about one fourth of those typically observed in slow decline phase of usual SU UMa stars. More observation is necessary to reveal the nature of this peculiarity.

The authors are grateful to M. Iida for notifying us of the outburst and calling our attention to this interesting dwarf nova. This research has been partly supported by Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists (T.K.).

Daisaku NOGAMI
Taichi KATO
Seiji MASUDA
Ryuko HIRATA

Department of Astronomy,
Faculty of Science, Kyoto University
Sakyo-ku, Kyoto 606-01, Japan

e-mail address:
nogami@kusastro.kyoto-u.ac.jp
tkato@kusastro.kyoto-u.ac.jp
masuda@kusastro.kyoto-u.ac.jp

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MORE CLARIFICATION NEEDED FOR NSV 11271 AND VY LYRAE

VY Lyrae and NSV 11271 are two stars needing further detailed observations. The slow variability of NSV 11271 has not been confirmed but the star is also a spectroscopic binary with a period of 2905 days (Batten et al., 1989). VY Lyrae has been classified as a W UMa type eclipsing variable by some observers whereas others have reported it as not variable.

In the NSV Catalogue (Kholopov, 1982) NSV 11271 is recorded as 8.0pg K5 and is identified with BD +39°3505 and HR 7041. The Bright Star Catalogue gives photometric data V=6.45, B−V=1.57 K5III, and the Washington Catalogue of Double Stars (Worley, 1986) indicates a 10.3v companion at $60''\!.2$, P.A. 192°. The companion is optical (Griffin, 1987) and too faint to affect estimates of the variability of the primary. Variability had been discovered by Soloview (1922) who reported that the star gradually increased in brightness from May 6 to June 4, 1922. Then poor observing conditions precluded further observations until August when Soloview and Selivanov found the star to have begun to fade. The amplitude was reported as about one magnitude, probably only about 0.7v (Samus, 1994). Long period variation was suspected. It would be of interest to ascertain whether or not there is a correlation between the spectroscopic and the light variations.

The variability of VY Lyr was also discovered in 1922 by Soloview, and confirmed by J. Kazansky. It was reported to have varied from 10.8 to 11.2v, with W UMa type curve in a period of 3^h45^m or $0\overset{d}{.}156$ (Seliwanow, 1923). Some later observers (see Prager, 1936; Schneller, 1957) failed to detect any variation: Guthnick and Prager (1928) from 10 observations, Zverev (1934 and 1937) from 41. Since 1935 it has been listed in the GCVS as cst: even though Sandig (1950) did report rapid variations among 17 observations between 1929 and 1939; and again among 10 in the fall of 1948 amounting to an amplitude of $0\overset{m}{.}6$; but only marginal variation in 32 observations in the fall of 1949.

A finder chart (reproduced here as the left diagram of Figure 1) as well as a summary of new observations, whose amplitudes do not exceed the observational errors, is given by Zverev and Makarenko (1979). The star circled is identified as VY Lyrae. But that star is BD +39°3507 at $18^h38^m45^s$+39°$2'\!.3$ (1855) whereas Prager (1936) clearly states that VY Lyr is not a BD star. The position given by Prager and in all GCVS catalogues since 1927, $18^h38^m57^s$+39°$5'\!.8$ (1855) agrees with the position given by Seliwanow in his announcement of the Soloview discovery. This star is labelled as comparison star x. Hence it appears that x and VY may have been interchanged on the original chart. The stars marked b, c, p, and x are the comparison stars cited by Zverev and Makarenko for brightness determinations. Step values for c, x and p are 0.0, 2.1 and 6.0 respectively, while the magnitudes assigned to b and c are 11.57 and 12.09 pg. It is not clear whether the published magnitudes correspond to star x or BD +39°3507. Moreover, it does not seem a forgone conclusion that all the observers who found no variation were all examining the same star.

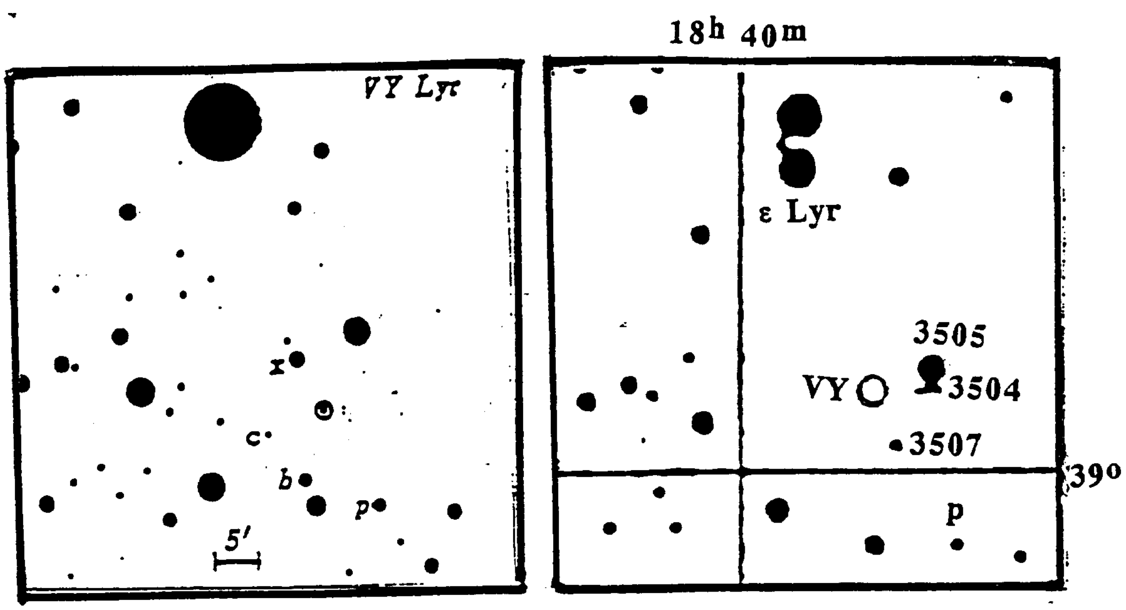

Figure 1. Left figure, from Russian Variable Stars, Supplement **3**, 440, 1979, photographic magnitudes. Figure at the right from visual BD, with relevant BD numbers indicated. The open circle for VY Lyr is inserted at the position of star x in the left figure. For both charts North is at the top and East to the left.

Table 1. Positions of Critical Stars.

Star	RA (1855)	D (1855)	Mag	Remark
NSV 11271	18^{h}38^{m}27^{s}	+39°09$'\!.$2	8.0p K5	
+39°3504	18 38 26.0	+39 08.5	9.5v	Optical companion of +39°3505
+39°3505	18 38 27.0	+39 09.5	6.5v	SB 2905d
VY Lyr	18 38 57	+39 05.8	10.5-10.9	Period $0^{d}\!.156$, $0^{d}\!.31$, or cst.
+39°3507	18 38 45	+39 02.3	9.5v	
JBAA 33,291	18 37*57	+39 05.8	10.5-10.9	Period 3^{h}45^{m}

*Probably 38^{m}intended

VY Lyrae is in close proximity to NSV 11271 (BD +39°3505). The right hand diagram of Figure 1 is a copy of a portion of the BD chart including the area of the variables. Several BD stars in the +39° zone are identified. The stars marked x, b, and c in the left figure are not BD stars, while p is BD +38°3270, mag. 9.4v. The approximate position of star x is circled in the right figure. It is about 4′ north following BD +39°3507. An examination of the Carte du Ciel chart for plate center 18^{h}45^{m}+39°, reaching 14pg does show a faint star in the approximate position of star x. It may well be VY Lyrae. Indeed Chikinz and Kasitzyne (1923) of the Russian Society of Amateurs of the Universe's Knowledge, who either confirmed or quoted the 3^{h}45^{m} period, indicated the position of the variable as 18^{h}37^{m}57^{s}+39°05'49" (1855). If for 37^{m} we read 38^{m}, then this position does agree with the location of star x (see Table 1).

The positions given for VY Lyrae in all the general catalogues of variable stars from 1926 through 1985 are consistent with the position of star x, not the one circled as VY on the Zverev-Makarenko chart. Aside from the questioned chart identification, no reference to VY Lyr indicates any relation to BD +39°3507. The question remains whether Zverev and Makarenko merely interchanged the labels of x and VY Lyr on their chart; or do their observations of non-variability correspond to BD +39°3507, a star not listed as variable in either the GCVS or the NSV catalogue?

As the amplitudes of both NSV 11271 and VY Lyrae are small, extensive photoelectric observations are needed to ascertain dependable light curves.

Acknowledgements. Dr. Imants Platais kindly translated passages from the Russian and contacted N. Samus for a Russian publication not available in the Yale Library. Samus sent us translation of the relevant reference to NSV 11271 together with his own comments.

Dorrit HOFFLEIT
Department of Astronomy
Yale University
New Haven, CT 06520-8101

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NEW PERIOD DETERMINATION FOR EY Cyg

EY Cyg is a U Gem-type dwarf nova. The brightness during outburst and minimum are respectively 11.4 mag. and 15.5 mag. (Ritter, 1990). The interval between two subsequent outbursts is about 240 days and the duration of the outburst is typically around 30 days. More details about the spectroscopic observations are given by Smith, Sarna & Jones (1995). The first orbital period determination was made by Hacke & Andronov (1988) from photographic observations. They found:

$$\text{Min. JD}=244\,6595.323+0.181228\times E$$

This is the period quoted in the catalogue by Ritter (1990), but in our opinion this determination is very uncertain because of the poor quality of the data.

We obtained CCD photometry in V, R, I of EY Cyg during two nights in 1993 (August 17 and October 13), using the 60-cm Cassegrain telescope located at the Warsaw University Observatory at Ostrowik. Exposure times of 60 and 120 sec were used for different colours and nights. We used the standard reduction procedure available in Warsaw, which is based on the IRAF reduction package.

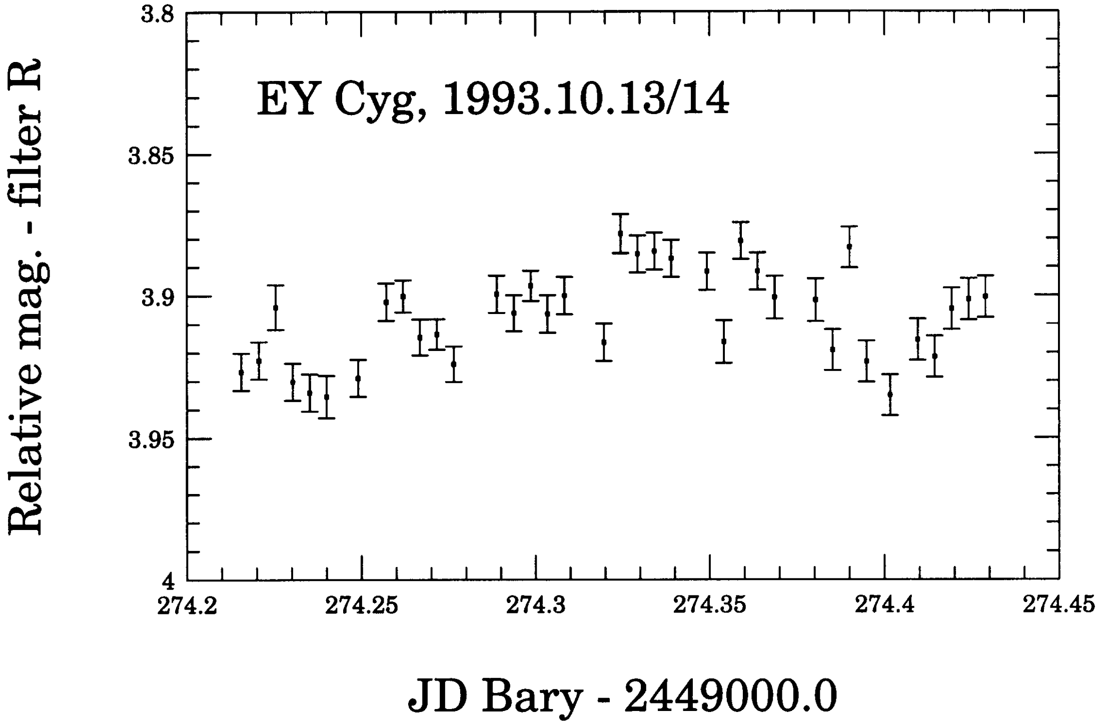

Figure 1

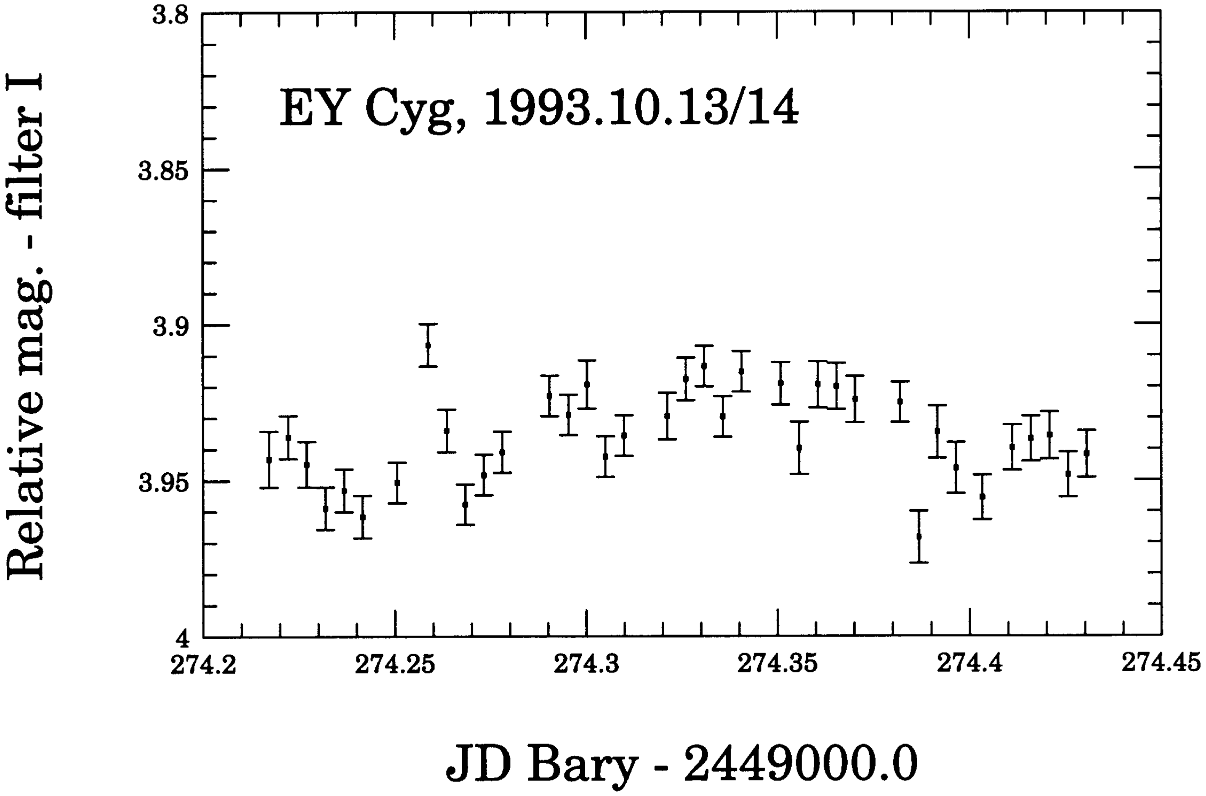

Figure 2

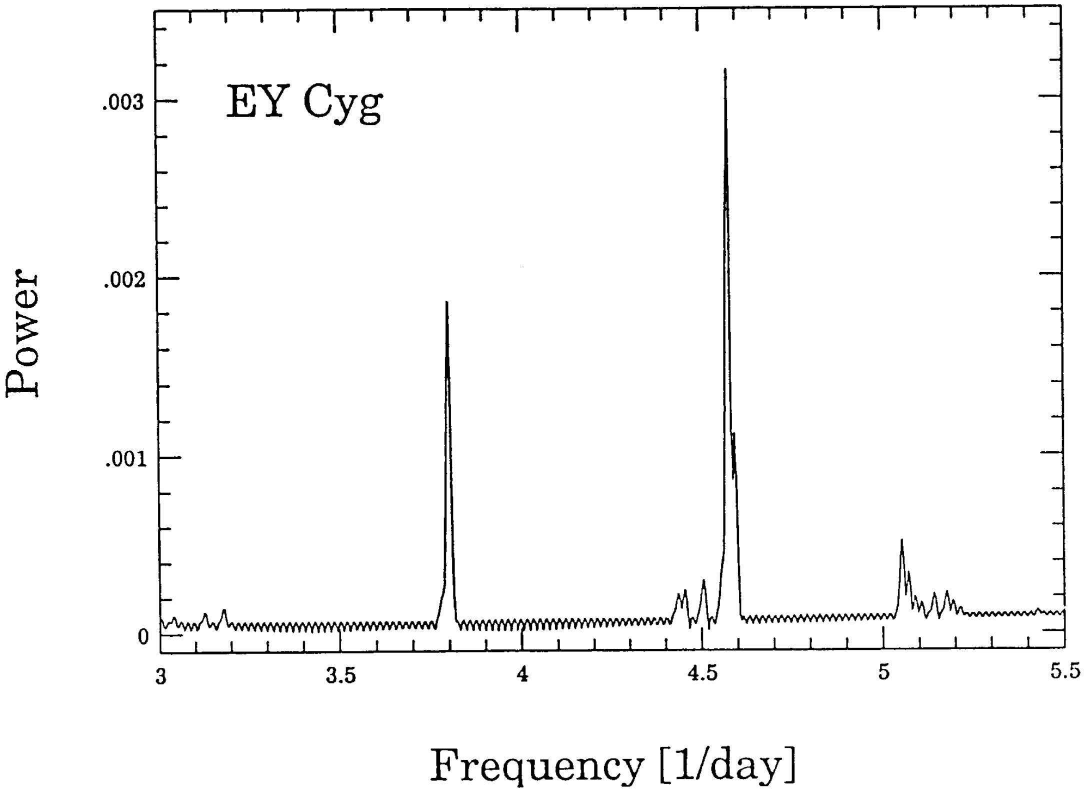

Figure 3

The R and I observations are presented in Figures 1 and 2 respectively. We show only relative magnitudes in both colours, because the majority of bright stars in our field of view are variable. We detected a very smooth light curve modulation with an amplitude of about 0.05 mag. The formal error of observations is ±0.01 mag.

The power spectrum periodogram is presented in Figure 3. Two peaks are seen at frequencies: $f_1=3.800\pm0.004$ day^{-1} and $f_2=4.576\pm0.004$ day^{-1}. These give orbital periods: $P_1=0.2630\pm0.0005$ and $P_2=0.2185\pm0.0005$ day, respectively. The second period has a higher statistical weight; further, there are evolutionary and spectroscopic arguments to support this value (see discussion below).

From the spectra of EY Cyg (Smith, Sarna & Jones, 1994) we can classify the red dwarf spectral type as dM2-dM3. From the calibration by Popper (1980) we found that the mass of the red dwarf component lies in the range 0.5-0.4 $M_\odot$. Next from Echevarría's (1983) mass-radius relationship, and assuming that the red dwarf main-sequence star fills its Roche lobe, we determined a possible range for the orbital period: 0.22-0.182 day. From the results of the period analysis only the second value

$$P=0.2185\pm0.0005 \text{ day}$$

is consistent with this constraint.

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Marek J. SARNA[1,3]
W. PYCH[2]
Robert Connon SMITH[3]

[1] N. Copernicus Astronomical Center, Polish Academy of Sciences, ul. Bartycka 18, 00-716 Warsaw, Poland
[2] Warsaw University Observatory, Al. Ujazdowskie 4, 00-478 Warsaw, Poland
[3] Astronomy Center, Division of Physics and Astronomy, University of Sussex, Falmer, Brighton BN1 9QH, UK

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HAS THE DELTA SCUTI STAR BE Lyn A COMPANION?

The high amplitude δ Scuti-type variation (V=8.6-9.0 mag, A3) of BE Lyn (= HD 79889 = HIC 45649) was discovered by Oja (1986, 1987). The period change was discussed in some papers (Rodríguez et al., 1990a, Liu et al., 1991, Tang et al., 1992, Wunder et al., 1992, Liu and Jiang 1994, Rodríguez et al., 1995). Earlier the O−C diagram was fitted with a negative parabola, later with a positive parabola. The aim of our measurement was to obtain new points on the O−C diagram in order to determine the recent period variation.

We carried out photoelectric photometry (through Johnson UBV filters) of BE Lyncis on three nights: 31 Jan, 5 and 13 Feb 1995 with the 40 cm Cassegrain telescope and SSP-5A photometer of Szeged Observatory, Hungary. The comparison star was HIC 45515 (V=9.30 mag, F8). The phase diagram of the light curve is plotted in Figure 1. The period was determined with the Phase Dispersion Method.

The new times of maxima are listed in Table 1, where the O−C residuals have been obtained from the ephemeris:

$$Hel.JD\,max = 2449018.2684 + 0.09586953 \times E$$

The O−C diagram (N=65) can be seen in Figure 2. Instead of parabola we fitted a light-time effect curve supposing a cyclic period variation due to orbital motion in binary system. The parameters of the fit and their estimated errors are given in Table 2.

Accepting $M_1 = 1.7 \pm 0.1\ M_\odot$ mass for the pulsating component (Claret et al. 1990, Rodríguez et al., 1990b), we can calculate the semi-major axis of the orbit of the secondary and its mass with iteration (Table 3). The errors are due to the uncertainty of the P and M_1. The results suggest a red or brown dwarf companion which is probably not detectable in the spectrum of BE Lyn due to its low brightness. The calculated orbital radial velocity amplitude (K) of the delta Scuti star is very small, therefore the spectroscopic measurements cannot help to confirm the binary nature.

There is an interesting possibility to determine the pulsation constant (Jørgensen and Grønbech, 1978). Combining Kepler's third law and the pulsation constant formula

$$\frac{a^3}{P_{orb}^2} = \frac{G}{4\pi^2}(M_1 + M_2), \qquad and \qquad Q = P_{pul}\left(\frac{M_1}{R_1^3}\right)^{1/2} \tag{1}$$

we obtain

$$Q = 0.1159\frac{P_{pul}}{P_{orb}}\left(\frac{R_1}{a}\right)^{-3/2}\left(1 + \frac{M_2}{M_1}\right)^{-1/2} \tag{2}$$

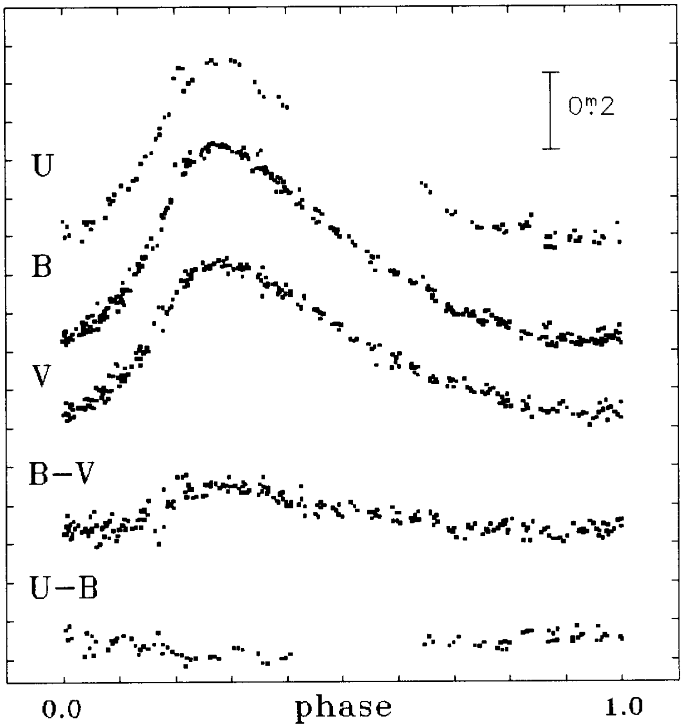

Figure 1. Phase diagram of BE Lyn (P=0.0958784 day, T_0=2449018.2684)

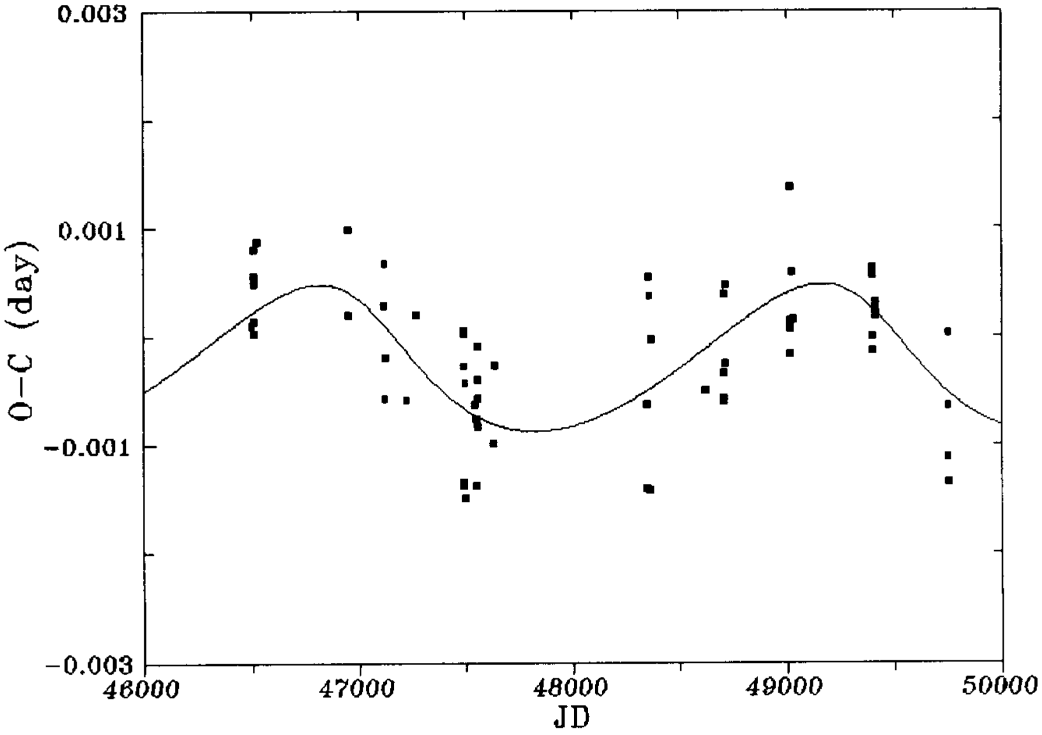

Figure 2. O−C diagram of BE Lyn with the fitted light-time curve (P=2350 day)

Table 1. Times of maximum light in early 1995

No.	Hel.JD	O−C (day)
1	2449749.4642	−0.00111
2	2449749.5612	+0.00003
3	2449749.6564	−0.00064
4	2449754.3533	−0.00135

Table 2. Parameters of the light-time curve

$P_{orb} = 2350 \pm 100\ day$

$a_1 sin\, i = 18 \pm 2 \times 10^6\ km$

$e = 0.30 \pm 0.05$

$\omega = 140^\circ \pm 5^\circ$

$\tau = 2447050 \pm 50$

$t_0(O - C = 0) = 2448700 \pm 50$

$K = 0.58 \pm 0.10\ km/s$

$f(M_2) = (4 \pm 1) \times 10^{-5}$

$A_{O-C} = (6.8 \pm 1.0) \times 10^{-4}\ day$

Table 3. Inclination, semi-major axis of the orbit and mass of the companion

$i(deg)$	$a(AU)$ ±0.08	$M_2(M_\odot)$ ±0.012
10	4.35	0.313
30	4.19	0.101
50	4.17	0.065
70	4.16	0.053
90	4.15	0.049

Adopting $P_{pul} = 0.09587$ days, $P_{orb} = 2350 \pm 50$ days, $R_1 = 2.43 \pm 0.10\ R_\odot$, $a = 4.2 \pm 0.1$ AU, $M_1 = 1.7 \pm 0.1\ M_\odot$ and $M_2 = 0.05 - 0.3\ M_\odot$ we calculated $Q = 0.033 \pm 0.004$. This value corresponds to the radial fundamental mode (eg. Petersen and Jorgensen 1972). Rodríguez et al. (1990b) and Garrido et al. (1990) also concluded that this mode is excited.

On the other hand accepting M_1 and R_1 (Rodríguez et al., 1990b) the $m16e07-08-09$ and $m18e07-08-09$ models of Milligan and Carson (1992) give for the linear adiabatic periods $P = 0.086 - 0.107$ days with an average of $P = 0.094$ days which is very close to the observed P_{pul}. The pulsation constant from these models $Q = 0.0326 \pm 0.0001$ which is similar to the value calculated above.

This means that the physical parameters of the star, the radial pulsation in the fundamental mode and the binary orbit determined from the O−C diagram are in agreement.

We conclude that BE Lyn may have a low mass companion. Of course, the binary hypothesis can be confirmed only a few years later.

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L.L. KISS,
K. SZATMÁRY
Astronomical Observatory and
Dept. of Experimental Physics
JATE University
Szeged, Dóm tér 9.
H-6720 Hungary
Internet: L.Kiss@physx.u-szeged.hu

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PRECISION B,V LIGHT CURVES OF EK COMAE BERENICES

EK Comae Berenices was discovered by Kinman et al. (1966) in a study of fields near the north galactic pole. He identified it as a W UMa variable. The paper includes accurate positions, a finder chart, and a list of photographic magnitudes giving a range of 12.7 to 13.4 mag. This binary was brought to our attention by AAVSO observer Borovicka (1990), who conducted a thorough visual investigation determining the preliminary light elements to be:

$$\begin{array}{rl} \text{JD Hel Min. I} = & 2447609.405 + 0\overset{\text{d}}{.}2666874 \times \text{E}. \\ & \quad \pm .007 \pm \quad .0000001 \end{array} \qquad (1)$$

making it among the shortest period non-degenerate systems known.

Our present observations were made on 11, 12 and 14 February and 9, 12 May, 1994 at Lowell Observatory, Flagstaff, Arizona. A thermoelectrically cooled EMI 6256S (S-13 cathode) PMT was used in conjunction with the 0.78 m National Undergraduate Research Observatory reflector. Approximate coordinates of the variable, comparison and the check star are given in Table 1 and are designated as star 33, d, and c, respectively, on the charts by Kinman et al. (1966). About 250 observations were taken in each passband.

Table 1

Star	R.A. (2000)	Dec. (2000)
EK Com	$12^{\text{h}}51^{\text{m}}20\overset{\text{s}}{.}2$	27°12’57”
Comparison	$12^{\text{h}}51^{\text{m}}55\overset{\text{s}}{.}7$	27°16’17”
Check	$12^{\text{h}}50^{\text{m}}59\overset{\text{s}}{.}2$	27°15’30”

Five mean epochs of minimum light were determined from the observations made during two secondary and three primary eclipses. The bisection of chords technique was utilized in their determination. These minima are given in Table 2 accompanied by their probable errors in parentheses. The five precision epochs, along with eight times of low light from Kinman et al. (1966), the epoch by Borovicka (1990) and the visual timing by Locher (1986) were introduced into a weighted least squares solution to obtain a linear ephemeris. A quadratic ephemeris was also determined. In both of these calculations, visual timings and photographic timings given a weight of 0.1. While photoelectric observations were given a weight of 1.0 with the exception of our last timing which was given a lower weight of 0.5. The improved ephemerides are:

$$\begin{array}{rl} \text{JD Hel Min. I} = & 2449399.0022 + 0\overset{\text{d}}{.}26668726 \times \text{E and,} \\ & \quad \pm .0019 \pm \quad .00000011 \end{array} \qquad (2)$$

$$\begin{array}{rl} \text{JD Hel Min. I} = & 2449399.0018 + 0.26668637 \times \text{E} - 2.05 \times 10^{-11} \times \text{E}^2 \\ & \pm .0018 \pm .00000036 \qquad \pm \ .80 \end{array} \qquad (3)$$

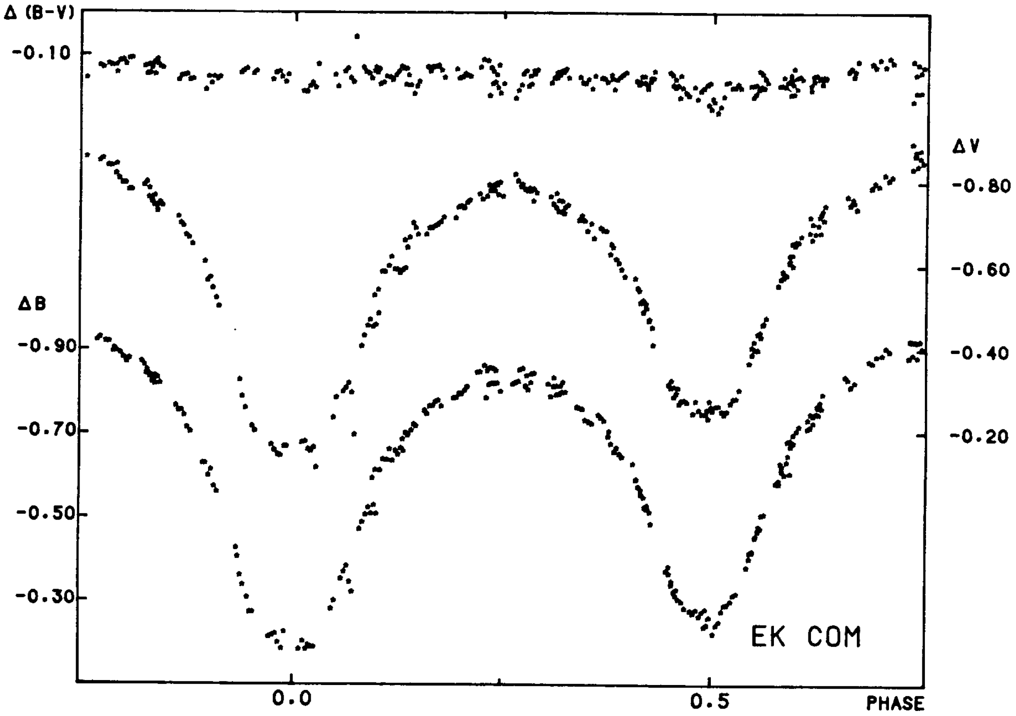

Figure 1. Photoelectric light curves of EK Com as defined by the individual observations.

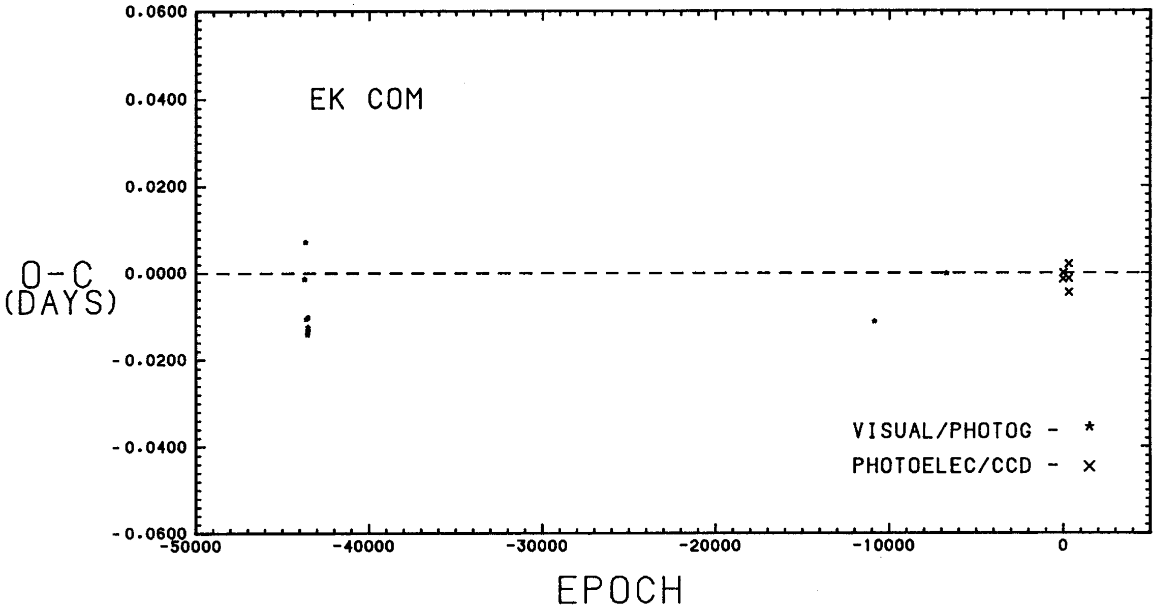

Figure 2. Period behavior of EK Com as calculated from Equation 2.

Table 2

JD HEL. 2400000+	Minimum	Cycles	$(O-C)_1$	$(O-C)_2$
49397.0006(3)	II	−7.5	−0.0015	−0.0011
49399.0022(5)	I	0.0	0.0000	0.0004
49482.7440(1)	I	314.0	−0.0020	0.0027
49482.8740(7)	II	314.5	−0.0013	−0.0007
49485.6710(13)	I	325.0	−0.0002	−0.0038

Equation 2 was used to calculate the $(O-C)_1$ residuals in Table 2 and the phases of the present observations. Equation 3 was used to calculate the $(O-C)_2$ residuals. The quadratic term in the second ephemeris is marginally significant and negative. Because of its small magnitude and doubtful significance, we cannot regard this as proof that the present period behavior of EK Com is dominated by magnetic breaking. More timings of minimum light are needed, both from photographic archives and future observations.

The B,V light curves of EK Com as defined by their individual observations are shown in Figure 1 as differential magnitude (variable–comparison) versus phase. The period behavior of the system as calculated from the linear ephemeris, equation (1), is shown as Figure 2. Our preliminary unspotted solution yields a mass ratio of 0.32 and a fill-out of 13% for this W-type W UMa system. The analysis of the observations is underway.

Ronald G. SAMEC*,
Brian CARRIGAN* and
Eric E. PADGEN*
Millikin University
Decatur, IL 62522 USA

*Visiting Astronomer, Lowell Observatory, Flagstaff, Arizona, USA

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PERIOD CORRECTION FOR THE NEW ECLIPSING BINARY DHK 41

Recently, Kaiser (1994) announced that the 9th magnitude G0 star HD 284195 = SAO 76494 is a detached eclipsing binary, which he designated DHK 41 in his discovery list. He reported a preliminary period of 3.176 days. However, JG and BH soon observed the non-occurrence of an eclipse predicted by this period.

Continued visual monitoring by MEB and CS revealed that this eclipsing binary has an eccentric orbit with secondary minimum occurring at phase 0.3. The reported period, 3.176 days, is actually the interval from secondary minimum to the following primary minimum in a true period of 4.5 days.

Table 1 contains heliocentric times of minima obtained to date. DHK, DT, JG, and BH have observed photoelectrically, MEB and CS have monitored the star visually. The photoelectric timings were reduced with a program based on the Kwee–Van Woerden (1956) method, and the mean errors are given. These errors are large for photoelectric data, due mostly to poor observing conditions.

The period was determined by least squares using the minima from Table 1. The data were weighted as follows, discovery photograph 1, visual 3 and photoelectric 10. The O–C residuals in the table were calculated according to the following light elements:

$$\begin{array}{c} \text{Min. I} = \text{HJD}\,2\,449\,701.7062 + 4\overset{d}{.}49407 \times E \\ \pm 0.0004 \quad \pm .00005 \end{array} \qquad (1)$$

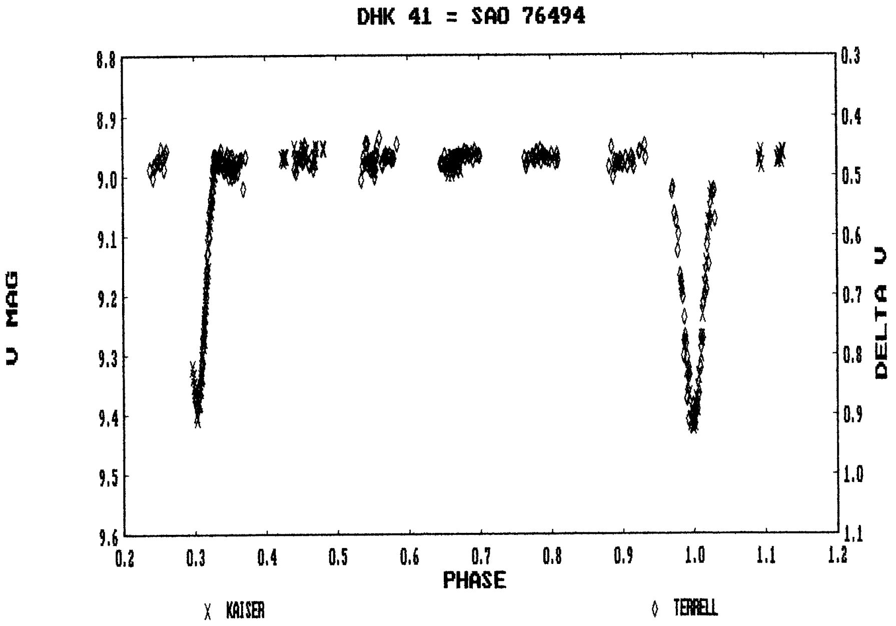

Figure 1

Table 1

HJD 2400000+	Min.		O−C	Observer
49602.846	I	ptg*	+0.008	Kaiser
49653.632	II	vis	−0.004	Baldwin
49680.597	II	vis	−0.003	Baldwin
49701.7061 ±0.0013	I	pep	0.000	Terrell
49707.5649 ±0.0018	II	pep	0.001	Kaiser
49755.6355 ±0.0020	I	pep	0.001	Kaiser

* – Discovery photograph

Figure 1 has DHK's V data and DT's delta V data merged into one graph to show phase coverage. The two eclipses are nearly equal in depth, about 0.44 V. At this time, our choice of primary eclipse is nominal, the slightly greater apparent depth of Min. I being similar to the scatter in the observations.

In a poster paper presented at the January 1995 meeting of the American Astronomical Society (Terrell and Kaiser, 1994), DT and DHK estimated the orbital eccentricity to be near 0.3 and noted that the star may be a distant member of the Hyades cluster. Photoelectric and radial velocity observations of this interesting binary system are continuing, and a full analysis will be published when these observations have been completed.

Daniel H. KAISER
2631 Washington Street
Columbus, IN 47201, U.S.A.

Marvin E. BALDWIN
8655 N. Co. Rd. 775 E.
Butlerville, IN 47223, U.S.A.

Jerry GUNN
606 Skyview Drive
East Peoria, IL 61611, U.S.A.

Dirk TERRELL
Department of Physics &
Astronomy
University of Calgary
Calgary, Alberta T2N 1N4
Canada

Chris STEPHAN
219 Andretti Avenue
Sebring, FL 33870, U.S.A.

Brian HAKES
7059 N. Fox Point Drive
Peoria, IL 61615, U.S.A.

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FAINT COMPANIONS TO UX ANTLIAE

Recently, UBV photometry was provided for stars in the fields of the R CrB type stars UX Ant and UW Cen (Milone, 1994); later, identifications in several catalogues ("Guide Star Catalogue" (GSC), Henry Draper Catalogue, Cordoba Durchmusterung and Cape Photographic Durchmusterung) of the photometrically observed stars were also published in these Bulletins (Skiff, 1994). Precisely, it was said (Milone et al., 1990, Note 1; Milone, 1994, Note 2) that the variable star UX Ant has "a faint near-by companion" but, unfortunately, there is an erroneous identification of the close companion in Note 2. In fact, the reason for the large discrepancy in the B magnitude of the near-by star as indicated in Notes 1 and 2 is, that we are referring to different stars (see Figure 1): it was star 1 for which we measured B=16.5 (Note 1), whereas for star 2 it was found, V=14.55, B−V=0.41 (Note 2). This is the point we want to emphasize here, as (faint) stars of known brightness neighboring a variable star can be useful in several respects.

It is worth mentioning that there are several examples of close companions among the variable stars of the R CrB type. The following cases were noted (indicated distances in arc seconds from the variable are only approximate): UX Ant, component 1:
B=16.5, ρ=15" to the NW, component 2: B=14.96, ρ=45" to the NE;
UW Cen, B=14.19, ρ=20" to the NNW;
Y Mus, B=16.0, ρ=15" to the W;
RZ Nor, B=13.7, ρ=8" to the NE;
RY Sgr, B=16.48, ρ=12", (Andrews et al., 1967; Feast, 1968).

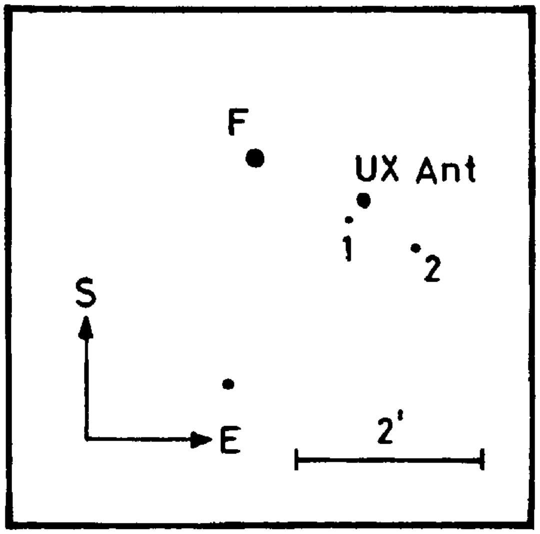

Figure 1.
Details of the region around UX Ant
Star F: V=11.78, B−V=0.45
(see IBVS No. 4002.
According to Skiff (1994),
UX Ant=GSC 7212-0077;
star F=GSC 7212-0258
=CoD −36°6812).

Very probably these are not physical pairs, but the point rather is that the variable being studied can be misidentified when it weakens.

L. A. MILONE
Observatorio Astronómico
Universidad Nacional de Córdoba
Córdoba, Argentina

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A LONG PERIOD EARLY F-TYPE VARIABLE: HR 8799

In summer 1987 the early F–type variable star HR 8799 (=HD 218396) was observed on 5 nights with the 0.75 m reflector at Observatorio de Sierra Nevada by means of a Strömgren-Crawford six-channel simultaneous photometer.

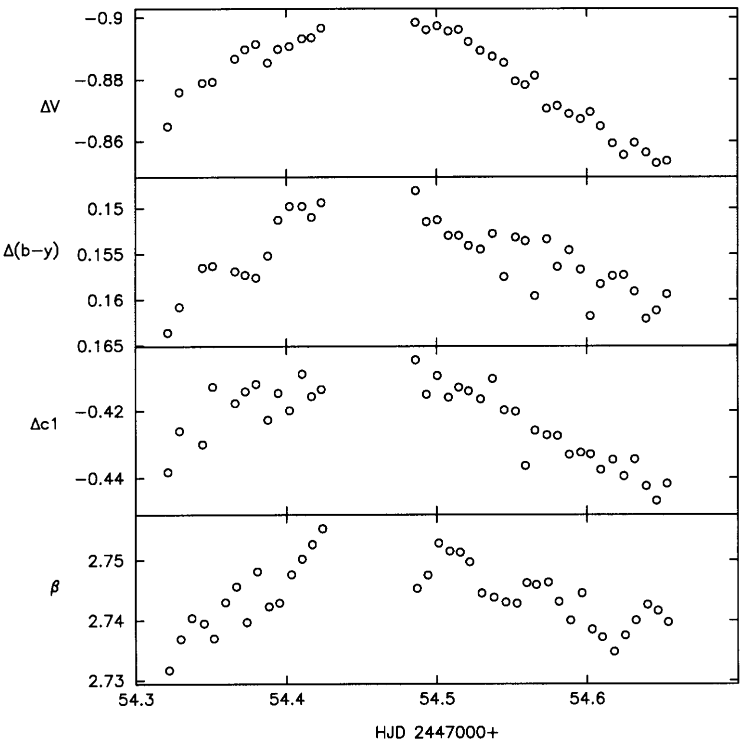
The purpose of the campaign was to investigate its possible SX Phe nature, proposed by Shuster and Nissen (1986) who noticed its slightly low metallicity and a high dispersion in V and c_1 light curves. They proposed a variability on unknown time-scale and amplitude ranging between $0\overset{\mathrm{m}}{.}05$ and $0\overset{\mathrm{m}}{.}1$ in both colours.

During the 1987 observations, HD 217715, HD 218574 and HD 217510 were used as comparison stars. In this campaign 168 differential measurements were collected with respect to HD 217715 in $uvby-\beta$ colors, unfortunately with large gaps between different observing nights. The differential time-series between HD 217715 and HD 218574 provided evidence of constancy within $0\overset{\mathrm{m}}{.}0047$ (u), $0\overset{\mathrm{m}}{.}0047$ (v), $0\overset{\mathrm{m}}{.}0032$ (b), $0\overset{\mathrm{m}}{.}0038$ (V) assumed as mean external errors. Similarly the differential time-series between HD 217715 and the third comparison star HD 217510 provided $0\overset{\mathrm{m}}{.}0054$, $0\overset{\mathrm{m}}{.}0042$, $0\overset{\mathrm{m}}{.}0034$ and $0\overset{\mathrm{m}}{.}0036$ in the four colours respectively. A comparison of the above results with the dispersions computed for HR 8799 versus HD 217715, i.e. $0\overset{\mathrm{m}}{.}0093$ (u), $0\overset{\mathrm{m}}{.}0145$ (v), $0\overset{\mathrm{m}}{.}0129$ (b), $0\overset{\mathrm{m}}{.}0107$ (V) confirms what reported by Shuster and Nissen.

Furthermore during each night we found variations in the colour indices $b-y$, c_1, and β in the same sense and approximately phased with the V light curve. This can be seen in Figure 1 where the observed light and colour index curves are shown for the night of September 17 as an example. Variations in the m_1 color index can be forecasted but due to its intrinsically low amplitude in the scanty data of this campaign they cannot be revealed.

In spite of the large gaps in the data set spectral analysis, performed on these points by means of Vanicek's (1969) least squares technique, provided evidence of a principal frequency of 1.961 d^{-1} (period $0\overset{\mathrm{d}}{.}510$) and the absolute absence of signals in the 5-30 d^{-1} region where δ Sct and SX Phe pulsational frequencies are generally found. However such a periodicity fails to explain the whole signal contained in the time-series: further frequencies must be present even if their determination is beyond the possibility of such a small amount of measurements.

In a pulsational scenario the period found should be related to a non-radial g-mode pulsation never reported in the lower part of the instability strip at the time when the observations were collected. Nevertheless in the last decade a number of objects in this region of the HR-diagram showing variability on longer time-scales with respect to typical δ Sct or SX Phe pulsations and with amplitudes below $0\overset{\mathrm{m}}{.}1$, were reported by various authors and gathered into a group of about ten objects believed to undergo the same phenomenon (Mantegazza et al., 1993). The physical nature of their behaviour its still



Differential light and colour index curves of HR 8799 with respect to HD 217715 versus Heliocentric Julian Day in the night September 17, 1987.

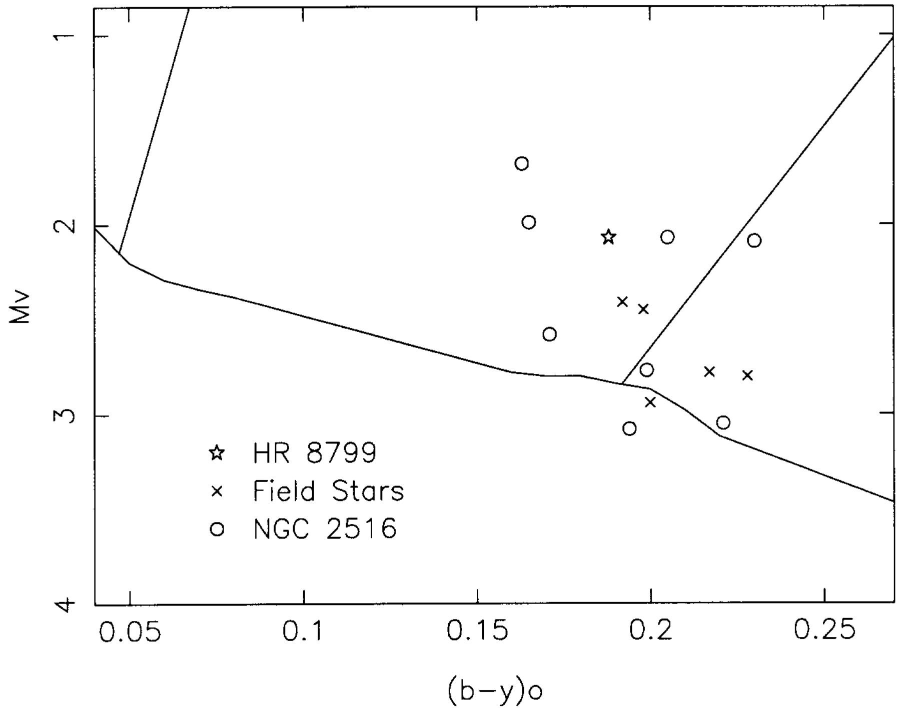


Figure 2. Position of the new variables in HR diagram. Main Sequence track is taken from Philip and Egret (1980) while hot and cool border of the instability strip from Rodríguez et al. (1994).

Table 1. Comparison between HR 8799 and other stars in the group of new early F-type variables. Data are taken from the corresponding references quoted in the text. HR 8799 Strömgren's colours are taken from Shuster and Nissen (1986) while its radial velocity from Uesugi and Fukuda (1982). ν_{ph} means photometric frequency.

Name	$(b\text{-}y)$	m_1	c_1	β	$v \sin i$	ν_{ph}
HD 224638	0.192	0.147	0.719	2.743	24	0.68, 0.81
HD 224945	0.198	0.154	0.690	2.726	60	0.70, 0.93
HD 164615	0.228	0.179	0.624	2.716	60	1.23
γ Dor	0.200	0.175	0.660	2.739	50	1.34
9 Aur	0.217	0.152	0.642	2.723	14	0.80, 0.32
HR 8799	0.188	0.137	0.689	2.742	45	1.95

a matter of discussion and beside non-radial g-mode pulsation also models taking into account spots and binarity have been proposed and developed. Some of the stars in the sample have been studied more thoroughly: HD 164615 (Abt et al., 1983), HD 224638 and HD 224945 (Mantegazza et al., 1994), 9 Aur (Krisciunas et al., 1993), γ Dor (Balona et al., 1994). The principal characteristics of these stars, to be compared with HR 8799 results, are briefly summarized in Table 1.

In order to locate HR 8799 in the Hertzsprung–Russell diagram we computed its absolute visual magnitude by means of Philip and Egret (1980) calibrations obtaining a value $M_V = 2.7$. As can be seen in Figure 2 our star lies in the same region where all of the new variables were found. Similar position in HR diagram and similar photometric behaviour make HR 8799 a possible candidate belonging to this type of variables.

A number of tools are at present being studied (Zerbi and Garrido, 1995) in order to achieve a better understanding of the behaviour of the whole sample and to select the most suitable between the proposed models. Such tools are based on comparison between colour and radial velocity curves that should present a different behaviour in the case of spots, binarity or pulsation. In addition frequencies close to an integer multiple of $1d^{-1}$, as that found in HR 8799 as well as in many other variables in the sample, suggest to avoid night/day cycle through a multisite campaign.

Any further observations should therefore be planned within a coordinated multisite campaign devoted to multicolor photometric observations and possibly with associated high resolution spectroscopy.

E. RODRIGUEZ[1]
F.M. ZERBI [1,2]

[1]– Instituto de Astrofísica de Andalucia, Apto 3004 E-18080 Granada, España

[2]– Dipartimento di Fisica Nucleare e Teorica, Universitá di Pavia, Via Bassi 6, I-27100 Pavia, Italia

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ONSET OF PULSATION OF V99 IN M15?

The variable V99 in the globular cluster M15 was discovered by Mannino on plates obtained in the years 1954-1955 in Asiago Observatory. From about 200 plates a period of 0.27995 day has been determined and light curve constructed. It is interesting to note that this newly discovered RRc variable had been chosen as comparison star by Bailey in his previous study (Bailey, 1919).

Notni and Oleak (1958) measured the brightness of this star on plates taken by Guthnick and Prager previously to Mannino's observations, in the years 1925 and 1933, in Potsdam–Babelsberg Observatory. On these plates light variation could not be detected.

Brightness measurements were carried out on the plate material of the Konkoly Observatory (1937-1991). The light curves folded on Mannino's period, including the Babelsberg material, show clear light variation only in the years 1956, 1957 and 1963.

As the plates were originally obtained to study period changes the temporal distribution of the data is inconvenient and a high level of noise inherent in the photographic method is present. Still existence of any definite periodic variation can be determined. A larger amount of plates were obtained in the years 1938, 1951 and 1990-91. Fourier analysis of the data for these years was performed.

In the Figures the light curves of the years 1937, 1954 (Mannino's data), 1956 and 1963 can be seen folded on Mannino's period and the amplitude spectra with their spectral windows from the years 1938, 1951, 1954 (Mannino) and 1990-91.

The Fourier analysis of the data of 1925 and 1937 does not show any frequency but noise. We reanalysed Mannino's (1956) observations and we could confirm that the period of the star in 1954 and 1955 given by Mannino was correct.

In 1938 a period of 0.28747 day and 0.1 magn amplitude was found. The period differs from the one given by Mannino by about 0.007 day. This would be far beyond the rate of period change typical for RRc stars. So it can be concluded that the deviating period and the small amplitude of the light curve might show the presence of a non radial pulsational component. In the year 1951 the spectrum shows noise with increased amplitude which would indicate scatter of the data exceeding observational error.

The light curve of 0.40 magn amplitude from 1954 and 1955 defined by Mannino is that of a typical RRc variable of radial mode pulsation. The same holds for the Budapest material from the years 1956 and 1963. From the seventies the limited number of the data shows only scatter slightly exceeding the photographic error. At any rate it suggests diminishing amplitude of any of the periods.

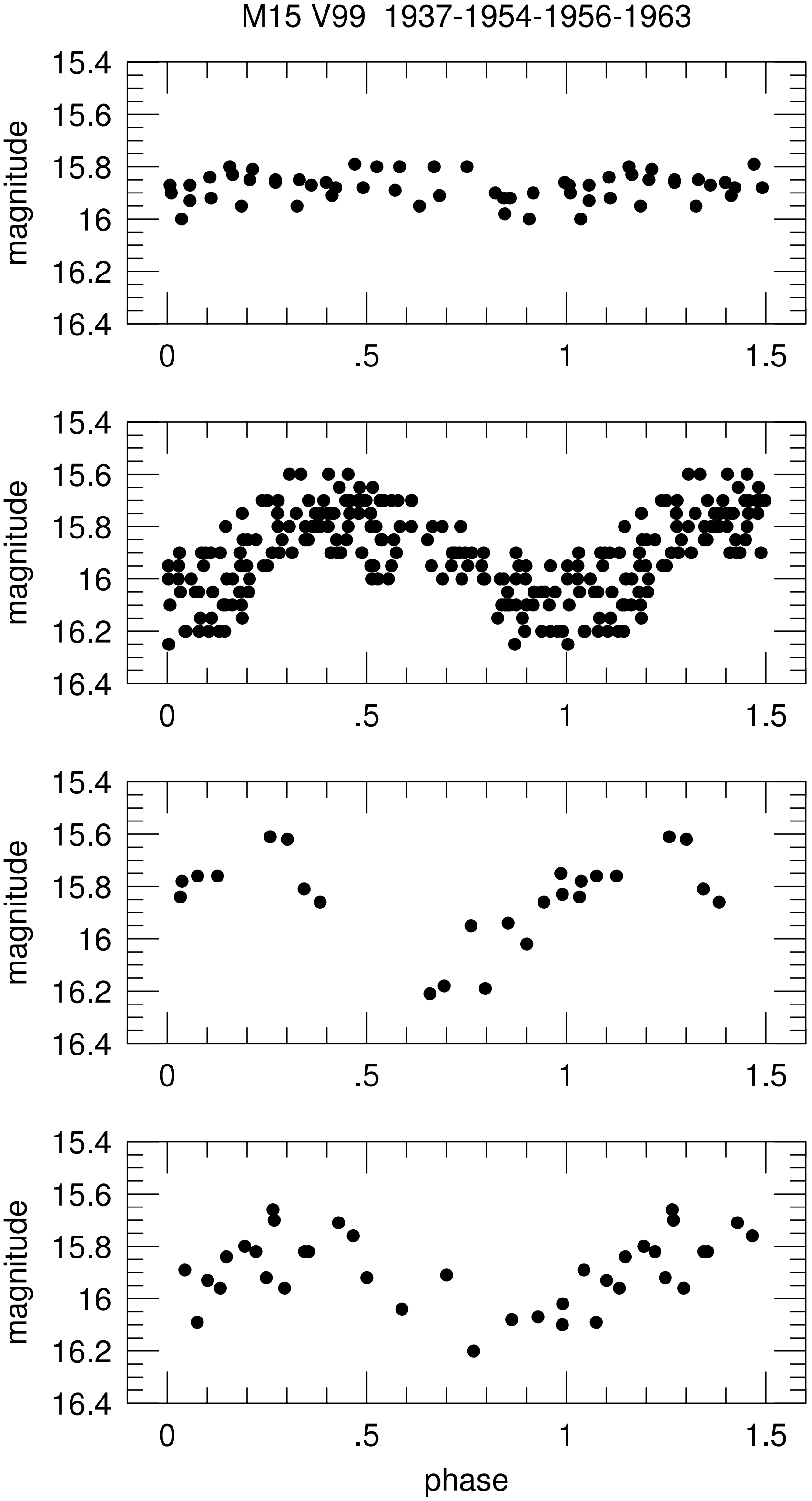

Figure 1. Light curves from Budapest observations in the years 1937, 1956 and 1963 folded on Mannino's period. The light curve from 1954 is based on Mannino's observations.

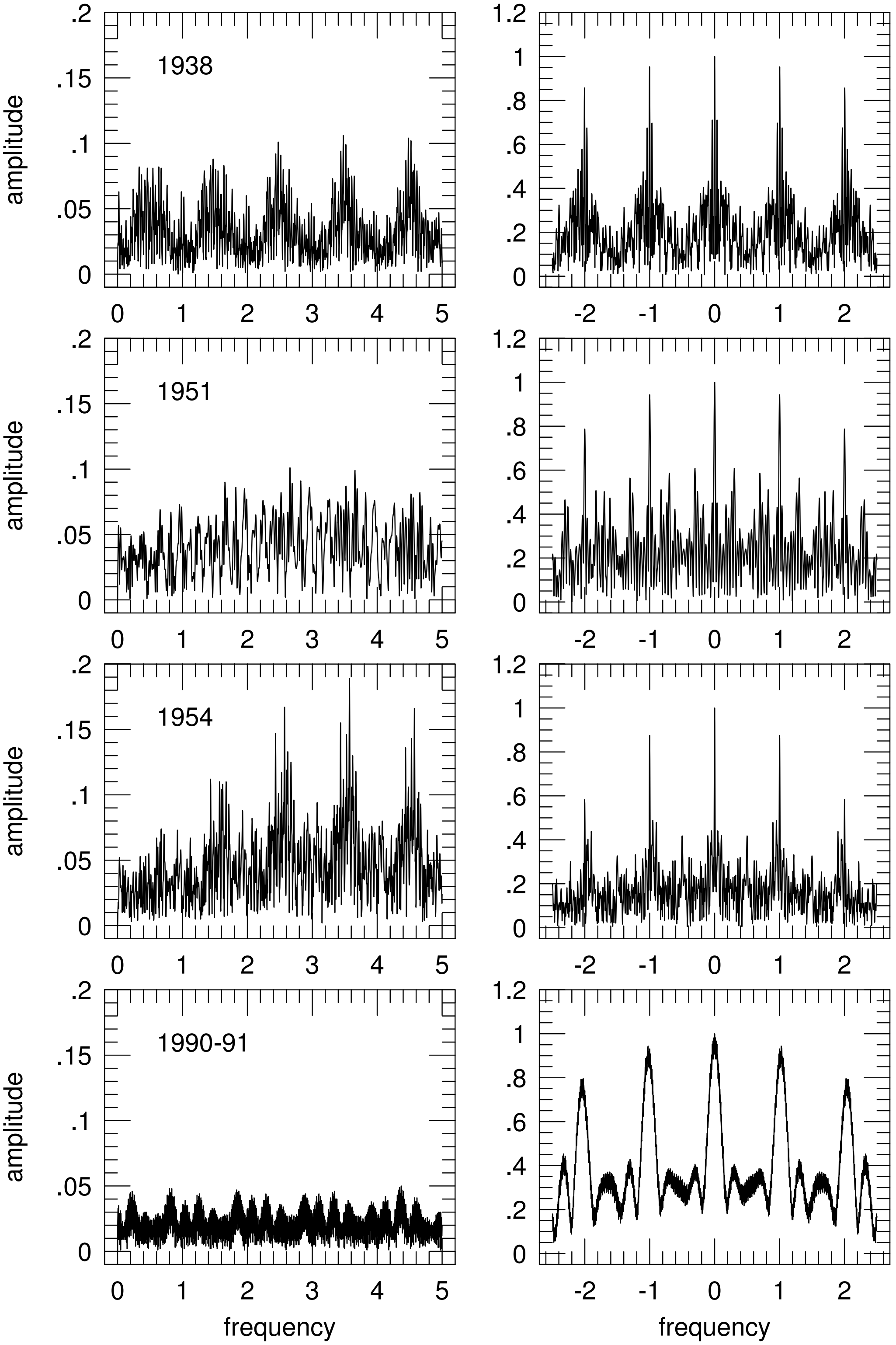

Figure 2. Amplitude spectra with their spectral windows from the years 1938, 1951, 1954 (from Mannino's data) and 1990-91.

In the years 1990 and 1991 the structure of the spectra in spite of the very low amplitude might indicate some oscillation inside the star.

Time and more accurate photometry can only solve the problem of this unique cluster member. It is suggested that the starting of pulsation has been caught.

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K. BARLAI and
B. SZEIDL
Konkoly Observatory, Budapest
Hungary

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NEW MINIMA TIMES AND PERIOD BEHAVIOUR FOR THE ECLIPSING VARIABLES RT ANDROMEDAE, 44i BOOTIS AND GO CYGNI

In the present report new photoelectric minima times of RT And, 44i Boo and GO Cyg are given as they were derived from our observations made either in Greece or in Romania.

The photoelectric observations of RT And and 44i Boo were made during 1989 and 1994, respectively with the two-beam, multi-mode, nebular-stellar photometer of the National Observatory of Athens, attached to the 48-inch Cassegrain reflector at the Kryonerion Astronomical Station. While those of GO Cyg were made during 1994 with an EMI 9502 B type photocell, attached to the 50 cm Cassegrain telescope of the Bucharest Observatory. The filters used in both cases are in close accordance with the standard UBV and the reduction of the observations has been made in the usual way (Hardie, 1962).

RT Andromedae

The short period variable RT And (BD +52°3383A, HD 218915) is a very interesting eclipsing binary with many peculiarities in its light curve. It is classified as an RS CVn-type system with both components to be main-sequence stars in contrast to the main group, which contains active sub-giant stars (Budding and Zeilik, 1987).

From our observations made during 1989, 5 new minima times were derived and given in Table I. The O−C diagram of the system based on all minima times found in the literature (614 points) is presented in Figure 1; a quadratic least squares fitting applied to all of them, improves Williamon's (1974) ephemeris formula to:

$$\text{Min I} = 2441141.6401 + 0\overset{d}{.}62893928 \times \text{E} - 1\overset{d}{.}16 \times 10^{-10} \times \text{E}^2$$

showing that its orbital period is decreasing.

A detailed analysis of the period variations of RT And has been recently made (Rovithis-Livaniou et al., 1994). Moreover our new 5 minima times together with the last photoelectric ones yield the following linear ephemeris:

$$\begin{aligned}\text{Min I} = 2447756.3385 &+ 0\overset{d}{.}628929355 \times \text{E} \\ \pm.0003 &\pm\ \ .000000010\end{aligned} \qquad (1)$$

which is proposed for the future observations of RT Andromedae.

Table I. Photoelectric Minima Times of RT And

Hel. JD 2440000+	$(O-C)_I$ days	$(O-C)_{II}$ days	$(O-C)_{III}$ days
7756.3385	−.0056	−.0022	.0000
7758.5390	−.0062	−.0029	+.0008
7759.4832	−.0054	−.0021	+.0001
7760.4256	−.0064	−.0031	−.0009
7763.5711	−.0052	−.0023	−.0001

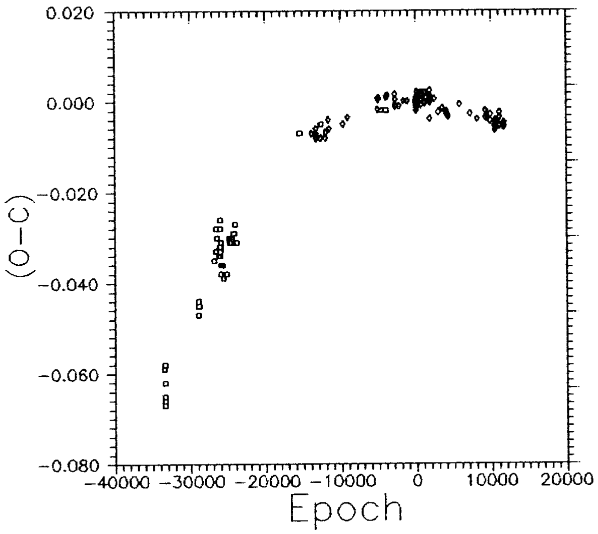

Figure 1. The O−C diagram of RT And based on 44 photographic (squares) and 84 photoelectric (diamonds) minima times. The C values have been calculated using Williamon's (1974) linear ephemeris.

In Table I the residuals $(O-C)_I$, $(O-C)_{II}$ and $(O-C)_{III}$ have been calculated according to Williamon's (1974) ephemeris formula:

$$\mathrm{Min\ I} = 2441141.8888 + 0\overset{d}{.}62892984 \times E$$

Kholopov's (1985):

$$\mathrm{Min\ I} = 2241141.88902 + 0\overset{d}{.}628929513\times E$$

and our new one, given by equation (1), respectively. They are the mean values of our B and V observations and have been computed using Kwee & Van Woerden's (1956) method.

44i Bootis

The eclipsing binary 44i Boo is the fainter companion (B+C) of the close visual binary ADS 9494. It is one of the mostly observed systems, since its light curves exhibit "active" and "quiet" periods and its period is variable (e.g. Bergeat et al., 1972; Rovithis et al., 1990; Oprescu et al., 1989 & 1991; Gherega et al., 1994).

From our recent photoelectric observations of 44i Boo, two new minima times have been found and given in Table II.

Table II. Photoelectric Minima Times of 44i Boo

Hel. JD 2440000+	Min	Fil.	$(O-C)_I$ days	$(O-C)_{II}$ days	$(O-C)_{III}$ days
9489.3479	I	V	0.0393	0.0028	−0.0173
9489.3490	I	B	0.0414	0.0039	−0.0162
9489.4832	II	V	0.0407	0.0042	−0.0159
9489.4825	II	B	0.0400	0.0035	−0.0166

In Table II the residuals $(O-C)_I$, $(O-C)_{II}$ and $(O-C)_{III}$ have been calculated using Kwee & Van Woerden's method (1956) and according to the following ephemeris formulae:

$$\mathrm{Min\ I} = 2439852.4903 + 0\overset{d}{.}2678159 \times E$$

(Duerbeck, 1975)

$$\text{Min I} = 2439852.4644 + 0\overset{\mathrm{d}}{.}2678176 \times \text{E}$$

(Rovithis et al., 1990)

and

$$\text{Min I} = 2443604.5880 + 0\overset{\mathrm{d}}{.}26781856 \times \text{E}$$

(Oprescu et al., 1991)

They fit pretty well the last (O−C) diagram for 44i Bootis (Gherega et al., 1994) – based on Oprescu's et al. (1991) ephemeris formula – showing that the period of the system continues to increase.

GO Cygni

The eclipsing binary GO Cyg (BD +34°4095) has been observed photoelectrically many times after its discovery and many minima times can been found in the literature from which its period was found to be variable (e.g. Purgathofer and Prochazka, 1967; Sezer et al. 1985, Hall and Louth, 1990).

From our recent observations of GO Cyg three new minima times were derived and are presented in Table III.

Table III. Photoelectric Minima Times of GO Cyg

Hel. JD 2440000+	Min	Fil.	$(\text{O}-\text{C})_I$ days	$(\text{O}-\text{C})_{II}$ days	$(\text{O}-\text{C})_{III}$ days
9605.34526	II	B	0.0546	0.0143	0.0377
9605.34585	II	V	0.0552	0.0149	0.0383
9623.29007	II	V	0.0555	0.0149	0.0386

In Table III the residuals $(\text{O}-\text{C})_I$, $(\text{O}-\text{C})_{II}$ and $(\text{O}-\text{C})_{III}$ have been calculated using Kwee & Van Woerden's method (1956) and according to formulae:

$$\text{Min I} = 2433930.40561 + 0\overset{\mathrm{d}}{.}71776382 \times \text{E}$$

(Kholopov, 1985)

$$\text{Min I} = 2445865.4056 + 0\overset{\mathrm{d}}{.}71776707 \times \text{E}$$

(Sezer et al., 1985)

and

$$\text{Min I} = 2446351.328 + 0\overset{\mathrm{d}}{.}7177632 \times \text{E}$$

(SAC, 1989)

The newly observed minima times are in accordance with the O−C diagram of GO Cyg (Sezer et al., 1985) showing that the period of the system continues increasing. A detailed analysis of the period variations of GO Cyg – based on the new method developed by Kalimeris et al., (1994) – will be done later.

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H. ROVITHIS-LIVANIOU
P. ROVITHIS
Section of Astrophysics
Astronomy & Mechanics
Dept. of Physics
Athens University
157 84 Zografos
Greece

G. OPRESCU
A. DUMITRESCU
Astronomical Institute
Academia Romana
Street Cutitul d'Argint 5
75212 Bucharest 28
Romania

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OPTICAL MONITORING OF TWO X-RAY TRANSIENT SOURCES

1. The X-ray transient pulsar GRO 1008-57

The hard x-ray transient pulsar was detected in 1993 at the 1950.0 position RA = $10^{\rm h}08^{\rm m}02\overset{\rm s}{.}43$ and $\delta = -\ 58°02'45\overset{''}{.}2$ (Stollberg et al., 1993, Tanaka 1993).

To analyse its long-time behaviour and/or possible low energy emission, we have investigated the position of GRO 1008-57 on archival patrol plates from the collections of the Sonneberg and Bamberg Observatories. Altogether 218 Sonneberg patrol plates reaching the limiting magnitudes of 12-13 and taken in the years 1935-1953 as well as 125 Bamberg patrol plates reaching limiting magnitudes 13-15 and taken during the time interval 1964-1976, i.e. total of 343 plates representing $\sim$ 310 hrs of exposure have been analysed. No optical activity has been detected from the position of the X-ray pulsar with the above mentioned threshold.

We conclude that the optical emission of the transient pulsar is either an infrequent phenomenon and/or does not reach the limiting magnitudes on corresponding plates.

2. The X-ray Nova GRS 1716-249 = GROJ 1719-24

The X-ray nova in Ophiuchus was detected in 1993 (Ballet et al., 1993) with a radio and optical counterpart exhibiting brightening from 21 to 17.1 mag. (Mirabel et al., 1993). The position of the radio and optical counterpart has been measured as follows (Mirabel et al., 1993) : RA = $17^{\rm h}16^{\rm m}32\overset{\rm s}{.}52$, $\delta = -24°58'01\overset{''}{.}1$ (1950.0).

We have analysed this position on archival plates from the collections of the Leiden, Sonneberg and Bamberg Observatories in order to see whether or not this is a repeating phenomenon. We have analysed 552 archival patrol plates from the Sonneberg collection (reaching typical limiting magnitudes of 11 to 13), taken during the time period from 1929 to 1964, 226 Franklin Adams archival plates from the Leiden Observatory collection with typical limiting magnitudes 15.5 - 16.0 taken during the time period 1930-1950 and 146 archival plates taken at the southern stations of the Bamberg Observatory with typical limiting magnitudes of 13 to 15 taken in the years 1963 to 1969, i.e. total of 924 plates representing $\sim$ 720 hrs of exposure. We have not found any sign of optical activity from this position exceeding the corresponding magnitude limit. We conclude that either the object was optically inactive in the time intervals covered by the plates or that the possible brightenings were below the plate threshold.

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R. HUDEC
Astronomical Institute
Academy of Sciences of
the Czech Rep.
CZ–251 65 Ondřejov
Czech Republic

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OBSERVATION OF A $V = R$ TRANSITION IN THE Be STAR 66 Oph[1]

As part of our long-term high resolution spectroscopic monitoring programme of Be stars, we have repeatedly observed the interesting equatorial Be star 66 Oph = HR 6712 (B2 IV-Ve, $v \sin i = 240$ km s^{-1}). During the past two decades, its Hα emission strength has been observed to steadily increase from $F_\alpha = 3F_c$ in 1973 (Gray & Marlborough 1974) to 8–10F_c in 1992–1994 (see Table 1). This latter value corresponds to equivalent width $W_\alpha \approx 50 - 60$Å, thus presently making 66 Oph one of the brightest Be stars at Hα.

We have mainly investigated the Hα and the Fe II λ5317 emission lines. Our data cover the epoch 1989–1994 and have been measured at ESO 1.4m Coudé Auxiliary Telescope (observers: Hanuschik, Hummel), at the 2.2m telescope at the German-Spanish Observatory DSAZ on Calar Alto/Spain (observers: Hummel, Vrancken), and at the 2.0m Ondřejov telescope (observer: Štefl). Resolution $R = \lambda/\Delta\lambda$ has been around 50 000, except for the Ondřejov data (15 000). The signal-to-noise ratio is usually several hundred except for some of the Fe II profiles shown here. Profile parameters are collected in Table 1.

Our profile survey in Fig. 1 demonstrates that in 1989–April 1993, and since June 1994 again, 66 Oph has shown asymmetric single or double-peak profiles at Hα, and extremely asymmetric, so-called steeple profiles in Fe II. Especially striking is the inversion of asymmetry from $V > R$ (in 1989) to $R > V$ (1992) back to $V > R$ (1994).

The steeple-type Fe II profile shape and the cyclic V/R asymmetry are two connected phenomena, both being produced by a large-scale density inhomogeneity. This structure is likely to be a *global density wave*, slowly precessing under the influence of the centrifugally flattened B star (Hanuschik et al. 1995).

In 1988, 66 Oph showed a sudden onset of cyclic V/R variability, after at least 15 years of symmetric double-peak structure ($V \approx R$). Its present full V/R cycle time is only 5 years, rather short if compared to other such Be stars which have typical cycle duration of about 10 years. With this cycle time, the first $V = R$ transition must have occurred in early-1991, but escaped detection. In 1993, we have been fortunate enough to observe the second $V = R$ transition, both in Hα and Fe II (see Fig. 2). This transition occurred in November 1993 and appears to have lasted only a few months, as a comparison of our data from September 1993 (Hα: $R > V$), November 1993 ($R = V$), and June 1994 ($V > R$) clearly shows.

The transition appears quite smooth, with a gradual decrease in asymmetry in 1993 from April over September to November, and a new increase, with opposite sign, to 1994 August. The overall time of observed $V = R$ shape is only a few months, a small fraction of the full cycle time. Such temporal behaviour agrees well with the expectation that the slope of the V/R evolution is sinusoidal, with much longer periods of V/R asymmetry than with $V = R$.

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[1] Based on observations obtained at the European Southern Observatory, La Silla, Chile; at the German-Spanish Observatory DSAZ, Calar Alto, Spain; and at the Ondřejov Observatory, Czech Rep.

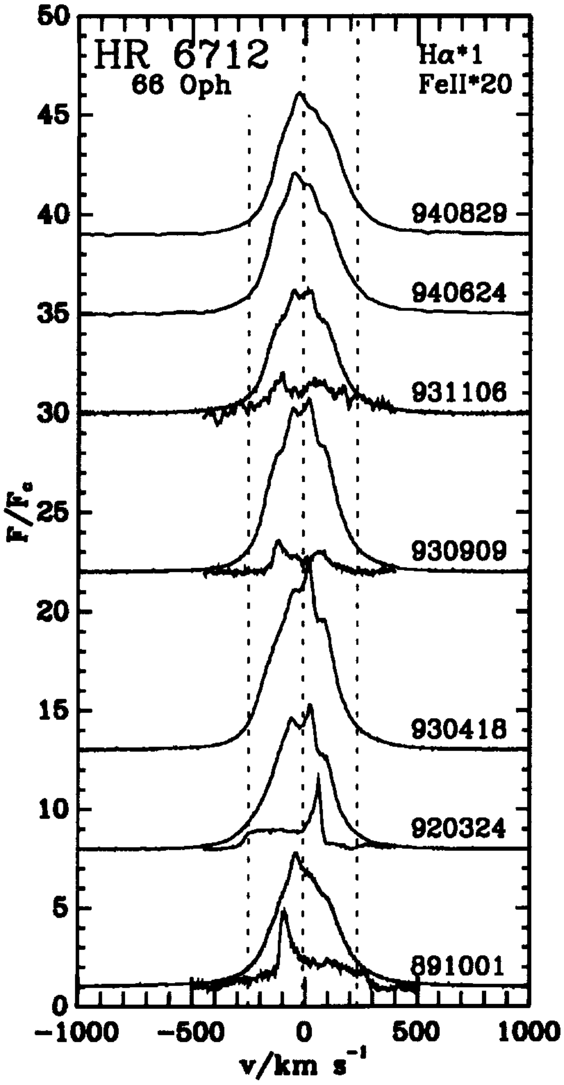

Figure 1. Hα and Fe II emission line profiles in 66 Oph (left), both on a common heliocentric velocity scale. The flux scale of the Fe II lines is expanded by a factor of 20.

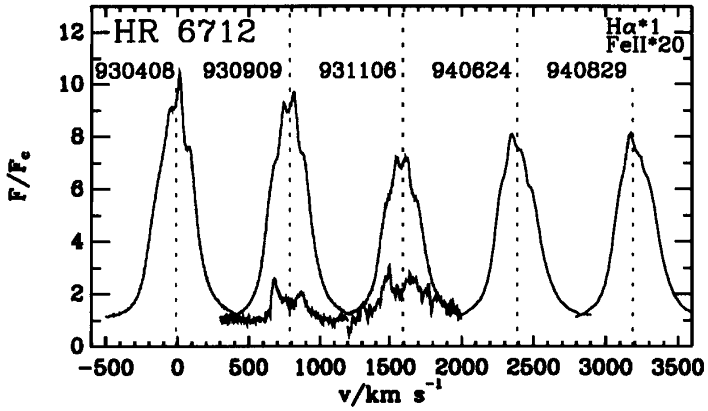

Figure 2: Comparison of the 1993 and 1994 profiles of 66 Oph, demonstrating the $V < R \rightarrow V > R$ transition in November 1993.

Table 1. Line parameters for Hα and Fe II

Date[a]	Hα			Fe II λ5317		
	W_λ/Å	V/R[b]	F_p/F_c[c]	W_λ/mÅ	V/R	F_p/F_c
891001	45.9	> 1	7.78	680	3.78	1.189
920324	46.6	0.911	7.95	391	0.241	1.174
930418	59.7	0.852	9.80			
930909	59.1	0.944	9.47	227	1.59	1.063
931106	44.6	1.00	7.16	500:	≈ 1	1.09:
940624[d]	50.5	1.10	7.82			
940706	49.8	1.11	7.73			
940803[e]	48.7	1.14	7.76			
940815	49.5	1.14	7.64			
940829	49.9	1.15	7.66			

[a] 891001 = 1989 October 1

[b] $V/R = [F(V) - F_c]/[F(R) - F_c]$

[c] average intensity if two peaks exist

[d] averaged from 7 measurements on June 23, 24, and 25

[e] averaged from 3 measurements

An interesting observation is that shortly before the $V = R$ transition, Hα and Fe II profiles showed slightly opposite V/R behaviour: in September 1993, $V < R$ in Hα, $V > R$ in Fe II. This may be partly due to the fact that in a certain critical parameter range, the superposition of different line broadening mechanisms (causing the winebottle-type inflections and the profile peaks) causes slightly inverse V/R ratios in Hα and the Fe II line. Alternatively, this may be indicative of a certain time lag between the $V = R$ transition in both lines due to very different optical depth and therefore different contributing disk regions. Thus these measurements contain valuable information for the modelling of the density wave.

A very pronounced decrease in equivalent width occurred in November 1993 (by 25 %), after the star had shown a stable value of 59 Å for almost half a year before. Half a year later, W_α was again observed at higher values, remaining constant thereafter for at least two months. Such rather strong variability seems to be uncommon in this star. However, we are not fully sure that the sudden decrease is not a mere chance coincidence. If it is physically related to the $V = R$ transition, then this observation may be interpreted as result of the relatively small velocity gradient (averaged across the whole emitting disk) at the moment of symmetry ($V = R$), as compared to the situation shortly before and after the transition when the velocity gradient becomes larger again.

We strongly encourage other observers to continue to monitor this interesting Be star at high spectral resolution, in order to follow up its V/R behaviour and to furthermore document its emission strength variability pattern.

R.W. HANUSCHIK[1],
S. ŠTEFL[2],
W. HUMMEL[3],
M. VRANCKEN[3]

[1] Astronomisches Institut, Ruhr-Universität, Postfach 10 21 48, D-44780 Bochum, Germany
[2] Astronomical Institute, Czech Acad. of Sciences, CZ-251 65 Ondřejov, Czech Republic
[3] Astrofysisch Instituut, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussel, Belgium

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PHOTOMETRIC EXAMINATION OF CP2-PECULIARITY FOR HD 200405, HR 44, HR 7752 and HR 9092

In the course of a programme aimed at checking spectroscopic peculiarity assignments of chemically peculiar stars on the upper main sequence belonging to group CP2 (in older terms: the α^2 CVn variables) we have chosen the above stars for 3 runs at the L. Figl Observatory (Univ. of Vienna) on the summit of Schöpfl using its 60cm photometric telescope equipped with a classical one-channel photoelectric photometer (photomultiplier: EMI 9844A, Peltier-cooled). Observer was AS.

The filter system employed is that of Δa (Maitzen, 1976) which has been shown to identify CP2 stars as effectively as classification spectroscopy (Maitzen and Vogt, 1983). Details on the filters $g1$ and $g2$ were given in Maitzen and Floquet (1981), the third filter is a conventional Ströemgren system filter y.

Measurements for this programme were obtained on August 5/6, August 9/10 and October 15/16, 1994. 10 stars were chosen to define the normality line of the index $a(= g2 - (g1 + y)/2)$ versus the colour index $b - y$, the deviation of which has been defined as Δa-value. A measurement series for a programme star consisted of 8-12 repeats of the sequence $g1, g2, y$ each covering 15 seconds of integration. The resulting mean error for the HR-stars was 2-3 millimags in a, and 3-4 millimags in $g1 - y$. Only for the relatively faint HD 200405 the error was 3-4 millimags in a and 4-5 millimags in $g1 - y$.

We have taken the $b - y$-values from Hauck and Mermilliod (1990), but no such value seems to have been published for the peculiarity candidate HD 200405. Since a very good correlation between $b - y$ and the colour difference $g1 - y$ had been found on previous occasions, we made use of it also in the present case. Fig. 1 shows this correlation with a slope of 0.51.

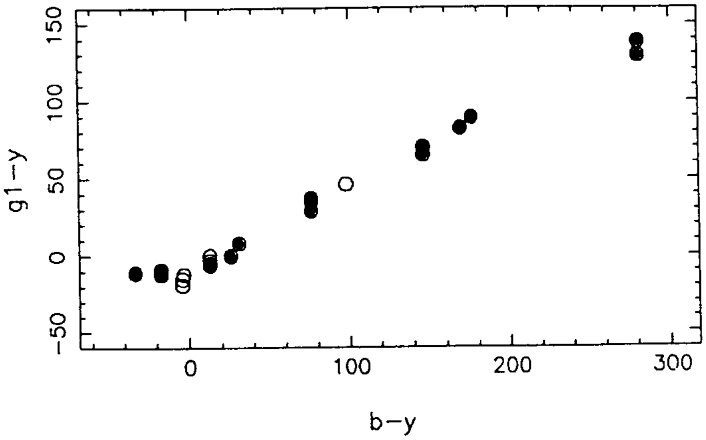

Figure 1. Correlation between $g1 - y$ and $b - y$ (both in mmags). Candidates for peculiarity are represented by open circles.

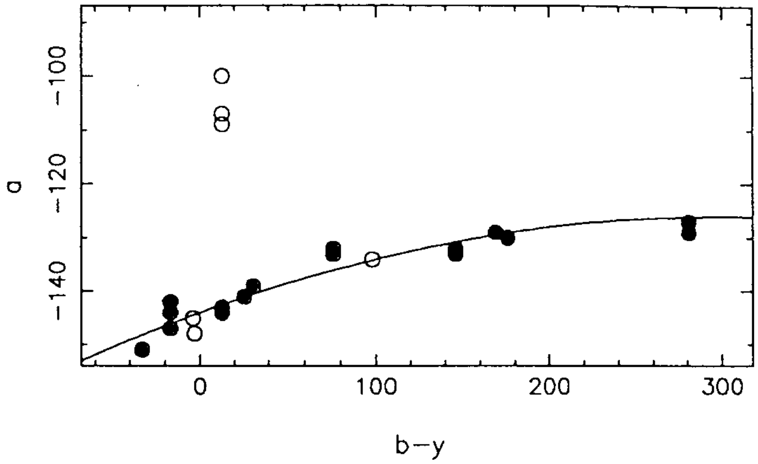

Figure 2. Peculiarity index a vs. $b-y$ (both in mmags). Open circles are for measurements of CP2 candidates. Full line is the locus of normal stars.

From this correlation a value $b - y = 0.013$ can be inferred for HD 200405. Even considering an error of 0.020 mag of this value, this will only very marginally influence the resulting Δa-value. The relationship a vs. $b-y$ is displayed in Fig. 2. A regression curve yields

$$a = -144 + 0.12(b-y) - 0.0002(b-y)^2$$

with a scatter of only 2.28 millimags for the normal stars. Table 1 gives the results of our Δa-system measurements individually for the 3 nights, expressed in millimags.

RESULTS AND DISCUSSION:

1. HD 200405 = Renson (1991) Catalogue (=RE) 55830.

North (1994) has shown that this binary has the shortest orbital period (1.63 days) known among those which host a CP2 star. Although he reports a $\Delta(V1-G) = 0.021$ indicating a CP2 star photometrically, North (private communication) asked for an independent confirmation of this result. Without any doubt we can give this confirmation based on our photometry:
our Δa-values (36, 43, 34 millimags, obtained on JD 2449/570.513,574.553,641.374, resp.) classify the pertaining component as medium strong peculiar star with a slight indication that it may be variable. Variability should not be very pronounced according to the orbital analysis of North (1994) since the star seems to be seen nearly pole-on. Future observations may help to get more insight into this very special example of a binary containing a CP2-star whose characteristics are obviously preserved despite the important tidal forces exerted by the nearby companion (North, 1994).

2. HR 44 = RE 150

Cowley et al. (1969) have classified this star A1V Si:. This prompted Floquet (1975) to reobserve this object and she derived A0III for this star. Our Δa-result (obtained on JD 2449641.434) is in agreement with a non-peculiar star.

3. HR 7752 = RE 53850

Osawa (1959) classified this star B9.5Vp with the remark that the K-line is as strong as in A1 and that He I 4026 is visible. Floquet (1970), however, classifies this object as normal A0V star which is in agreement with our completely normal Δa-values (obtained on JD 2449/570.398 and 574.395).

Table 1. Δa-photometry

Object	$b-y$	a			Δa			$g1-y$		
HD 200405	13	−107	−100	−110	36	43	34	−3	−5	0
HR 44	−3			−148			−4			−12
HR 7752	−4	−145	−145		−1	−1		−19	−15	
HR 9092	98			−134			0			46
HR 68	26			−141			0			0
HR 70	−33			−151			−3			−11
HR 114	169			−129			0			82
HR 7253	176		−130			−1			89	
HR 7453	146	−133	−132		−2	−1		70	65	
HR 7756	281	−127	−129		−1	−3		129	138	
HR 7769	13	−144	−143		−2	−1		−6	−5	
HR 7792	−17	−142	−147	−144	4	−1	2	−9	−12	−12
HR 7826	31		−139			2			8	
HR 8463	76	−133	−132	−133	3	4	3	37	29	35

4. HR 9092 = HD 224995

Contrary to the preceding three stars this object is not contained in the Renson catalogue of Ap and Am stars. It has been included in our programme because Δa-photometry of Vogt et al. (1995) exhibited a marginally peculiar value (0.015 mags).

Except for the observation of Hauck (1986) that HR 9092 is one of 22 stars classified as dwarfs in the Bright Star Catalogue, but which have the same Geneva colours as giants, this star does not show a peculiar behaviour, and lacks CP2 characteristics. Our photometric value has been obtained on JD 2449641.418.

As a summary we arrive at the conclusion that only HD 200405 is photometrically a CP2-star. Because of its special nature as member of a close binary system it deserves further observations. The other three stars are normal in our photometry.

This research has made use of the Simbad database, operated at CDS, Strasbourg, France.

A. SCHNELL
H. M. MAITZEN
Institut für Astronomie
Universität Wien
Türkenschanzstr. 17, A-1180 Wien
maitzen@astro.ast.univie.ac.at

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PHOTOMETRIC VARIABILITY OF THE ELLIPSOIDAL STAR AND SPECTROSCOPIC BINARY 7 CAMELOPARDALIS

For several years we have used 7 Cam (= BS 1568, HD 31278, ADS 3536; Sp = A1V, but see below; V = 4.47) as our principal check star for differential photometry of 9 Aurigae, with BS 1561 (Sp = A2V; V = 5.78) as the comparison star. Recently, over the course of a seven-night photometric run at Mauna Kea we noticed that the nightly means of 7 Cam vs. BS 1561 were the same only every other night. So we added a second check star, BS 1668 (Sp = F5V, V = 5.68), to the observing sequence. Photometry of the second check star, with respect to BS 1561, showed it to be constant to within the observational errors. A power spectrum of the recent 7 Cam vs. BS 1561 data indicated a period just under two days, but we suspected that it was just an alias of data taken primarily at a single site. However, a footnote in the *Bright Star Catalogue* indicated that 7 Cam is a known spectroscopic binary with a period of 3.88 days. It occurred to us that 7 Cam could be an ellipsoidal variable star with a photometric period equal to half the orbital period.

A SIMBAD search pointed us to a paper in which Lucy and Sweeney (1971) recomputed, under the assumption that the orbit is exactly circular, the orbit determined by Harper (1911) on the basis of Ottawa and Lick radial velocities. It is not clear from their paper whether Lucy and Sweeney took into account the additional velocities measured at the Dominion Astrophysical Observatory and used by Harper (1934) to refine the orbital period. The exact period, and its uncertainty (which Lucy and Sweeney did not give), are of particular interest to us, as they enable us to extrapolate to the present day the spectroscopic phase of the system for comparison with the photometric phase. We therefore recomputed the orbit ourselves from the Lick, Ottawa, and Dominion Astrophysical Observatory radial velocities. We know of no others of comparable precision. An empirical adjustment was made to the zero-point of the Lick data, and the three sources were weighted so as to equalize the variances of their residuals. The solution is:

$P = 3.884505 \pm 0.000033$ days
$T_0 =$ JD 2418636.210 ± 0.011
$V_0 = -9.2 \pm 0.5$ km sec^{-1} (γ velocity)
$K = 35.4 \pm 0.7$ km sec^{-1}
$e = 0$
$a_1 \sin i = 1.89 \pm 0.04 \times 10^9$ m
$f(m) = 0.0179 \pm 0.010\ M_\odot$

Here T_0 is the epoch of maximum velocity (when the component we see is receding from us). $a_1 \sin i$ is the true radius of the orbit of the primary about the center of mass, projected in the line of sight. f(m) is the mass function.

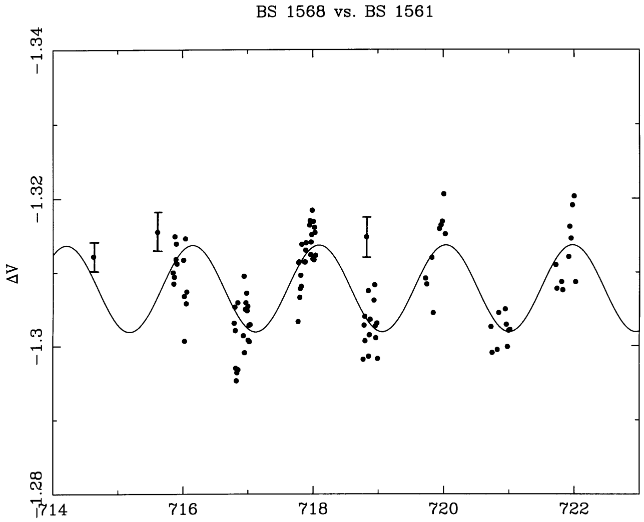

Figure 1 – Differential photometry of 7 Cam (BS 1568) vs. BS 1561. The three points with error bars are nightly means of data by Luedeke. The rest are individual differential magnitudes obtained at Mauna Kea.

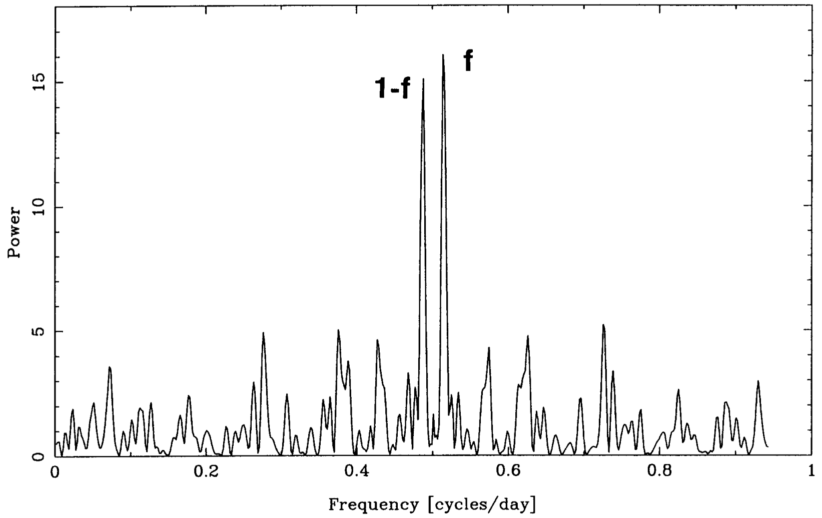

Figure 2 – Power Spectrum of data obtained by Guinan and McCook in 1989/90. The frequency f = 0.51487 and its one-day alias are indicated.

In Figure 1 we give the data recently obtained, also showing the least-squares sinusoid fit to the data obtained at Mauna Kea, with a period equal to half of the spectroscopic period. The derived photometric amplitude is 5.9 ± 0.9 mmag. If we adopt an epoch of HJD 2449000, the derived phase of minimum light is −.2238 ± 0.0263, where the negative phase means that the photometric minimum occurs slightly *after* the given epoch. The goodness of fit is ± 3.8 mmag for a single observation.

Do previous data confirm the variability? The best set to use was obtained over a 136-day period in 1989/90 by Guinan and McCook with the Phoenix-10 APT at Mt. Hopkins, Arizona. These data can be obtained from Archives of IAU Commission 27 as file 218 of unpublished photometry (see Krisciunas and Guinan 1990). In Figure 2 we show the power spectrum of the V-band data from five years ago. The least-squares phase of the

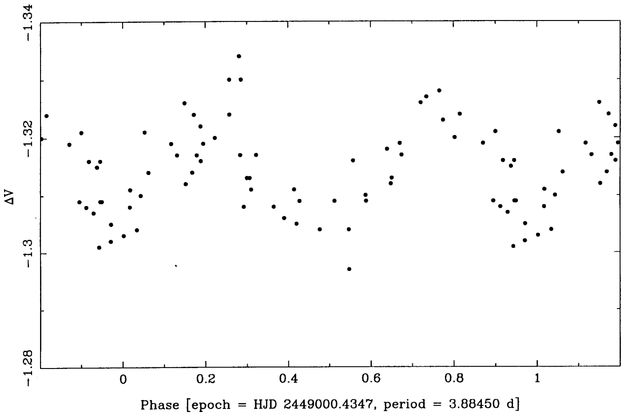

Figure 3 – Data by Guinan and McCook from 1989/90, phased with ephemeris derived from the 1994/5 data. The mean value of ΔV = –1.3145 ± 0.0010 is slightly brighter than the mean value obtained from the more recent photometry obtained at Mauna Kea, ΔV = –1.3078 ± 0.0006.

1989/90 data, from an epoch of 2449000, is –.2010 ± 0.0204, within the errors equal to the phase of the 1994/5 data. In Figure 3 we show the 1989/90 data phased with the ephemeris derived from the most recent data, but folded with the full orbital period, just in case one side of the primary appears differently than the other. One can see graphically that the ephemeris has not changed. The photometric amplitude derived from the 1989/90 V-band data is 7.8 ± 1.0 mmag, with a goodness of fit of ± 5.6 mmag for a single observation. B-band and U-band data taken in 1989/90 yield amplitudes of 6.6 ± 1.3 and 7.6 ± 1.2 mmag, respectively.

A tentative piece of confirming evidence, that we are seeing the larger projected area of an ellipsoidal star every half orbit, comes from the orbital determination. We should see the minimum light, when either of the visible star's smaller sides is facing us, when the orbital phase is .25 or .75. Between the spectroscopically derived epoch of maximum velocity, and an epoch of minimum light of HJD 2449000.4347, the difference in time divided by Griffin's orbital period gives 7816.755 ± 0.068 orbits. Since the fractional part of this number is close to .75, it is entirely consistent with the notion that the visible component of 7 Cam is tidally distorted by a less massive, unseen component. This could be greatly reinforced by a new spectroscopic determination of the orbital phase.

It is likely that the published luminosity class of 7 Cam is wrong. It may be a subgiant, not a main sequence star. Given the mass function, an assumed mass of 2.2 $M_\odot$ for the primary and a range of masses for the secondary, we attempted to model the ellipsoidal nature of the primary and found that there is no solution if the primary is the size of a main sequence early A-type star ($R \approx 1.8 R_\odot$). However, if the primary has $R > 3.0 R_\odot$, a photometric range of ± 6–7 mmag can be obtained. Given the primary's projected rotational rate of 45 km sec^{-1}, if $R > 3.45 R_\odot$ the rotational period could equal the orbital period. This tidal locking is not unexpected. If $\sin i \approx 1$ (expected for a photometrically variable ellipsoidal star), the mass of the secondary is ≈ 0.5 $M_\odot$.

Roman (1949) includes 7 Cam in her list of probable members of the Ursa Major stream. There is a problem with this. The age of the UMa cluster is about 2–3 × 10^8 years (Wielen 1978; Soderblom 1990). A 2.2 $M_\odot$ star such as 7 Cam would have a main sequence lifetime an order of magnitude longer than this. If 7 Cam is indeed a subgiant, it is much too old to be a member of the UMa stream.

We note that the secondary we have been discussing is *not* the $m_v = 7.9$ companion discovered by Dembowski, listed by Aitken (1932), and more recently observed at $\rho = 0\farcs483$ by McAlister *et al.* (1989) via speckle observations. 7 Cam also has an $m_v = 11.3$ companion at $\rho = 26''$.

The HIPPARCOS parallax, when it becomes available, will allow many of parameters of this system to be more accurately determined.

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K. KRISCIUNAS
Joint Astronomy Centre,
660 N. A'ohōkū Place,
University Park, Hilo,
Hawaii 96720, USA
[kevin@jach.hawaii.edu]

E. F. GUINAN
G. P. McCOOK
Villanova University,
Department of Astronomy,
Villanova, Pennsylvania 19085, USA

R. F. GRIFFIN
The Observatories, Madingley Road,
Cambridge CB3 0HA, UK

R. A. CROWE
M. ROBERTS
Department of Physics
and Astronomy,
University of Hawaii at Hilo,
200 West Kawili Street, Hilo,
Hawaii 96720, USA

K. D. LUEDEKE
9624 Giddings Avenue NE,
Albuquerque, New Mexico 87109, USA

P. POBOCIK
P. O. Box 1189, Keaau,
Hawaii 96749, USA

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COMPLETE CCD U,B,V,R,I LIGHT CURVES OF THE SHORT PERIOD ECLIPSING BINARY: V361 LYRAE

The 14th magnitude variable, V361 Lyrae, was discovered by Hoffmeister (1966) who classified it as an RR Lyrae-type star but gave no period. No further work was done for almost two decades until Galkina and Shugarov (1985) conducted a photographic study which indicated that V361 Lyr is actually a Beta Lyrae type eclipsing binary with an orbital period of about 7.5 hours. Andronov and Richter (1987) confirmed this conclusion while also noting an unusual difference between the heights of the maxima. They suggested that V361 Lyr is a semi-detached system undergoing vigorous mass transfer as evidenced by a hot spot on the mass accreting component. Kaluzny (1990) presented 1988 V, I photoelectric light curves and gave U,B,V standard magnitudes for some particular phases. He listed three times of minimum light and estimated the components to be of early K spectral type. Later, he (Kaluzny, 1991) published 1989 photoelectric V, I light curves as well as one primary epoch of minimum light. Shugarov et al. (1990) presented photoelectric U,B,V light curves accumulated over four observing seasons (1986-1989) listing standard magnitudes at key phases. They suggested that the secondary is accreting matter and give estimates of K1 V and K4 V for the primary and secondary components, respectively. Nations et al. (1994) indicated that they have B, V, R, I light curves and some preliminary models.

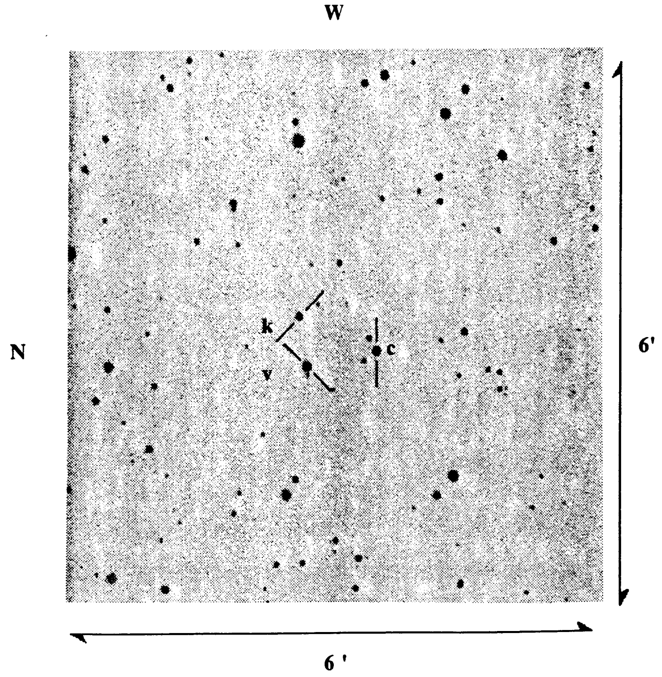

Figure 1

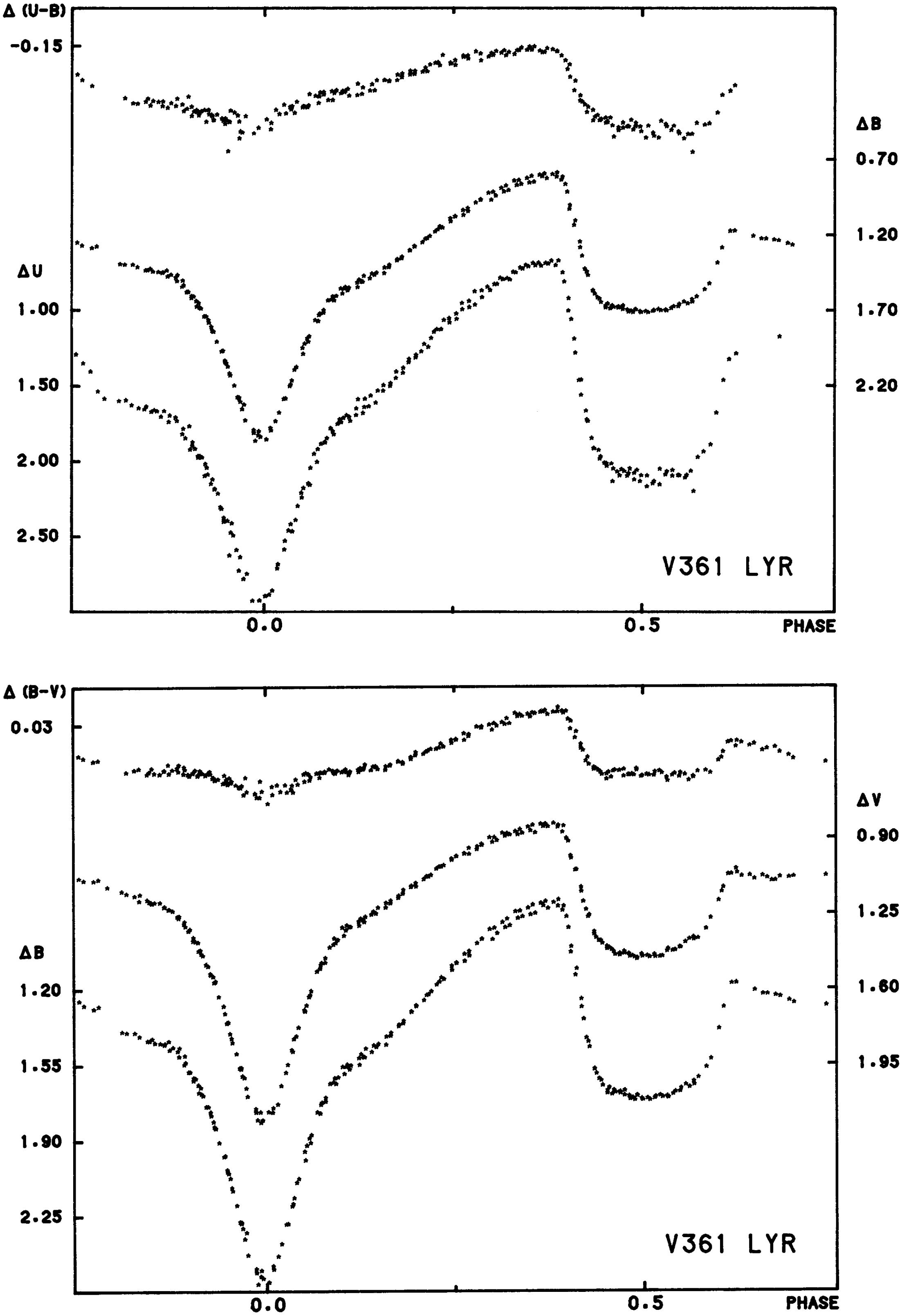
Δ (U-B)
-0.15
ΔB
0.70
1.20
1.70
2.20
ΔU
1.00
1.50
2.00
2.50
V361 LYR
0.0
0.5
PHASE
Δ (B-V)
0.03
ΔV
0.90
1.25
1.60
1.95
ΔB
1.20
1.55
1.90
2.25
V361 LYR
0.0
0.5
PHASE

Figure 2

Table 1

Star	RA(2000)	DEC(2000)
V361 Lyrae	$19^{\mathrm{h}}02^{\mathrm{m}}27^{\mathrm{s}}$	46°58’59”
Comparison	$19^{\mathrm{h}}02^{\mathrm{m}}16^{\mathrm{s}}$	46°57’43”
Check	$19^{\mathrm{h}}02^{\mathrm{m}}15^{\mathrm{s}}$	46°58’30”

Table 2

JD Hel. 2400000+	Cycles	$(\mathrm{O}-C)_1$	$(\mathrm{O}-\mathrm{C})_2$
49163.8090(1)	0.0	0.0002	0.0001
49164.7381(3)	3.0	0.0000	−0.0001
49165.9762(6)	7.0	−0.0003	−0.0002
49168.7630(2)	16.0	0.0000	0.0001

Our present U, B, V, R, I CCD light curves of V361 Lyrae were obtained as part of our ongoing study of compact solar-type eclipsing binaries. The observations were made on 1993, June 23-25, inclusive, and 29-30 at Kitt Peak National Observatory (KPNO), Arizona. A Tektronix Te2K chip and CCD camera system was used in conjunction with the 0.9-m reflector. Between 225 and 250 observations were made in each passband.

A CCD image of the field is shown in Figure 1. The variable, comparison, and check stars are designated as v, c, and k, respectively with coordinates of each given in Table 1.

Four new precise epochs of minimum light were determined from the observations made during primary eclipses. Several secondary were also calculated but were later removed from our period analysis due to severe distortions in the light curve around the secondary eclipse (0.5 phase). The bisection of chords technique was used to determine all epochs of minimum light. These new primary minima are listed in Table 2. In Table 2 and throughout the paper, values are accompanied by their probable errors in parentheses.

The recent epochs of photoelectric and CCD minima were introduced into a least squares solution to obtain a new linear ephemeris which best represents the present observations:

$$\text{JD Hel Min.} = \underset{\pm 3}{2449163.8092} + \underset{\pm 7}{0\overset{\mathrm{d}}{.}30961404} \times \mathrm{E} \tag{1}$$

The O−C residuals calculated from equation 1 are listed as $(\mathrm{O}-\mathrm{C})_1$ in Table II. We then calculated a quadratic ephemeris by introducing all available times of minimum light and times of lowlight from Galkina and Shugarov (1985) and Andronov and Richter (1987) into a least squares quadratic solution:

$$\text{JD Hel Min.} = \underset{\pm 4}{2449163.8091} + \underset{\pm 7}{0\overset{\mathrm{d}}{.}30961373} \times \mathrm{E} \underset{\pm 2}{-3\overset{\mathrm{d}}{.}6} \times 10^{-11} \times \mathrm{E}^2 \tag{2}$$

The quadratic term is statistically significant at greater than the 10 sigma level. This negative term would indicate that the secondary (less massive) component is the accretor. The residuals calculated from equation 2 are listed in Table 2 as $(\mathrm{O}-\mathrm{C})_2$.

The standardized B,V,R_c,I_c light curves of V361 Lyrae as defined by their individual observations are shown in Figure 2 as differential magnitudes (variable−comparison) versus phase. The analysis of the observations is in progress.

Jamison D. GRAY
Ronald G. SAMEC*
Brian J. CARRIGAN
Department of Physics and
Astronomy
Millikin University
Decatur, Illinois 62522, USA

* Visiting Astronomer, Kitt Peak National Observatory, National Optical Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc. under contract with the National Science Foundation.

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CCD PHOTOMETRY OF SIX FAINT CATACLYSMIC VARIABLES

Photometric observations of several CV candidates were obtained using the CCD camera on the Danish 1.5m telescope at the European Southern Observatory in June/July 1988 (Table 1). Differential instrumental magnitudes were then derived relative to nearby comparison stars on the same CCD image. The major goals were to confirm or reject the CV nature of the targets and to search for orbital variability and eclipses. Detailed analysis of interesting systems is published separately. This notice presents results for six objects.

PG 1403−111

This object was classified as a CV showing a composite spectrum (Green et al., 1986). Recent spectrophotometric observations (Zwitter and Munari, 1994) revealed no emission lines or hot continuum. It may be that this object is a misidentification as a CV because the photometry also showed no evidence of any variability.

PG 1522+122

This object was also classified as a CV by Green et al. (1986). The photometry showed no indication of a typical CV light curve. There was only a small decline in brightness of about 0.04 mag within three hours. The small scatter of about 0.02 mag rules out flickering activity. The object is probably not a CV.

NSV 09208

Eggen (1969) lists this object (BPM 24960) as a probable variable white dwarf suspect. A possible CV nature is assigned in the NSV catalogue. The 1.5-hour light curve shows a slight increase in brightness by about 0.15 mag with superimposed flickering of about 0.1 mag. There is no indication for a periodic modulation. Nevertheless, the object is likely to be a CV.

NSV 14152

Haro and Luyten (1960) suggest this blue object (Var 7) to be an eruptive variable. It is listed as a possible CV in the NSV catalogue. The 0.8-and 4-hour runs show typical flickering activity with an amplitude of about 0.2 mag. Whereas during the first night the system remained nearly constant it brightened during the second steadily by about 0.25 mag. The mean magnitudes on the two nights differ by about 0.35 mag. A periodic variation longer than 4 hours is therefore expected.

CF Gru (2138-453)

Hawkins and Veron (1987) detected the variability of this blue object and classified it spectroscopically as a CV. CCD photometry by Howell et al. (1991) revealed hot-spot modulations with a period of 93±11 min and the presence of large flickering. The present data set shows generally the same behaviour, but can be better fitted with a period of 100±11 min (Figure 1).

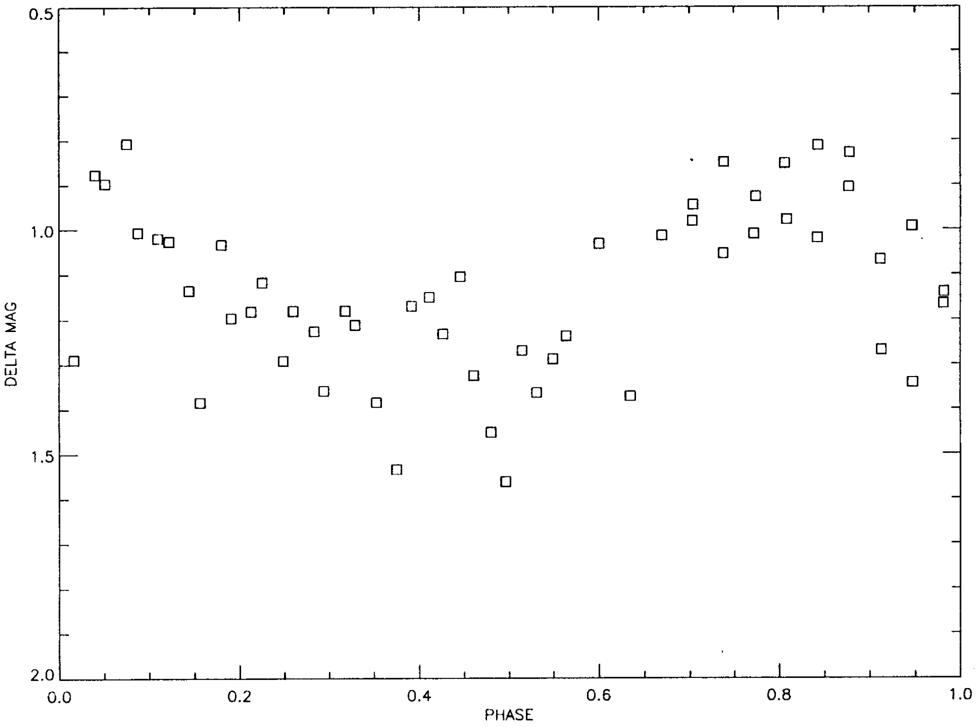

Figure 1: Differential light curve of CF Gru in integral light. The measurements taken on 1988 June 28 are folded with a period of 100 min (phase arbitrary). This period represents the present observation better than the 93 min given by Howell et al. (1991).

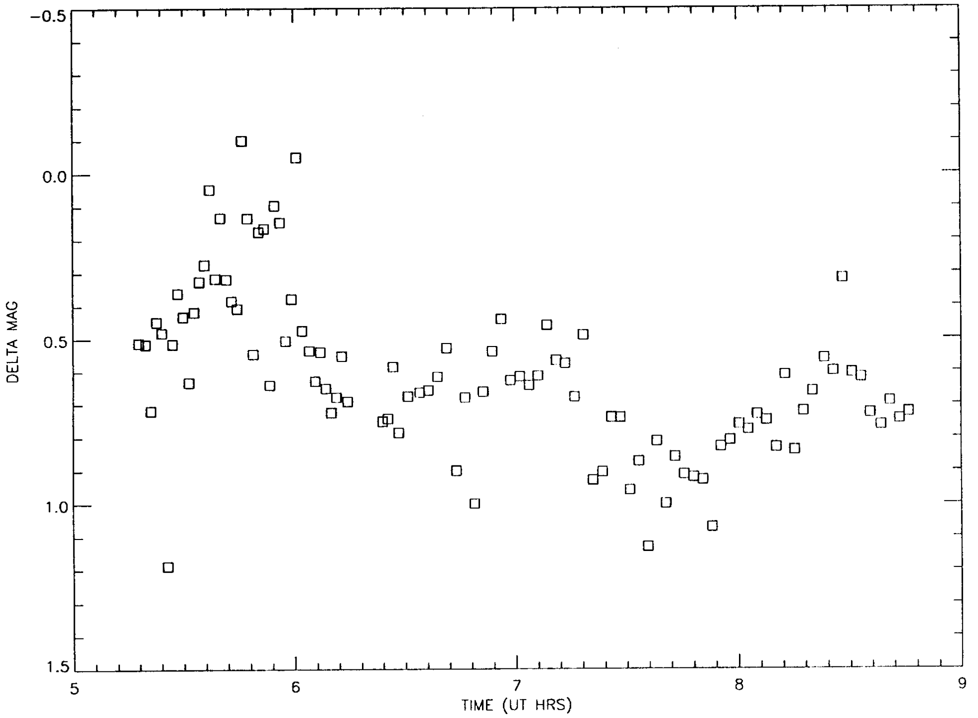

Figure 2: Differential photometry of Hawkins V6 obtained in integral light on 1988 July 01. A repeatable modulation with a period of 80 min is present. At 6:30 UT the integration time of 60 s was changed to 120 s.

Table 1: Observing log. Start is the time for the midpoint of the first exposure. The observation interval also includes gaps due to any interruption of the exposure series. Magnitudes are in B except for the NSV objects where the values from the NSV catalogue are given. Observations were performed in integral light except for NSV 09208 where a Johnson B filter was used.

Object	Date (1988)	Start (UT)	Interval (h)	Int. Time (s)	Frames	Mag
PG 1403−111	Jun 29	01:27:59	2.05	45	94	16.0
PG 1522+122	Jul 01	00:21:36	3.00	120	73	16.1
NSV 09208	Jun 30	03:48:23	1.56	180	28	15.8
NSV 14152	Jun 29	10:02:04	0.84	120	21	20.2
	Jun 30	06:39:19	4.06	120	96	
CF Gru	Jun 28	07:42:06	3.08	180	53	20.4
Hawkins V6	Jul 01	05:17:48	3.47	60/120	98	18:5

Hawkins V6

Based on its outburst behaviour Hawkins (1981, 1983) classified this object as a CV. The 3.5-hour photometric run shows evidence for a periodic modulation masked by strong flickering activity (Figure 2). A periodogram analysis yielded a possible period of 80 7 min. Further, the light curve shows a steady decrease of about 0.4 mag over the entire run thus indicating that the system was probably observed during a decline from outburst.

R. HAEFNER
Universitäts-Sternwarte
Scheinerstr. 1
81679 München
Germany

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THE FIRST PERIOD CHANGE DISCOVERED IN THE BRIGHT ALGOL SYSTEM UV LEONIS

(BAV Mitteilungen No. 77)

The UV Leo system consists of two detached main sequence stars of solar type and nearly equal properties (m_1=0.99, m_2=0.92, R_1=1.00, R_2=1.11 solar masses and radii, according to Giuricin et al. [11]). Hoffmeister [14] discovered the variability and the system has soon classified as an eclipsing binary by Jensch [16]. The depth of the primary and the secondary minima is nearly equal, nevertheless some small night-to-night fluctuation in the light curve has been observed [3], probably due to intrinsic variability of one or both of the components. The magnitude outside eclipse is given as V=8.91 by Popper [33], so the system is fairly bright.

The correct period very near to 0.600 days was first derived by Schneller [35]. McCluskey [22] demonstrated that the period of UV Leo had been constant since at least 1933. This finding can also be extended back to 1897 on base of data from sky-patrol plates given by Gaposchkin [10]. The period change claimed by Ahnert [1] around the year 1952 could not be confirmed. Elements published by Rafert [34] – also cited in the 4th edition of the GCVS – describe the light variations well from 1897 up to the early eighties:

$$\text{Hel.Min. I} = \text{J.D.}\,2438440.72633 + 0\overset{d}{.}60008478 \times E \qquad (1)$$

At Nürnberg Observatory UV Leonis has been observed photoelectrically since 1964 ([9, 17, 18, 26-32]). We continued monitoring the system using a 0.34 m Cassegrain telescope, equipped with a 1P21 phototube, and V filter. Five new times of minima, determined from the light curves, are included in Table 1, which lists all available times of minima from the literature and their O$-$C residuals, computed against elements (1). The data given by Soliman et al. [36] was not included, since it seems to suffer from systematic error.

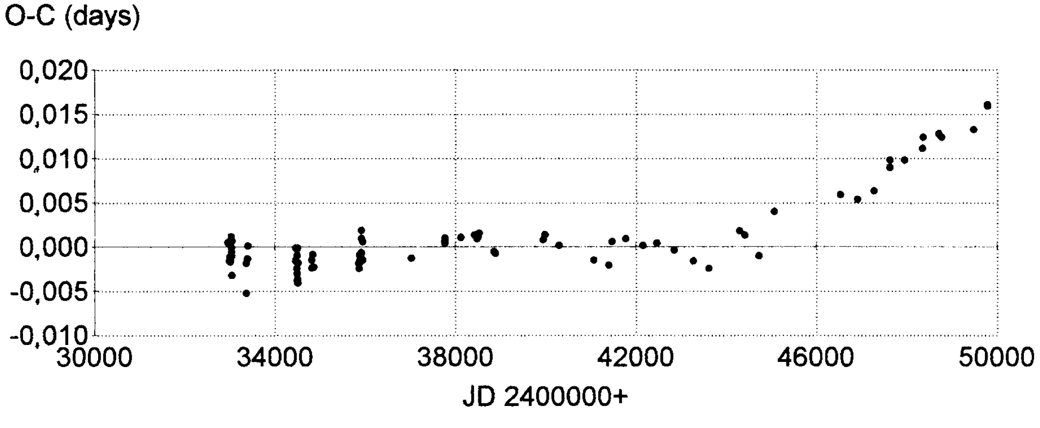

Figure 1.

Table 1

Hel. JD 2400000+	(O−C)$_1$ days	E cycle	Observer and Ref. No.	Hel. JD 24400000+	(O−C)$_1$ days	E cycle	Observer and Ref. No.
32951.4513	0.0005	−9147.5	Perek [24]	35905.370	0.002	−4225	Szczepan. [37]
32981.4535	−0.0015	−9097.5	Perek [24]	35934.4708	−0.0014	−4176.5	Broglia [4]
32995.5559	−0.0011	−9074	Perek [24]	35935.373	0.001	−4175	Szczepan. [37]
32997.3561	−0.0012	−9071	Perek [24]	37017.324	−0.001	−2372	Herczeg [8]
32999.4559	−0.0017	−9067.5	Perek [24]	37758.7310	0.0010	−1136.5	McCluskey [22]
33000.3565	−0.0012	−9066	Perek [24]	37764.7313	0.0005	−1126.5	McCluskey [22]
33006.3571	−0.0014	−9056	Perek [24]	37765.6316	0.0007	−1125	McCluskey [22]
33021.3615	0.0008	−9031	Perek [24]	38111.5809	0.0011	−548.5	McCluskey [22]
33024.3602	−0.0009	−9026	Perek [24]	38416.7243	0.0014	−40	McCluskey [22]
33027.3627	0.0012	−9021	Perek [24]	38440.7275	0.0012	0	McCluskey [22]
33030.361	−0.001	−9016	Piotrowski [25]	38470.7315	0.0010	50	McCluskey [22]
33030.3619	0.0000	−9016	Perek [24]	38474.6325	0.0014	56.5	McCluskey [22]
33033.3618	−0.0005	−9011	Perek [24]	38495.6353	0.0012	91.5	McCluskey [22]
33039.360	−0.003	−9001	Piotrowski [25]	38512.438	0.002	119.5	Müller [28]
33039.3639	0.0007	−9001	Perek [24]	38852.384	0.000	686	Krausser [28]
33349.3052	−0.0018	−8484.5	Wallenquist [24]	38882.388	−0.001	736	Pohl [28]
33354.4025	−0.0052	−8476.5	Wallenquist [24]	39940.339	0.001	2499	Bickel [29]
33386.811	−0.001	−8422	Nason [23]	39978.445	0.001	2562.5	Kurutac [29]
33390.713	0.000	−8415.5	Nason [23]	40291.388	0.000	3084	Ibanoglu [29]
34454.363	0.000	−6643	Szczepan. [37]	41060.395	−0.001	4365.5	Hölzl [17]
34456.462	−0.001	−6639.5	Wellmann [38]	41390.441	−0.002	4915.5	Grampp [18]
34457.362	−0.001	−6638	Wellmann [38]	41466.3544	0.0006	5042	Akinci [18]
34475.366	0.000	−6608	Wellmann [38]	41766.3971	0.0009	5542	Ebersberger [18]
34477.464	−0.002	−6604.5	Wellmann [38]	42147.4502	0.0002	6177	Ebersberger [30]
34479.565	−0.002	−6601	Wellmann [38]	42453.4937	0.0004	6687	Besold [31]
34481.366	−0.001	−6598	Wellmann [38]	42838.4473	−0.0003	7328.5	Ebersberger [32]
34487.364	−0.004	−6588	Wellmann [38]	43266.3065	−0.0016	8041.5	Ertan [9]
34488.565	−0.003	−6586	Wellmann [38]	43608.3540	−0.0024	8611.5	Chwastek [27]
34489.468	0.000	−6584.5	Wellmann [38]	44292.4549	0.0019	9751.5	Bode [26]
34493.365	−0.004	−6578	Wellmann [38]	44404.3702	0.0014	9938	Elias [19]
34496.365	−0.004	−6573	Wellmann [38]	44716.412	−0.001	10458	Diethelm [20]
34501.468	−0.002	−6564.5	Wellmann [38]	45061.4657	0.0040	11033	Fernandes [2]
34803.611	−0.001	−6061	Fracastoro [3]	46521.4739	0.0060	13466	Ells [15]
34808.4108	−0.0023	−6053	Fracastoro [3]	46903.4273	0.0054	14102.5	Diethelm [21]
34827.315	−0.001	−6021.5	Fracastoro [3]	47270.3801	0.0063	14714	Diethelm [5]
34844.416	−0.002	−5993	Fracastoro [3]	47615.4315	0.0090	15289	Wunder [39]
35846.558	−0.002	−4323	Broglia [4]	47616.3325	0.0099	15290.5	Wieck/Wund. [39]
35850.758	−0.002	−4316	Broglia [4]	47945.479	0.001	15839	Hudecek [12]
35867.5619	−0.0008	−4288	Broglia [4]	48332.535	0.011	16484	Paschke [6]
35871.4616	−0.0017	−4281.5	Broglia [4]	48358.3399	0.0124	16527	Blättler [6]
35873.5622	−0.0014	−4278	Broglia [4]	48700.3886	0.0128	17097	Diethelm [29]
35895.4654	−0.0013	−4241.5	Broglia [4]	48757.3963	0.0125	17192	Wunder [39]
35897.5661	−0.0009	−4238	Broglia [4]	49475.3986	0.0133	18388.5	Diethelm [30]
35901.467	−0.001	−4231.5	Broglia [4]	49775.4436	0.0160	18888.5	Wunder [39]
35904.469	0.001	−4226.5	Szczepan. [37]	49776.3439	0.0161	18890	Wund./Traub [39]

From the O−C diagram in Figure 1 it is obvious that the period of UV Leonis increased at around JD 2444000. This is the first reliable period change in the system discovered yet. Calculating new elements for the time since JD 2444000, the least squares method yields:

$$\text{Hel.Min. I} = \text{J.D.}\,\underset{\pm 31}{2447615.43178} + \underset{\pm 52}{0\overset{d}{.}60086414} \times \text{E} \qquad (2)$$

E. WUNDER
Bundesdeutsche Arbeitsgemeinschaft
für Veränderliche Sterne e.V. (BAV)
Nürnberg Observatory
Regiomontanusweg 1
90317 Nürnberg
Germany

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HD 6474: AN UU Her SPECTRUM VARIABLE?

The star HD 6474 (=V 487 Cas) is a yellow semiregular variable of small amplitude observed recently by Zsoldos (1993) who showed that it belongs to the small group of UU Her type variables, which comprises UU Her, V 487 Cas and perhaps BL Tel.

The star has been classified as G0 Iab (Bidelman, 1951), G0 Ia (Nassau and Morgan, 1952), and G4 Ia (Keenan and McNeil, 1976). The latter classification is based upon plates taken in 1972 (August 16 and December 22) and 1973 (July 24). The 1973 spectrum is reproduced on plate N.4 of Keenan-McNeil Atlas.

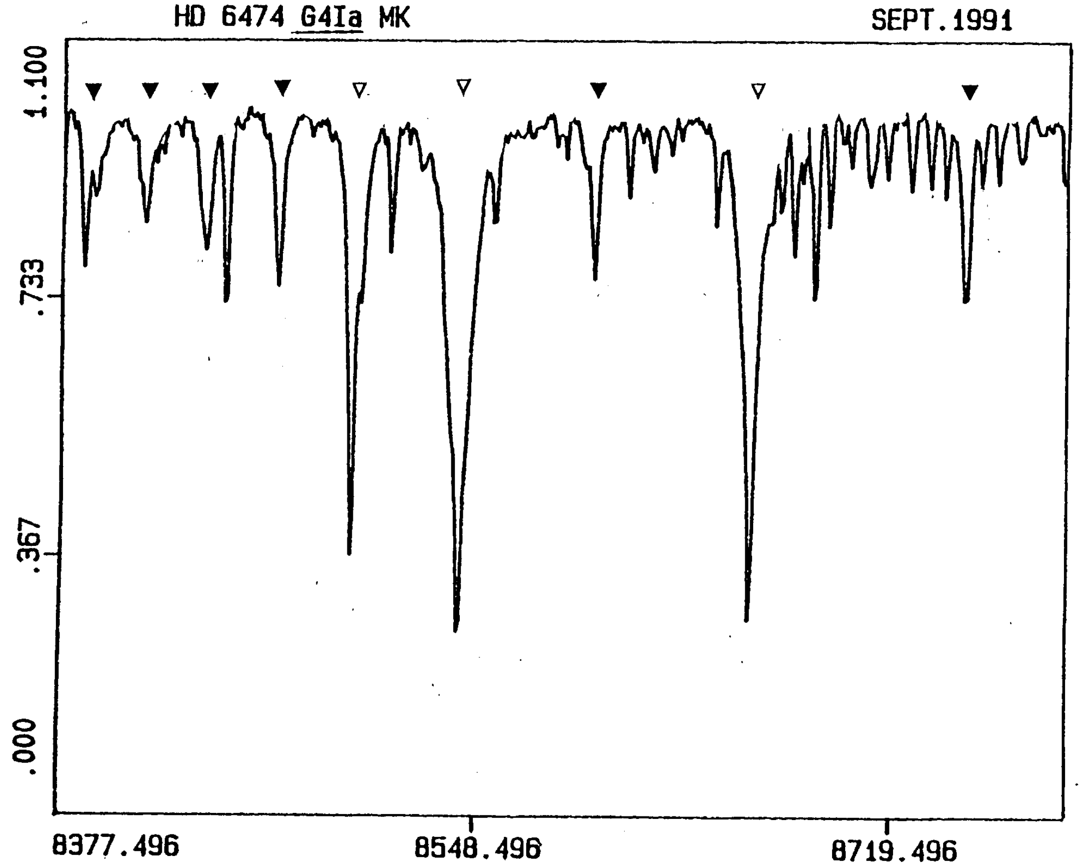

Figure 1. The spectrum of HD 6474 or a rapid orientation the Paschen lines from P12 to P20 are marked with black triangles and the Paschen lines blended with Ca II are marked with triangles. For fixing the spectral type, the figure should be compared with those contained in "An Atlas of the infrared spectral region" by Y. Andrillat, C. Jaschek, M. Jaschek, accepted for publication in AA Suppl.

A CCD spectrum of this object was obtained at the Observatoire de Haute Provence in September 1991 in the infrared region for the purpose of establishing an Atlas in the 8400-8800 Å region. The dispersion of the spectogram is 33Å/mm. By comparison with other MK standards it turns out that the spectrum is now definitely earlier than G0 – we have classified it as F9 Ia. It seems thus very likely that the star is a spectrum variable and further observations of this star and of the group members are highly desirable.

M. JASCHEK*
C. JASCHEK*
P. KEENAN**
N. GINESTET***
J. M. CARQUILLAT***

* Observatoire de Strasbourg, France
** Ohio State Observatory, US
*** Observatoire Midi-Pyrénées, France

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NEW TIMES OF MINIMA OF ECLIPSING BINARIES VW Cep, U Cep AND RZ Cas

VW Cephei (HD 197433 = BD +75°752 = SAO 9828) is a well observed active W UMa type binary. Its regular photometry was begun in 1992 at Szeged Observatory. The aim of this long term project is twofold. First, the light curve of the system shows temporal variation on short timescales (24 hours; Kreiner & Winiarski, 1981) as well as long timescales (6-8 years; Bradstreet & Guinan, 1988; 44 years; Karimie, 1983). Second, VW Cep is a member of a triple system (Hershey, 1975), its period is modulated by the light time effect, but the period variation of the system is quite complex. A detailed analysis of the period variation has been presented recently by Lloyd, Watson & Pickard (1992) and Vinkó et al. (1993).

Differential photoelectric photometry of VW Cephei was carried out on 3 nights in September, 1994 with a 40 cm Cassegrain telescope and an Optec SSP-5A photoelectric photometer. The light curve in Johnson V and B bands was obtained and it is presented in Figure 1. The comparison star was HD 199476 which was used previously by many observers.

Table 1 contains the heliocentric times of minima calculated from parabolic least-squares fit to the bottom of the minima. The O−C values were derived from the ephemeris given in the 4th edition of GCVS. The O−C of secondary minimum was calculated so that the time of the secondary minimum was expected at the 0.5 phase.

Our minimum times show that the period decrease of the system continues, in agreement with the conclusion of previous analyses by Lloyd, Watson & Pickard (1992) and Vinkó et al. (1993). The asymmetry of the light curve does not exceed 0.02 mag, which suggests that the next activity maximum proposed by Bradstreet & Guinan (1988) has not occurred yet.

The Algol type eclipsing binaries RZ Cas and U Cep were measured with an unfiltered ST4 CCD camera attached to a Telemator refractor. Only one minimum was observed in both cases. The comparison star of U Cep was HD 6006, while in the case of RZ Cas a nearby star (GSC 4317.1578; V ∼ 10.6) was used as comparison.

The heliocentric times of minima of U Cep and RZ Cas are listed in Table 2. The O−C values are computed from the ephemeris given in the GCVS.

In the case of U Cep simultaneous BV photoelectric and CCD photometry was made. The comparison of data strongly suggests that the unfiltered CCD measurements are useful for detection of light minima of eclipsing binaries. Since the duration of the totality was longer than 0.075 day, the observed eclipse was an undisturbed one according to the definition of Crawford & Olson (1979). Figure 2 shows a part of the O−C diagram of U Cep computed using our new time of minimum and some recent measurements (Olson et al. 1985; Sato & Nishimura 1987; Surkova 1990; Burnett, Etzel & Olson 1993). From the slope of the fitted line the following ephemeris has been derived:

$$Hel.JD Min I = 2449602.5601 + 2.4930614 \times E$$
$$\pm .0010 \quad \pm .0000004$$

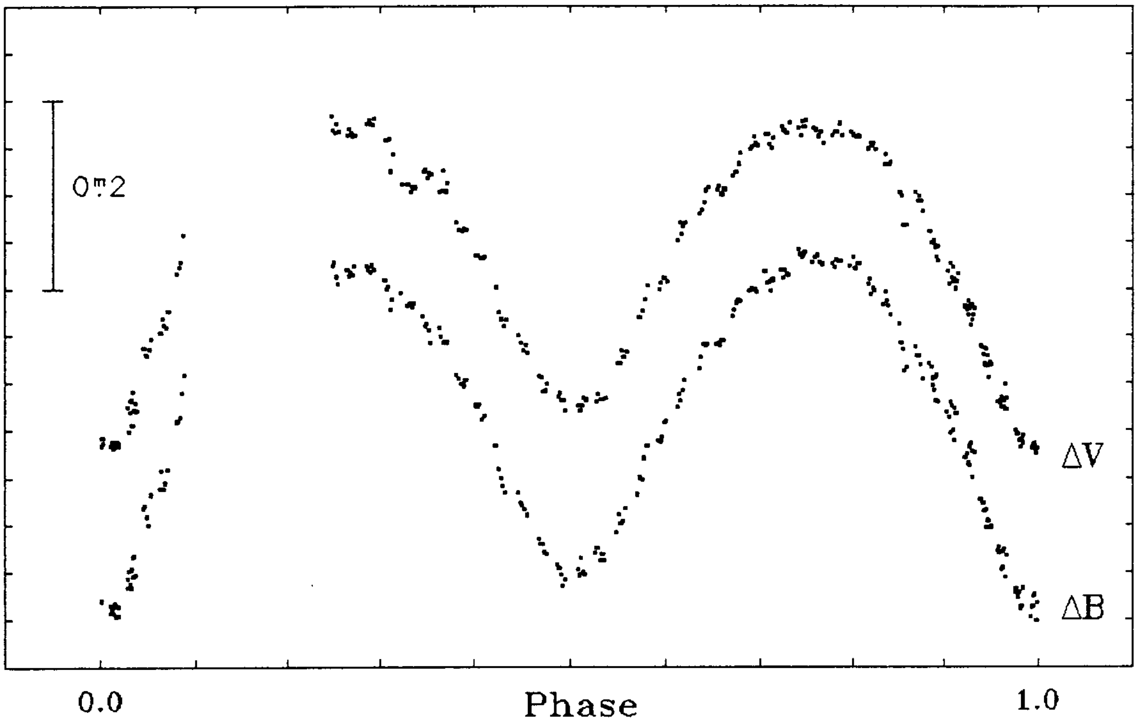

Figure 1. Differential B and V light curve of VW Cephei

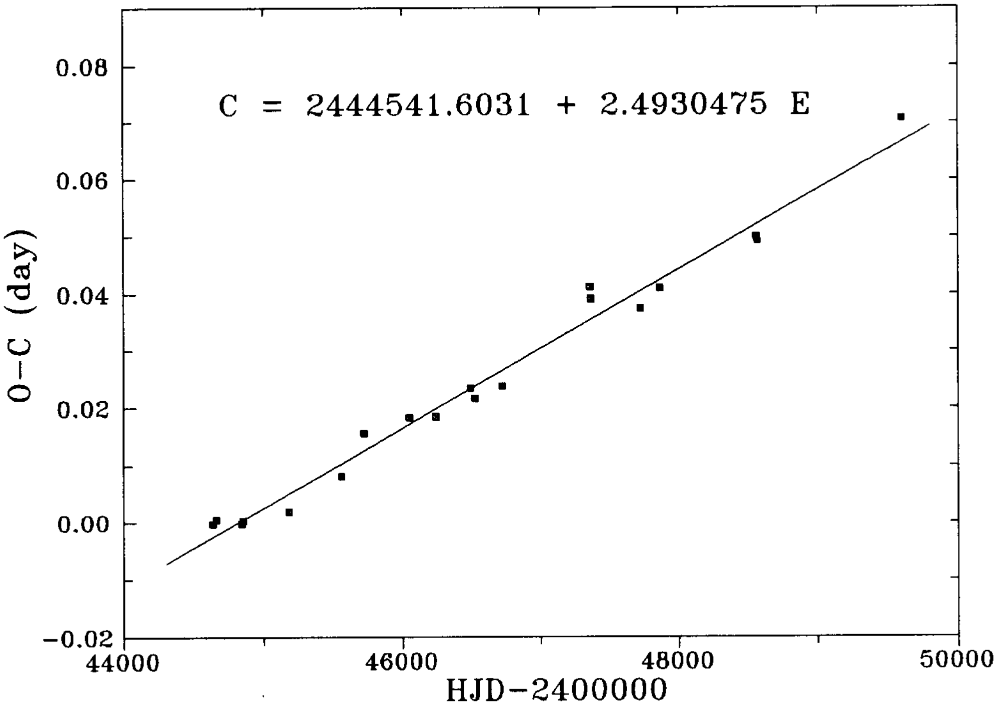

Figure 2. O−C diagram of U Cephei

Table 1. Minimum times of VW Cephei

Min (Hel.JD)	Type	O−C (days)
2449603.3761	I	−0.0971
2449608.3848	I	−0.0981
2449609.3603	II	−0.0967
2449609.4978	I	−0.0984

Table 2

Star	Min (Hel.JD)	type	O−C (days)
U Cep	2449602.5601	I	0.0706
RZ Cas	2449653.465	I	0.0201

Using the period values given in the GCVS and in this paper the rate of the period increase during the last 5000 days was also calculated, it is $dP/P = 6.849 \times 10^{-9} day/day$.

A detailed analysis of period variation of RZ Cas has been presented recently by Hegedüs, Szatmáry & Vinkó (1991). They showed that the period variation contains four periodic components. However, it seems that our new time of minimum does not agree with the prediction of their O−C curve fitting.

The list of individual observations is available via e-mail from l.kiss@physx.u-szeged.hu (Internet).

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L.L. KISS,
J. GÁL
Astronomical Observatory and
Dept. of Experimental Physics
JATE University
Szeged, Dóm tér 9
H-6720 Hungary
Internet: L.Kiss@physx.u-szeged.hu

G. KASZÁS
Dept. of Optics
JATE University
Szeged, Dóm tér 9.
H-6720 Hungary

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THE ORBITAL PERIOD OF THE ROSAT CATACLYSMIC VARIABLE S 10932 COMAE BERENICES

S 10932 Com, the optical counterpart of the ROSAT X-ray source RX J1239.5 + 2108, was – by observations on Sonneberg photographic plates – not only found to have high (17^{m}) and low (18^{m}) brightness states like magnetic cataclysmics; there could be noticed also an eruption ($13\overset{\mathrm{m}}{.}5$) similar to that of a dwarf nova (Richter and Greiner, 1995). The only star hitherto known to show a similar behaviour is V426 Oph (Wenzel and Splittgerber, 1990). May be that S 10932 is related to this object, whose exact physical nature is, however, still poorly known.

Additionally, large fluctuations in the above mentioned states of high minimum light and apparently also in the rare low states were observed. We therefore decided to carry out time-resolved differential photometry of S 10932 at the Sonneberg 60/180 cm reflector by means of a CCD camera of Wright Instruments Ltd, type EEV 02-06-1-206. Three night series of "repeated exposures" in the R band led to the detection of an eclipsing variability. The elements of brightness variations are:

$$\mathrm{Min.(hel.)} = \mathrm{J.D.}\,244\,9486.4821 + 0\overset{\mathrm{d}}{.}08703 \times \mathrm{E}$$
$$\pm\ 0.00002$$

Figure 1 shows the greater part of our series of 1994 May 15/16; Δm means the magnitude difference against one of the our comparison stars. The R band amplitude of the eclipses is about 1.5 mag and their duration approximately 10 min. In the following table the five minima observed in the three nights of 1994 and the deviations from the ephemeris are listed:

HJD 2440000+	E	O–C
9484.3934	–24	$0\overset{\mathrm{d}}{.}0000$
9484.4807	–23	+0.0003
9486.4816	0	–0.0005
9488.3969	22	+0.0001
9488.4841	23	+0.0002

Figure 2 gives all eclipse observations, folded by the above elements.

Interestingly, the period length is just at the lower boundary of the well-known period gap of cataclysmic variables ($0\overset{\mathrm{d}}{.}088...0\overset{\mathrm{d}}{.}118$).

Most objects with period lengths similar to that of S 10932 are either SU Ursae Maioris or AM Herculis stars. S 10932, however, is an outstanding object and deserves further attention.

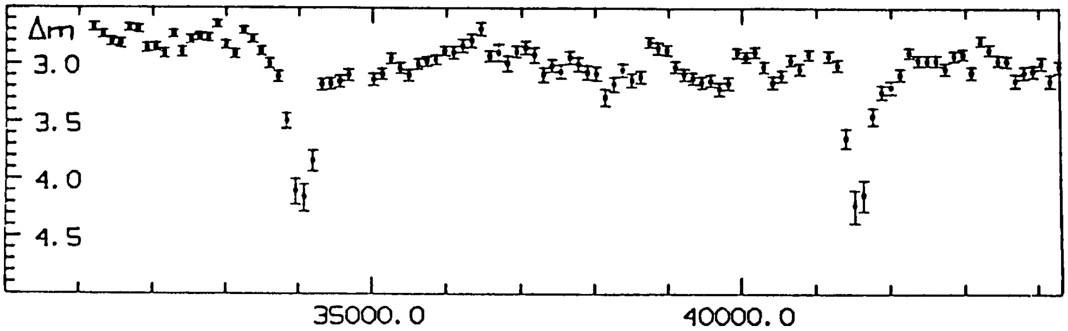

Figure 1. Geocentric observing time (s after beginning of the current Julian Day)

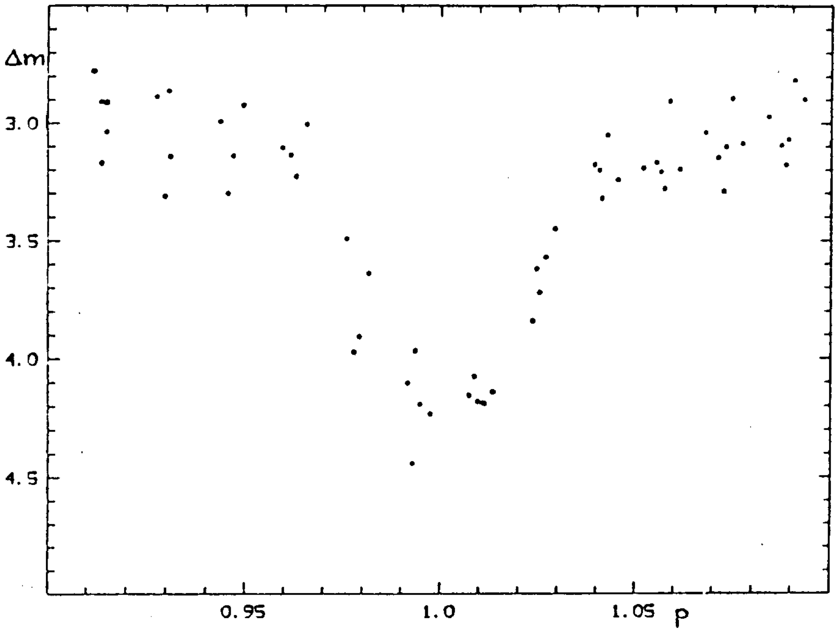

Figure 2

Acknowledgements. We are most grateful to J. Greiner (Max-Planck-Institut für Extraterrestrische Physik, Garching) for stimulating the search for optical variability of ROSAT sources. Our work was partly supported by funds of German Bundesministerium für Forschung und Technologie under contract nos. 05-2A052A (W.W.) and 05-2S0524 (G.A.R.).

W. WENZEL
G. A. RICHTER
R. LUTHARDT
Sternwarte
D-96515 Sonneberg
Germany

R. SCHWARTZ
Gleimstrasse 21
D-10437 Berlin
Germany

References:

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A NEW SEMIREGULAR VARIABLE S 10934 IN CORONA BOREALIS

When searching for an optical counterpart of the BATSE gamma-ray burst source 920525 B ($0^h41\overset{m}{.}8$ UT) at the improved position (Greiner, 1994) on a Sonneberg Sky Patrol plate taken by B. Fuhrmann 1.7 hours before eruption, I discovered a new semiregular variable at the following position (1950.0) within the error box of the gamma source:

$$\alpha = 15^h49\overset{m}{.}0, \quad \delta\ +31^\circ38'.$$

The object is easily localized by its brightness and red colour on the POSS sheets no. 121.

On a sample of 120 patrol plates taken between 1962 and 1965 by H. Huth I found an average cycle length of 60 days and amplitude of 1.7 mag in the photographic band ($10\overset{m}{.}9$-$12\overset{m}{.}6$; Mt. Wilson system of Selected Area 35). The light-curve is partly sine shaped, partly characterized by sharper minima, and partly more irregular. On a Sonneberg 50/70/172cm Schmidt camera objective prism plate taken 1962 April 12.0 UT by W. Götz the spectral type can be determined as M8.

There is at present no hint that either this variable or one of the variables formerly detected in the region of the error box (e.g. X CrB, RT Boo, Z CrB) can be physically related with the gamma-ray burst source.

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W. WENZEL
Sternwarte
D-96515 Sonneberg
Germany

Reference:
Greiner, J., 1994, unpublished

ERRATUM

In the No. 4134 issue of the IBVS all ephemerides of VW CVn refer to normal maxima and not Min I (as stated erroneously in the text). The authors of that note and editors of the IBVS are grateful to Dr. N. Samus for calling their attention to this inconsistency.

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THE ELLIPSOIDAL VARIABILITY OF HR 4646

The Eighth Catalogue of the Orbital Elements of Spectroscopic Binary Systems (Batten et al., 1988) lists the star HR 4646 (α(2000)=$3^h57^m3^s\!.8$, δ(2000)= +77°36' 58", V=$5^m\!.1$) as a single-lined spectroscopic binary with a period of $1^d\!.2709334$. This is based on spectroscopy due to Abt (1961).

HR 4646 was included in a recent campaign of potential ellipsoidal variables. Observations have been made with the Devon Astronomical Observatory 0.5 m telescope using a recently installed CCD imaging system. Photometry was carried out on HR 4646 over the 6 nights, January 21-24 and February 10-13 1995. The data consist of ~1500 V filter observations. Integrations were 0.35 - 0.70 seconds at approximately 2 minute intervals (~0.001 in phase).

The star SAO 7521 (V=$6^m\!.6$) was used as a comparison with SAO 7519 (V=$8^m\!.9$) serving as a check star. The data were phased with the $1^d\!.2709334$ period given by Abt (1961) and computed from his epoch of maximum radial velocity T_0=JD 2436758.245. The results were averaged in 100 equal phase bins. The data, as presented have not been transformed from the local to the standard UBV system.

A Fourier series of the form

$$l = A_0 + \sum(A_i \cos\theta_i + B_i \sin\theta_i)$$

where l is flux and θ is the orbital phase measured from the time of maximum velocity was fitted to the data. Linear regression analysis was used to perform a Fourier least-squares fit for the first 4 terms. The coefficients along with standard errors are presented in Table 1. The residual error in the fit is roughly 0.010 in flux which is typical of scatter in the observations. The Fourier series is plotted in Figure 1 along with the data. The dominance of the $\cos 2\theta$ term supports the suggestion that HR 4646 is an ellipsoidal binary system and the phase relationship between the photometric and spectroscopic data is consistent with that interpretation.

A complete discussion of this system which includes analysis of the spectroscopic data will be published as part of the M.Sc. thesis of E.S..

Table 1

Fourier Coefficents

A_0	A_1	A_2	B_1	B_2
0.963	0.002	0.017	−0.006	−0.001

standard error of coefficients = ±0.001

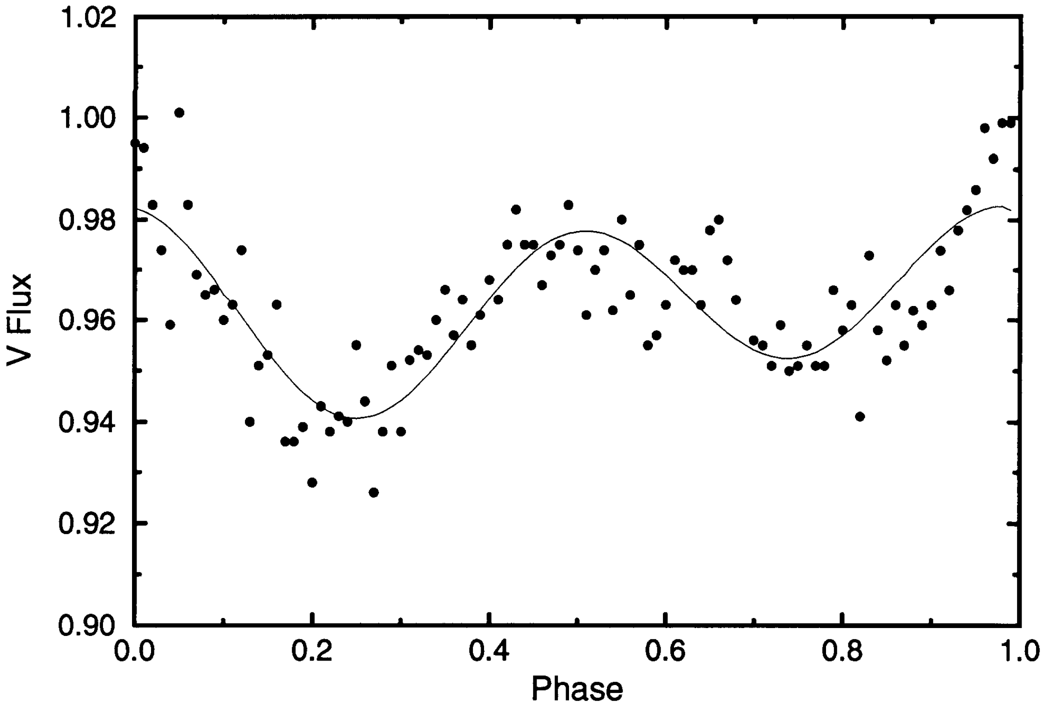

Figure 1 - V filter flux observations of HR 4646 phased in bins of width 0.01. Phasing is with respect to a period of $1\overset{d}{.}2709334$ and from epoch date T_0= JD 2436758.245. The solid line represents a least-squares, fourth-order Fourier fit to the data.

E. STEINBRING
(steinb@stellar.phys.ualberta.ca)

D. P. HUBE
Department of Physics
University of Alberta
Edmonton, Alberta
Canada, T6G 2J1

B. E. MARTIN
The King's University College
9125-50th Street
Edmonton, Alberta
Canada, T6B 2H3

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NARROWING THE MAIN SEQUENCE MASS GAP

Andersen's (1991) compilation of stellar masses contains 3 stars with masses between 1.10 solar masses and the long-known masses of the M1 dwarf, YY Gem, 0.59 $m_\odot$, namely the secondary of FL Lyr (G8, 0.96 $m_\odot$) and the components of HS Aur (G8, 0.90; K0, 0.88). The discussion of visual binaries by Henry and McCarthy (1993) contains only one star with a mass in this range with comparable accuracy, Alpha Cen B (K0V, 0.90).

In recent years a program has been undertaken at the Lick Observatory with the primary aim of helping to obtain masses of additional main-sequence stars in the mass range 1.0 to 0.6 $m_\odot$. The observations consist of spectra of eclipsing binaries which, on the basis of existing information, may contain at least one detached main-sequence component of spectral type G or K. To date, spectra have been obtained of approximately 60 eclipsing binaries, and the most promising ones are given high priority on the observing program. A progress report giving preliminary results as of about 2 1/2 years ago has been published (Popper 1993), as have definitive analyses of two of the systems, RT And and CG Cyg (Popper 1994). These two papers discuss the nature of the program in some detail.

An up-dated progress report is given in Table 1. It contains results based on limited material for those systems for which a provisional value of $m \times \sin^3 i$ of at least one component is equal to or less than 1.10 solar masses. Alpha CrB and V818 Tau (see Popper 1993) are binaries containing a star having less than one solar mass not observed in this program. The table includes five systems (ZZ UMa, HP Aur, 1E1919+0427, HD 197010, and BH Vir) for which this is the first announcement of new mass determinations. The very provisional nature of the results is to be emphasized. The systems are listed in order of decreasing period. Several of the provisional results in Table 1 are for systems (UV Psc, BH Vir, CG Cyg, RT And, UV Leo) that have been previously observed with much lower resolution than that employed in this program. References are in Batten et al. (1989).

The spectral types listed in Table 1 are rough values based on the strengths of the Na D lines, which are sensitive to temperature. The types are mean values weighted according to the luminosities of the components and to the intrinsic strengths of the D lines. The apparent magnitudes, presumably in the V band, are from a variety of sources. References to binaries not having constellation names are as follows: HD 192825, Kissling et al. 1993; HD 197010, Marschall et al. 1991; 1E1919+0427, Summers et al. 1992. The ephemerides of these recently discovered eclipsing binaries are not firmly established. I have found it necessary to subtract 0.05 from phases of HD 197010 computed with the ephemeris given in IBVS 3633. The ephemeris given in IBVS 3708 for 1E1919+0427 does not fit my velocities. An improved ephemeris is JD(min)=2449260.644 + 0.873713E.

Table 1. Detached eclipsing binaries with provisional values of m×$\sin^{-3}$i 1.10 solar masses or less.

Binary	Period (d)	V (mag)	Type*	$m_1\times\sin^3$i	$m_2\times\sin^3$i
ZZ UMa	2.30	10.0	G2	1.18	0.96
HP Aur	1.42	11.3	G4	0.90	0.75
DU Leo	1.37	9.5	F8	0.97	0.95
HD 192825	1.18	8.9	G0	1.08:	1.06:
1E1919+0427	0.87	10	K1	0.94	0.85
UV Psc	0.86	9.4	G8-K0	0.99	0.76
CV Boo	0.85	10.2	G2	1.00	0.94
BH Vir	0.82	9.6	F8	1.13	1.01
HD 197010	0.71	8.9	F9	1.08	0.69
CG Cyg	0.63	9.7	K1	0.92	0.79
RT And	0.63	9.0	F9	1.24	0.91
UV Leo	0.60	8.9	G0	1.10	1.07

* Types are means weighted according to the relative luminosities of the components and to the intrinsic strengths of their Na D lines.

The spectroscopic material on which the preliminary results summarized in Table 1 have been based is obtained with the Hamilton echelle-CCD spectrometer on the 3 m Shane telescope of the Lick Observatory (Vogt 1987). This instrument is proving to be ideal for the purpose: resolution approximately 60,000, scale 3 Åmm^{-1} in the visual region, S/N in the continuum of roughly 100 per resolution element for an exposure of about 20 minutes on a star of 10th magnitude. Details of the cross-correlation procedure employed for the velocities (IRAF program) are given in Popper (1994) and Popper and Jeong (1994).

The principal purpose of presenting these preliminary results at this time is to direct the attention of photometric observers to these important systems. Without reliable photometric observations and analysis, the spectroscopic results will have limited value. The short periods of most of these detached systems are noteworthy–the shorter the period, the greater the likelihood that eclipses will occur. This effect also permits coverage of the light curve in a relatively short interval of time, a favorable situation for observers. On the other hand, short periods are associated with larger rotational velocities, which, in turn, favor intrinsic variations associated with star spots and perhaps other manifestation of stellar activity. For this reason, it is essential that a complete light curve be observed in a relatively short interval and that the coverage be repeated several times over a period of a few years. RT And (Zeilik et al. 1989) and CG Cyg (Zeilik et al. 1994) are examples of systems for which repeated photometric coverage by a variety of observers has led to consistent basic solutions of the light curve (as well as to evaluations of star-spot parameters). While such numerous observations as in the cases of RT And and CG Cyg are ideal, considerably less frequent coverage of the light curves of the systems of Table 1 should lead to results of adequate reliability.

Photometry should be carried out in a photometric system carefully tied to a standard system. The Strömgren intermediate-band v,b,y system has the advantage of giving information on metallicity, which is of considerable importance in interpreting the stellar properties in terms of evolutionary models, as discussed by Andersen (1991), for example.

It is not possible to evaluate metallicity directly from spectra of rapidly rotating stars. None of the binaries is particularly faint, and a number of them can be observed with adequate precision (not worse than 0.01 mag) with modest equipment.

Pending more nearly definitive spectroscopic orbits and photometric solutions for most of the systems of Table 1, it appears that we may indeed be able to narrow the gap in the masses of detached main-sequence stars to the as yet unfilled interval 0.7 to 0.59 solar masses. One may hope that further discoveries–some of those represented in Table 1 are quite recent–will add significantly to our store of stellar masses in this mass range. Concentrated photometry on any or all of these binaries would provide a major contribution to this endeavor.

Daniel M. POPPER
Department of Astronomy
University of California
Los Angeles, CA 90095-1562 U.S.A.
internet:
popper@bonnie.astro.ucla.edu

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UBV LIGHT CURVES OF THE NEAR-CONTACT BINARY AK CANIS MINORIS

In our study of the eccentric eclipsing binary (EEB) candidates of Hegedüs (1988), we obtained UBV photoelectric light curves of AK Canis Minoris [R.A.(2000) = $07^{h}40^{m}15^{s}.5$, D.(2000) = 03°57'09"]. AK CMi (BD+04°1778, AN310.1934, P3052, SVS 1102) was discovered by Hoffmeister (1934). Notni (1955) published a photographic light curve, and determined a period of ~0.57d. He states that the shallow secondary eclipse (we measure 0.16 mag in B) occurred at phase 0.55. Given the high scatter and the sparse coverage of his light curve, this result is highly questionable. Strohmeier et al. (1957) includes a finder chart in his study. Robb and Moffat (1987) give two precision epochs of primary minima and one of a secondary minimum. We find that their secondary eclipse occurs at phase 0.46. Shaw (1994) includes AK CMi in his list of near-contact binaries. In all, some 200 timings of minimum light are found in the literature or in the BAV data base.

The present observations were taken on 1994, February 10-15, inclusive, at Lowell Observatory, Flagstaff, Arizona with the National Undergraduate Research Observatory 0.78-m reflector. A thermoelectric cooled PMT was used with Johnson UBV filters. Two nearby stars were used as comparison [R.A.(2000) = $07^{h}41^{m}5^{s}.9$, D.(2000) = 03°50'08"] and check [R.A.(2000) = $07^{h}40^{m}18^{s}.0$, D.(2000) = 03°52'19"]. The comparison star was an excellent color match to the variable with the Δ(B−V) and the Δ(U−B) averaging ~0.1 and ~0.0, respectively.

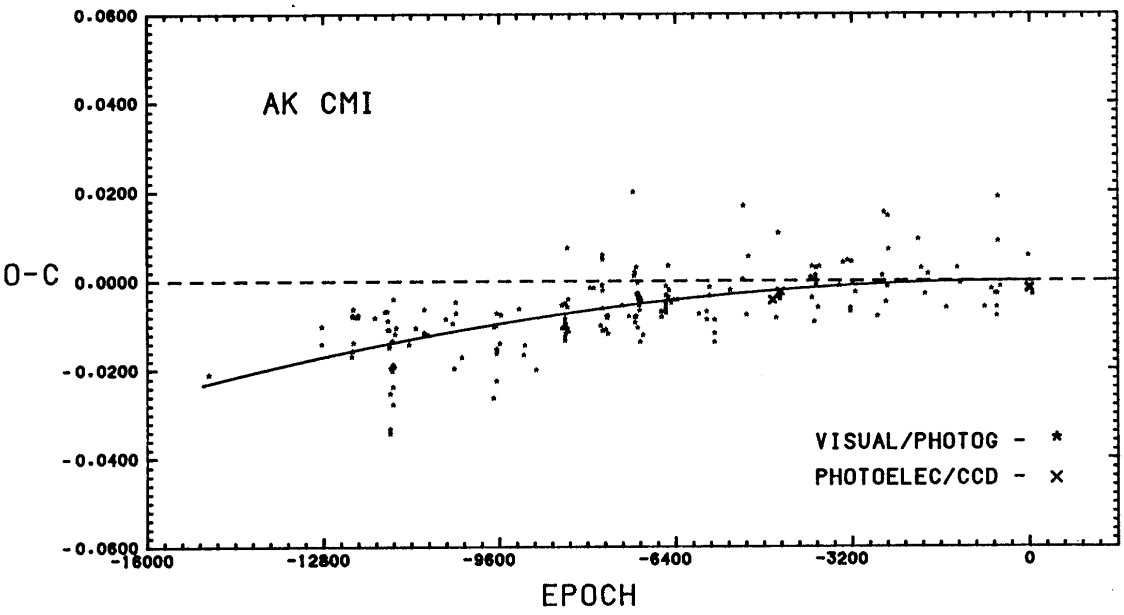
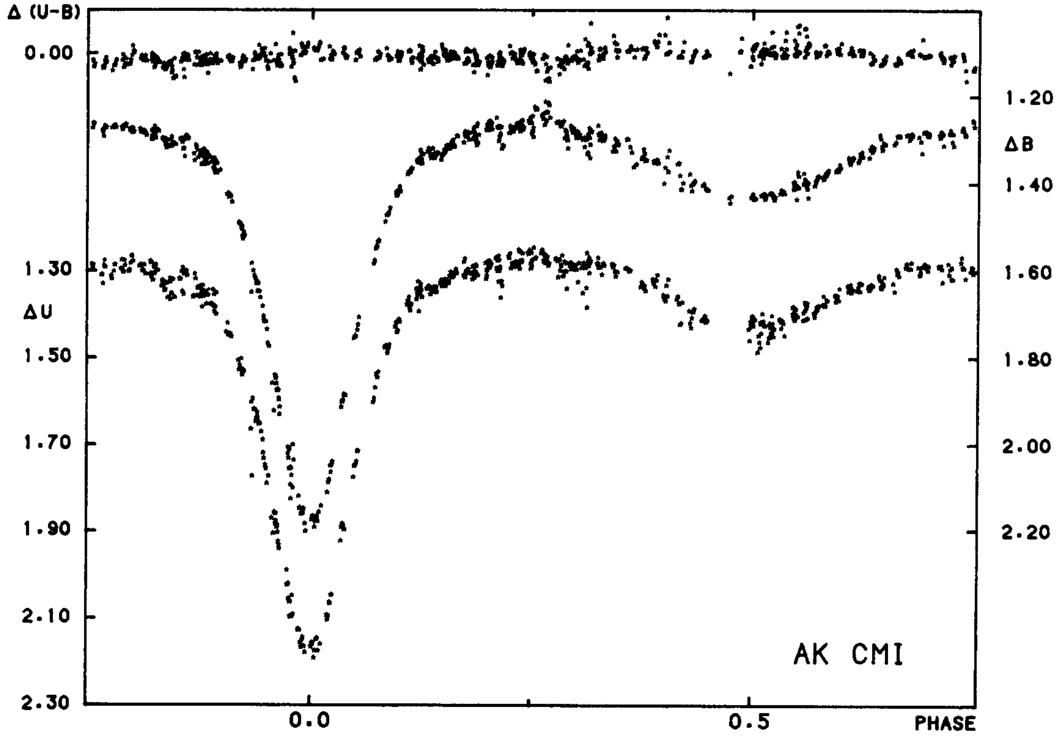


Figure 1. Period behavior of AK CMi as shown by the calculated from the quadratic ephemeris.



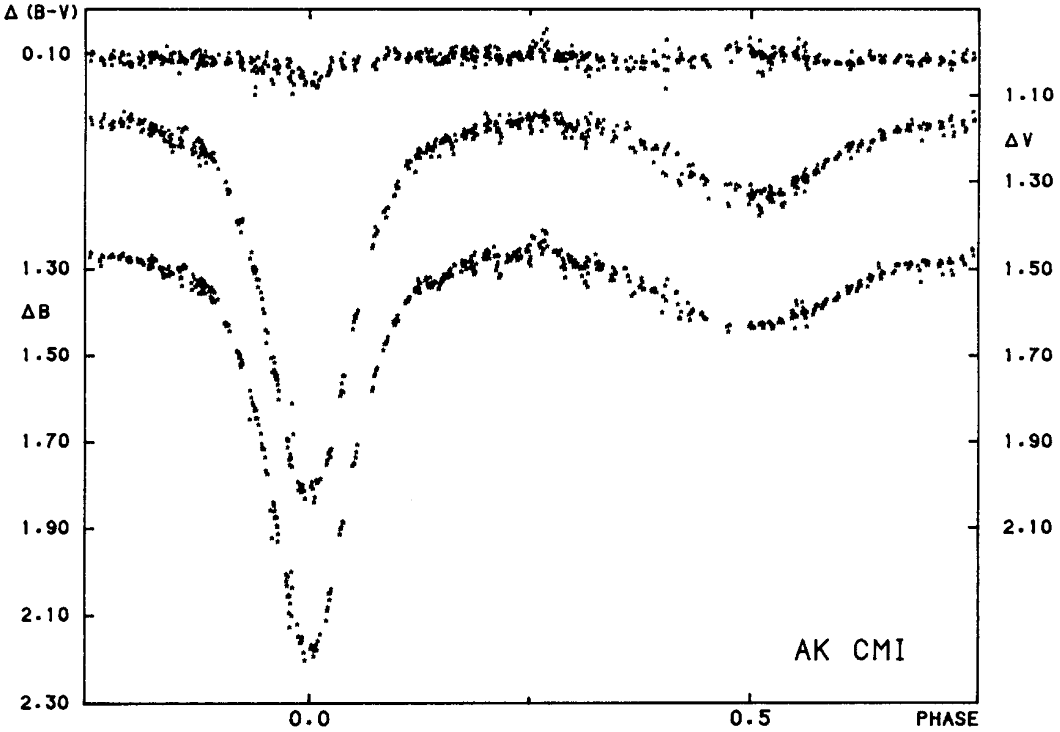


Figure 2. Light curves of AK CMi as defined by the individual observations.

Two mean epochs of minimum light were calculated from one secondary and one primary eclipse. The bisection-of-chords method was used. Our epochs were JD Hel. Min. I = 2449396.70325(±.00046) and JD Hel. Min. II = 2449395.8546(±.0003). From the densely packed data of the past 23 years, we determined the following improved epemeris:

$$\text{JD Hel. Min I} = \underset{\pm.0018}{2449396.7075} + \underset{\pm.0000002}{0^{\mathrm{d}}.5658968}\times\mathrm{E} \qquad (1)$$

The O−C's calculated from this ephemeris suggest that AK CMi is undergoing a continuous period decrease. Because of this we calculated the quadratic ephemeris:

$$\text{JD Hel. Min I} = \underset{\pm.0008}{2449396.7050} + \underset{\pm.0000002}{0^{\mathrm{d}}.5658956}\times\mathrm{E} - \underset{\pm.00000000002}{0.00000000010}\times\mathrm{E}^2 \qquad (2)$$

The O−C's generated from the first two terms of this equation are shown in Figure 1 overlain by a curve generated by the quadratic term. In these calculations, we weighted the precision epochs as 1.0 and the photographic and visual timings as 0.1. We used equation (1) to phase our observations. These equations indicate that our Min II occurred at phase 0.5 to within the errors. We believe that AK CMi is not an EEB. The appearance of the light curves about the secondary eclipse supports this conclusion.

The light curves of AK CMi defined by the individual observations are shown in Figure 2 as Δ mag vs. phase. Our preliminary light curve solution indicates that the components are in a near contact semi-detached configuration with the fillout of the primary component being ~80% and a component temperature difference of ~4100 K . The complete analysis of the observations are underway and will appear elsewhere.

RONALD G. SAMEC*
RICHARD J. McDERMITH
BRIAN J. CARRIGAN
Dept. of Physics and Astronomy
Millikin University
Decatur, Il 62522-2084
USA

* Visiting Astronomer, Lowell Observatory, Flagstaff, Arizona

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ECLIPSE OBSERVATIONS OF EQ Tau

EQ Tau (G1, V=11.9, $03^{\rm h}48^{\rm m}12\overset{\rm s}{.}9$, $+22°18'49''$, J2000) is a poorly studied W UMa eclipsing binary with a period of 0.34 days. This system is on the AAVSO list of eclipsing binaries (Baldwin and Samolyk 1993) but to our knowledge has had no previously published light curve or ephemeris. The AAVSO reference reports eclipse minima observations (chiefly by G. Samolyk) during the period JD 2442832 (1976) to 2448694 (1992). An O−C plot using the AAVSO observations indicates that the published period of 0.34134848 days (Brancewicz and Dworak, 1980) was slightly long, but it was not clear whether the period was constant or whether there was a small period derivative.

The present note describes CCD photometry of EQ Tau done using the University of Iowa Automated Telescope Facility located in Iowa City, IA. The system consists of an 18cm refractor, a Spectrasource HPC-1 CCD camera (format 512×512 binned pixels, $3\overset{''}{.}00$ per pixel) and a Johnson R-band filter. We used the nearby GSC stars at $03^{\rm h}48^{\rm m}31\overset{\rm s}{.}3$, $+22°12'43''$, and $03^{\rm h}48^{\rm m}16\overset{\rm s}{.}2$, $+22°17'28''$, J2000) as check and comparison stars respectively. Each observation consisted of 45 second exposures of a field containing EQ Tau as well as the check and comparison star. This cycle was repeated every 5 minutes for several hours each night. The differential aperture photometry was performed by an automated procedure after aligning all images to a common stellar reference. No air mass or color corrections were applied. The system was observed during three epochs (1 Dec 1994, 8 Feb 1995, 25 Feb 1995). By combining all three epochs, we obtained the nearly complete light curve as shown in Figure 1. The minimum at phase 0.5 occurred at heliocentric Julian date 2,449,687.607±0.007. Note the ∼0.05 magnitude depression present between phase 0.7-0.85 in both February epochs only. We believe this is not an artifact and may have been due to an active region on the stellar surface which developed since the December 1994 observations.

The O−C measurements available from the AAVSO compilation clearly showed that the previously available ephemeris:

$$JD_{min} = 2,440,203.325 + 0.34134848 \times E$$

was slightly in error, although it was unclear whether the deviation could be better fit with a linear or a quadratic dependence. The present observations are in better agreement with a linear fit and new ephemeris given by

$$JD_{min} = 2,440,203.342 + 0.34134750(\pm 0.00000015) \times E$$

where the period uncertainty represents the 90% confidence bounds. A plot of the AAVSO observations, along with the minimum reported in this note, is shown in Figure 2.

Interesting parties can obtain the raw photometry data from the authors at the following e-mail addresses: *rlm@astro.physics.uiowa.edu* or *uwb@astro.physics.uiowa.edu.*

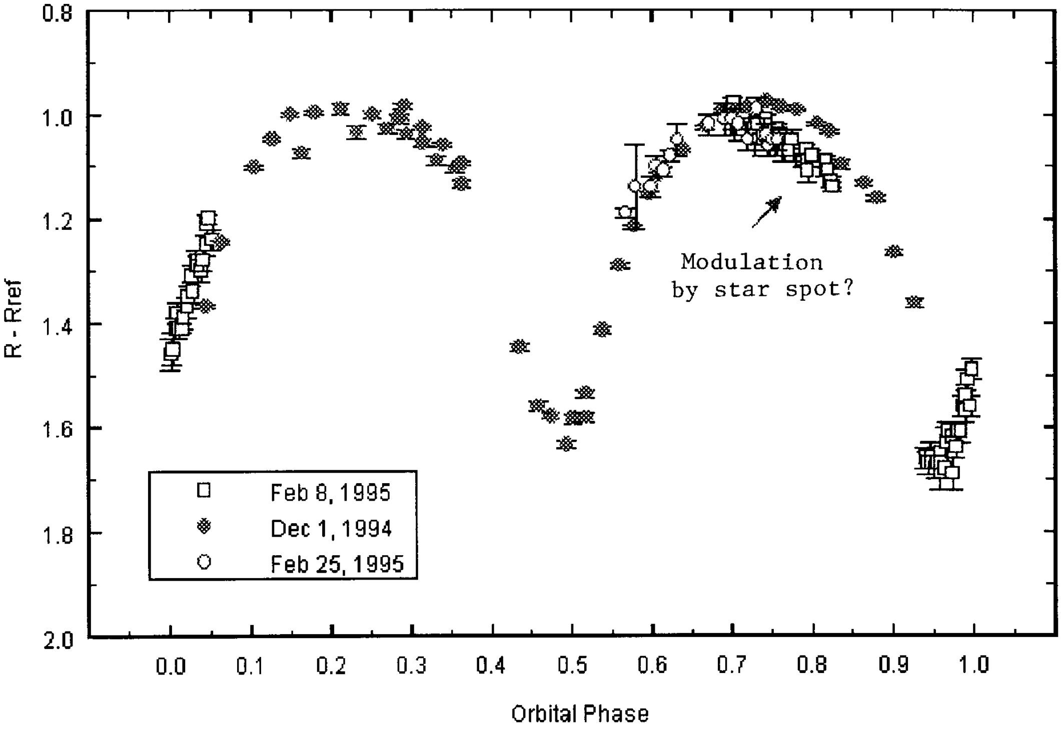

Figure 1. Light curve of EQ Tau. The depression evident near phase 0.7-0.8 seen during February 1995 may have been caused by a starspot.

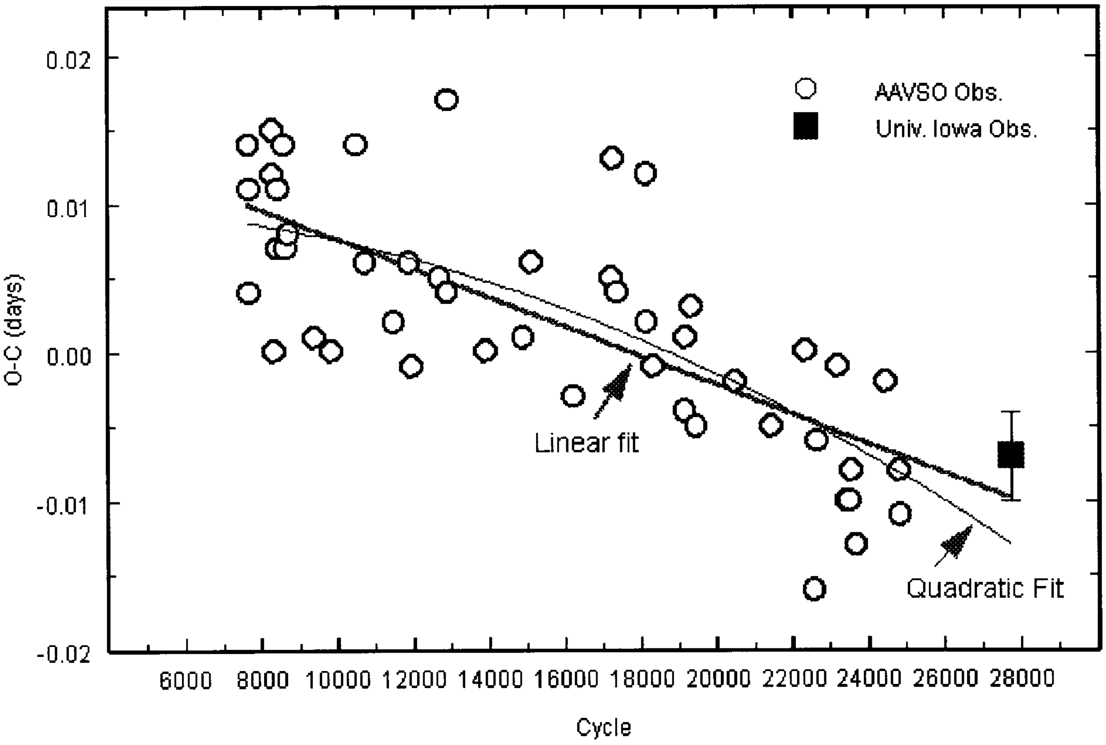

Figure 2. O−C plot for EQ Tau using JD=2,440,213.325+0.34134848·N, where N is the cycle number. A least-squares linear and quadratic fit is also shown. The linear fit represents the new ephemeris 2,440,203.342 + 0.34134750·N.

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W. R. BENBOW
R. L. MUTEL
Van Allen Observatory
Dept. Physics and Astronomy
University of Iowa
Iowa City IA 52242

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HD 147491 IS VARIABLE, BUT IT IS NOT A DELTA SCUTI STAR

Short-period variability of HD 147491 (α (2000.0) = $16\overset{m}{.}23^{m}23^{s}$, δ (2000.0) = $-26°22'$ 16", a few arcminutes north of the globular cluster M4) was claimed by Yao & Tong (1989, here after YT89) on the basis of 3 nights of photometry. Their observations implied a period of about 25 minutes. YT89 also gave arguments that this star has mid-A spectral type, using an estimate of the interstellar reddening of field stars in the direction of M4 and published UBV photometry. They concluded that HD 147491 is a new δ Scuti variable. Even earlier, Clementini (1979) suggested that this star is "likely to be variable", because her BVRI photometry disagreed with previously published results.

However, the data of YT89 were acquired at Beijing Observatory, located at a latitude of +40°, so that YT89 could never observe the star at air mass values lower than 2.5. Moreover, they neglected the spectral classification of HD 147491 from the Michigan Spectral Catalogue (Houk 1982), giving a spectral type of G0 V as well as the star's Hβ-index of 2.598 measured by Eggen (1983). Such a Hβ value is not typical of a δ Scuti star. Finally, YT89 find their estimated $(U-B)_0$ to be "too blue". If they dereddened the $(V-R_c)$ and $(V-I_c)$ colors of Clementini (1979) in the same way like the UBV photometry, they would have found further inconsistencies. On the other hand, assuming that HD 147491 is a G dwarf suggests that it is a foreground star relative to the objects adopted for the determination of interstellar reddening, and hence it could have lower reddening.

All this casts considerable doubt on the claim of YT89 that HD 147491 is a δ Scuti star. Therefore, it was decided to re-observe it in order to shed more light on its nature.

Observations and reductions: In March and April, 1995, HD 147491 was observed with the Modular photometer attached to the 50 cm telescope at the South African Astronomical Observatory, a dedicated instrument for high-precision photoelectric photometry. Keeping in mind the short period claimed for the star, the choice of the observing technique must be considered carefully.

In order to detect periods shorter than one hour, high-speed photometric observations can give excellent results (e. g. Handler et al., 1995), but this technique is not very useful in the presence of sky transparency variations (see Breger & Handler 1993). Therefore, it was decided to acquire differential photometry with two close comparison stars: this allows to compensate for transparency variations as well as to examine the data for possible variability of the comparison stars (the comparison star adopted by YT89 was HD 147592, for which the Michigan catalogue gives a spectral type of A0 V). Furthermore, by using close comparison stars the telescope can very quickly be moved from star to star.

For these purposes, HD 147592 (C1) and HD 147649 (C2, A5 III) were selected. Both objects are within less than 20 arcminutes distance from the program star HD 147491 (P). For each star, a 50 second integration in the V filter as well as a 10 second integration for sky background were made. The stars were observed in the order: C1–P–C2–C1–P–C2–...

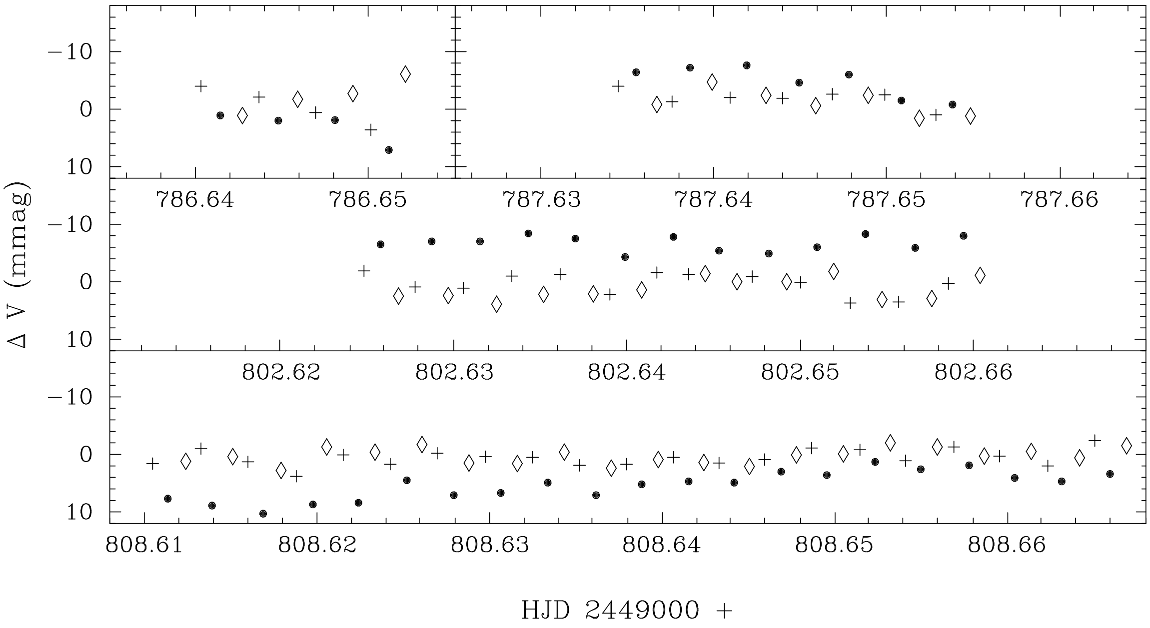

Figure 1: Differential time-series photometry of HD 147491 (filled circles), HD 147592 (crosses) and HD 147649 (diamonds)

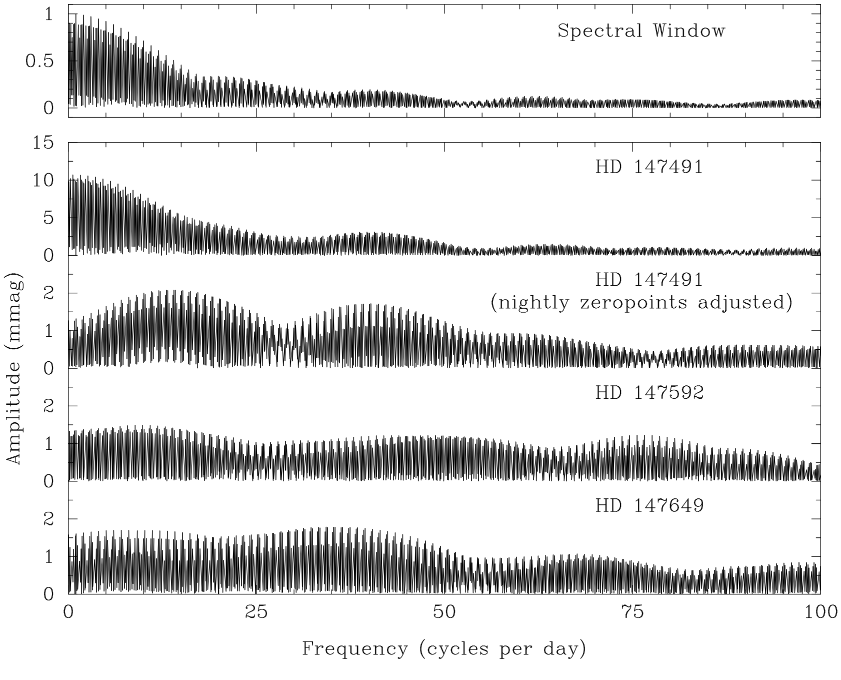

Figure 2: Amplitude spectra and spectral window of the data of Figure 1. The panels (from top to bottom) show the spectral window of the data, the amplitude spectrum of the program star data, as well as the amplitude spectra of the comparison star data.

Table 1. $UBVR_cI_c$ photometry of the program and comparison stars

Star	V	$B-V$	$U-B$	$V-R_c$	$V-I_c$
HD 147491	9.587	0.613	0.066	0.365	0.740
HD 147592	8.936	0.298	0.200	0.177	0.388
HD 147649	9.648	0.442	0.271	0.277	0.575

Thus, consecutive measurements of HD 147491 could be obtained about every 245 seconds (corresponding to a Nyquist frequency of 176 cycles per day), which is more than sufficient to detect a conjectured periodicity of 25 minutes. During the time-series photometric observations, the air mass never exceeded 1.07. As a further check of data quality, the E-region standards E690 (A2 V) and E629 (G5 V) were measured at the beginning of each run.

All data were corrected for dead-time losses as well as for sky background and mean extinction. Mean zeropoints (of all nights of observation considered together) of P, C1 and C2 were calculated relative to each other and subtracted from the time-series data. The zero-point subtracted data are plotted in Figure 1, where the variability of the program star is evident. It is also clear, however, that the light modulation occurs on a time scale much longer than 25 minutes. Moreover, Figure 1 shows that only very small transparency variations occurred during our measurements.

It should also be mentioned that the standard deviation of the zeropoints between the comparison stars and the E-region stars were comparable to the rms error of a single measurement of the standard stars. The rms errors of a single measurement of the data displayed in Figure 1 are 1.9 mmag for HD 147592, 2.1 mmag for HD 147649, but 6.0 mmag for HD 147491.

$UBVR_cI_c$ photometry was also acquired for these three stars (Table 1); the transformation into the standard system was secured by measuring several E-region standards. We conservatively estimate the rms errors with 0.020 mag in V, 0.010 mag in $B-V$ and $V-R_c$ as well as 0.015 mag in $U-B$ and $V-I_c$. Note that HD 147491 is variable and therefore the results for this star must be treated with caution.

Analysis and discussion: Since the photometric conditions were very stable during our observations, amplitude spectra can be calculated for each star separately, i.e. we do not consider differential data between the stars. These amplitude spectra are shown in Figure 2. Inspection of Figure 2 again suggests that the time scale of the variability of HD 147491 is longer than 25 minutes; it is at least several hours. However, the spectral window is far too complicated and the data are too sparse to make a more definite statement about the real time scale. In order to examine the possibility that the low-frequency variability could “mask” shorter-period variations, we have also calculated an amplitude spectrum for the HD 147491 data after removing the nightly zeropoint variations; once again there is no hint for a 25-minute periodicity.

What kind of variable can HD 147491 be? Considering the $UBVR_cI_c$ photometry in Table 1 as well as uvbyβ data for the star (Handler 1995), we find that it is unreddened. Hence, it is far too cool to be a δ Scuti star.

Applying the calibration of Crawford (1975), we find an absolute magnitude of $M_V = 4.0$. Thus, our results are perfectly consistent with Houk's (1982) spectral classification of HD 147491 (G0 V) as well as with colors measured by Lee (1977), and Clementini (1979).

Due to the small amount of data we obtained, we cannot pinpoint the cause of the light variability of HD 147491. However, we wish to emphasize that the star might be interesting for researchers studying variability of solar-type objects caused by starspots. If HD 147491 would be a related object, then its amplitude is rather high (note that Eggen (1983) found the star to be fainter than HD 147649) and it would be one of the most active solar-type stars. The photometric behavior of HD 147491 clearly requires a more thorough study. A spectrogram of the star with sufficient resolution to examine it for chromospheric emission or for a possible secondary spectrum would also be useful.

Summary and conclusions: We showed that HD 147491 is an early G-type main sequence star which exhibits light modulation on a time scale of at least several hours. Contrary to a previous claim, we demonstrated that it cannot be a δ Scuti star; it is far too cool.

It is suggested that authors reporting low-amplitude variability of certain objects critically check if the quality of their data is sufficient to assure that their claims are not a result of spurious effects, e. g. caused by the usage of a non-optimal observing technique. Quantitative statements about data quality (such as the rms scatter of comparison star measurements) are imperative.

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G. HANDLER
Institut für Astronomie
Türkenschanzstraße 17
A-1180 Wien, Austria
E-mail: HANDLER@ASTRO.AST.UNIVIE.AC.AT

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X PERSEI

The Be/X-ray binary X Persei is the optical counterpart of X-ray pulsar 4U 0352+30. Possible orbital period of the system is the 580 day periodicity detected in the radial velocities of the Balmer lines (Hutchings, 1977), in spite of existence of some doubts (Penrod & Vogt, 1985). The star is a known optical variable on time scales from minutes to years. The most comprehensive optical light curve over the past decades is presented by Roche et al. (1993).

X Per has been observed with 60 cm telescope and photon counting photometer of the National Astronomical Observatory Rozhen. HR 1197 (V=6.25, B−V=0.20, U−B=0.14) served as the comparison star. The APR software (Kirov et al., 1993) was used during the data reduction.

Our data are summarized in Table 1. Figure 1 presents the V band light curve over the period 1986-1995. Our observations showed the optical low state that began in the mid-1990 finished in the spring of 1993. Since this time the star has been in optical high state. A clear similarity between the light maximum in 1987-1988 and that in 1993-1994 is visible. The displacement is about 2400 days, i.e. 4 times larger than the supposed orbital period.

The last observations indicate that the optical high state is almost over and X Per is going to a new low state now. May be the star will lose its circumstellar disk again as it was observed in 1990 (Norton et al., 1991; Roche et al., 1993).

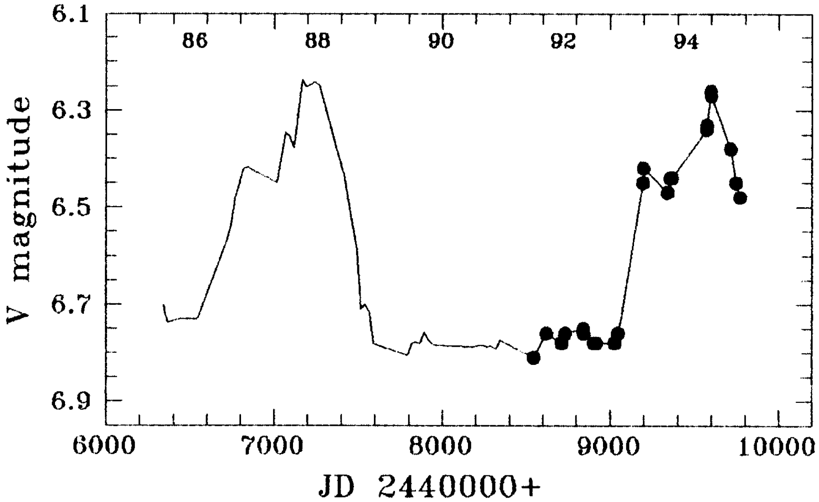

Figure 1. V band light curve of X Per. Circles indicate our data. The light curve before JD 2448500 is taken from Roche et al. (1993).

Table 1

JD 2440000+	V	B−V	U−B	JD 2440000+	V	B−V	U−B
8545.57	6.81	0.09	−0.68	9341.27	6.47	0.18	−0.78
8620.52	6.76	0.08	−0.64	9343.42	6.47	0.19	−0.78
8712.29	6.78	0.11	−0.73	9357.43	6.44	0.20	−0.78
8734.26	6.76	0.05	−0.68	9366.46	6.44	0.19	−0.78
8841.52	6.75	0.13	−0.66	9572.51	6.34	0.26	−0.73
8842.56	6.76	0.11	−0.67	9573.52	6.33	0.26	−0.73
8905.56	6.78	0.09	−0.70	9597.50	6.26	0.26	−0.73
8916.42	6.78	0.09	−0.70	9598.48	6.27	0.24	−0.73
9028.22	6.78	0.05	−0.66	9715.32	6.38	0.21	−0.75
9046.26	6.76	0.06	−0.66	9748.23	6.45	0.21	−0.81
9195.55	6.45	0.21	−0.75	9772.23	6.48	0.21	−0.83
9197.54	6.42	0.21	−0.76				
9340.28	6.47	0.18	−0.79				

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R. K. ZAMANOV
NAO Rozhen, POB 136,
4700 Smoljan, Bulgaria

V. I. ZAMANOVA
Planetarium, POB 132,
4700 Smoljan, Bulgaria

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PHOTOELECTRIC OBSERVATIONS OF THE ECLIPSING VARIABLE ER VULPECULAE

The eclipsing binary system ER Vul with the period of 0.6980960 days (Northcott and Bakos, 1967) was observed during four nights, 29 July-1 August, 1994, with the 51 centimeter Cassegrain telescope of Birouni Observatory (Iran, Shiraz, latitude=29°36' N, longitude=52°31'48" E) using a photoelectric photometer equipped with an unrefrigerated RCA 4509 photomultiplier tube. The observations were made through UBV filters which are approximately in the standard system. The probable errors of a single observation were estimated to be about ±0.01 in the three colours, i.e., corresponding to a measure of the observational scatter at a particular phase. The variable was observed differentially with respect to the comparison star HD 200270. The star HD 200425 was observed as check star.

Figures 1,2 and 3 show the UBV light curves for ER Vul, respectively.

The following light elements given by Ibanoglu et al. (1985) were used in computing the phases of the individual observations:

$$\text{Min. I=J.D. Hel. } 2440182.2621+0^{d}.69809409\times\text{E}.$$

Table 1 indicates the photoelectric minimum times of ER Vul, in the three different filters.

Table 1

J.D. Hel. 2449000+	Filter	Min.
563.26074	U	II
563.25953	B	II
563.24449	V	II
564.29480	U	I
564.31173	B	I
564.28007	V	I

Table 2

Date	Phase
29 July 1994	0.9448-0.1319
30 July 1994	0.3403-0.5707
31 July 1994	0.7729-0.9826
1 August 1994	0.2146-0.4309

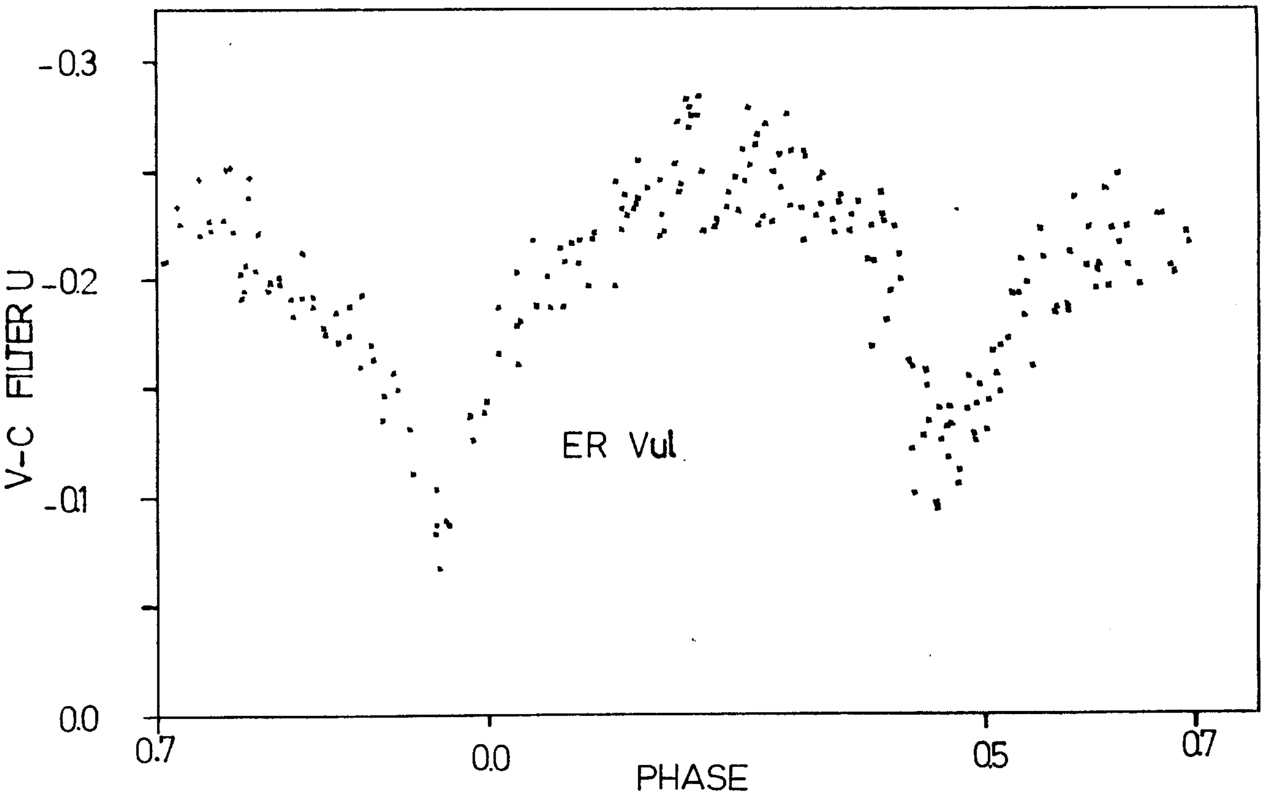

Figure 1

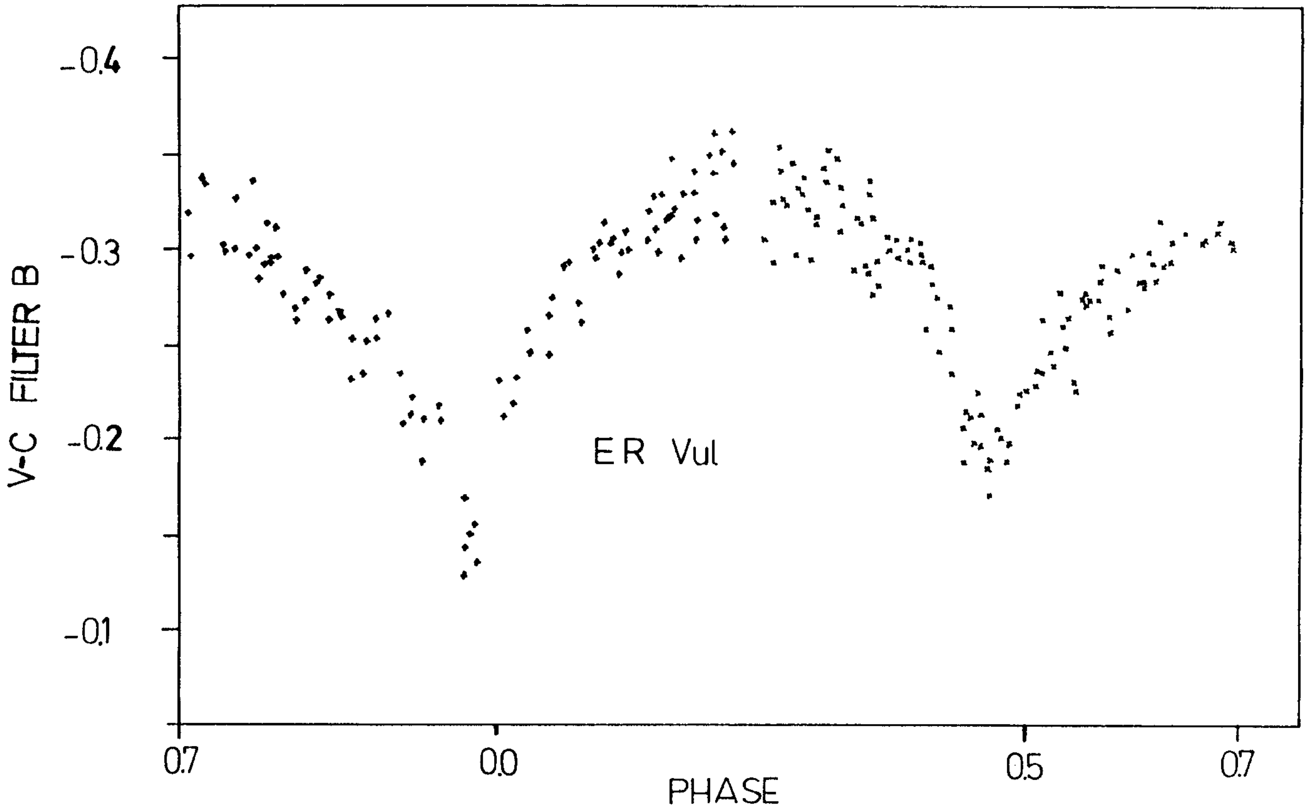

Figure 2

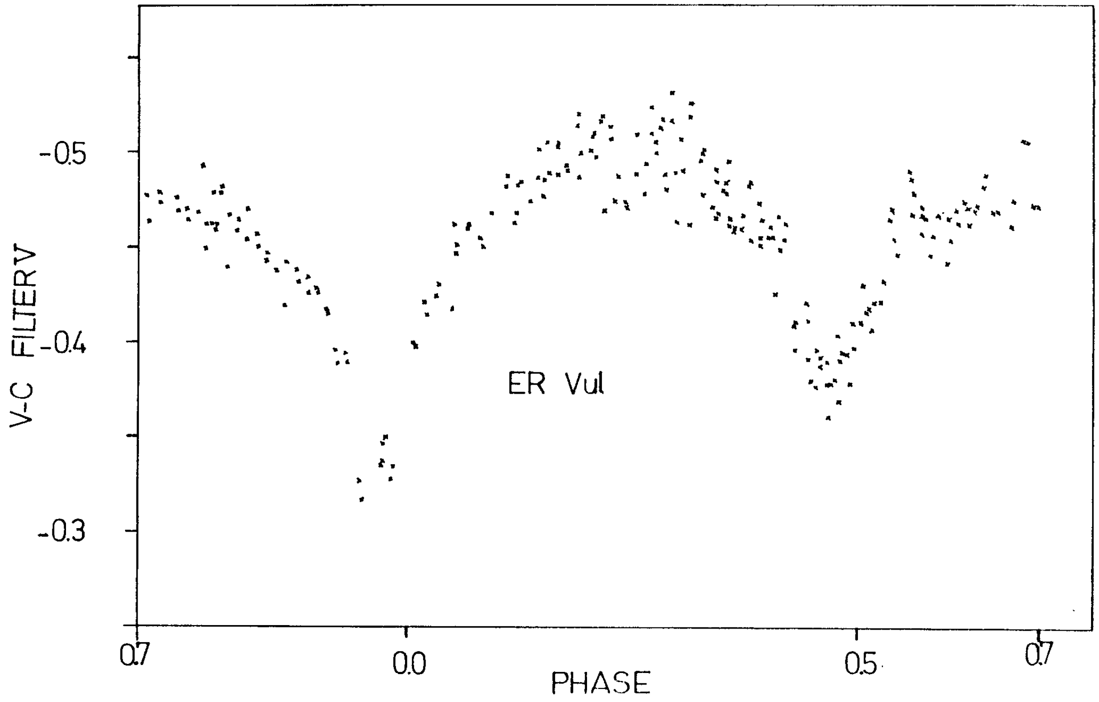

Figure 3

Our observations indicate the existence of asymmetry, especially in the beginning of the ascending part of the secondary minimum. These phenomena can be explained as a result of the presence of a gaseous stream flowing from the secondary to the primary component, starting off roughly in the inner Lagrangian point and falling behind the primary as that star moves round on its orbit (Struve, 1947). Also we see in our observations a shift for primary and secondary minima from phases zero and 0.5.

Table 2 lists the dates of observations and phases covered. The data has been folded so that both primary and secondary minima are clearly visible. These observations do indicate proximity effects, wave-like distortions, mutual eclipses and short-term light fluctuations (see Northcott and Bakos (1967)).

F. ZEINALI
M.T. EDALATI
Physics Dept.,
School of Sciences
University of Ferdowsi,
Mashad, Iran

M.T. MIRTORABI
Birouni Observatory
University of Shiraz,
Shiraz, Iran

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CONFIRMATION OF VARIABILITY IN THE λ BOOTIS STARS HD 142994 AND HD 142703

For the λ Bootis star HD 142994 two nights of differential photometry were obtained in the Strömgren photometric system. The observations were done by E. Paunzen with the ESO 50 cm telescope at La Silla during the nights of 25/26 and 27/28 July 1994. An integration time of 15 seconds was chosen. HD 143181 (m_V= 7.4, B9V) and HD 143232 (m_V= 6.8, F0) were used as comparison stars. The second comparison star was detected as a new δ Scuti star, which will be presented in a forthcoming IBVS-note (Paunzen et al., unpublished).

The variability of HD 142994 has been investigated by Weiss et al. (1994), where a semi-amplitude of 0.03 mag in Strömgren b with a period of about 4 hours had been derived. This photometry was not differential because at that time we were mainly interested in roAp–type variability. Hence we had to rely in our analysis on a constant sky transparency. Furthermore, the data sets obtained during the three nights were rather short, on the order of 2.5 hours each.

As part of our survey of pulsation among λ Bootis stars we decided to reobserve HD 142994 in two colors with the classical technique using two comparison stars (Fig. 1). Our new observations confirm the semi-amplitude of 0.031 mag in Strömgren b and of 0.037 in Strömgren v. However, the maximum amplitude in the frequency spectrum is found at a shorter period of about 3 hours (7.9 c/d, Fig. 2). This difference may be caused by the fact that our earlier data sets have an extremely poor duty cycle as well as a short time base, which did not allow us to resolve multiperiodicity and hence may have led us to a different period. HD 142994 obviously pulsates in more than one frequency, because amplitude modulation is evident already in our rather limited data set.

The periods of pulsating λ Bootis stars usually are in the range of 0.8 to 2.1 hours. These values satisfy the PLC-relation of Stellingwerf (1979) for early A-type stars at the ZAMS. Effective temperature and gravity of HD 142994 indeed are typical for an early A-type star. But this λ Bootis star pulsates with a period which is too long for a star at the ZAMS. This evidence may indicate that HD 142994 is evolved. An extensive observing campaign is required to investigate the evolutionary status of this star.

Two additional nights of differential photometry in the Strömgren system were obtained by the same observer for the λ Bootis star HD 142703 with the ESO 50 cm telescope (23/24 and 24/25 July 1994). The integration time was 15 seconds. HD 142640 (m_V=6.4, F6V) and HD 143333 (m_V=5.5, F7V) were used as comparison stars (Fig. 3).

HD 142703 was previously observed in 1993 (Paunzen and Weiss, 1994) and found to be variable. The amplitude was much smaller (5 mmag) than in the case of HD 142994 and in addition the photometric quality of the nights was not excellent. To corroborate the variability of HD 142703, we reobserved this star in 1994.

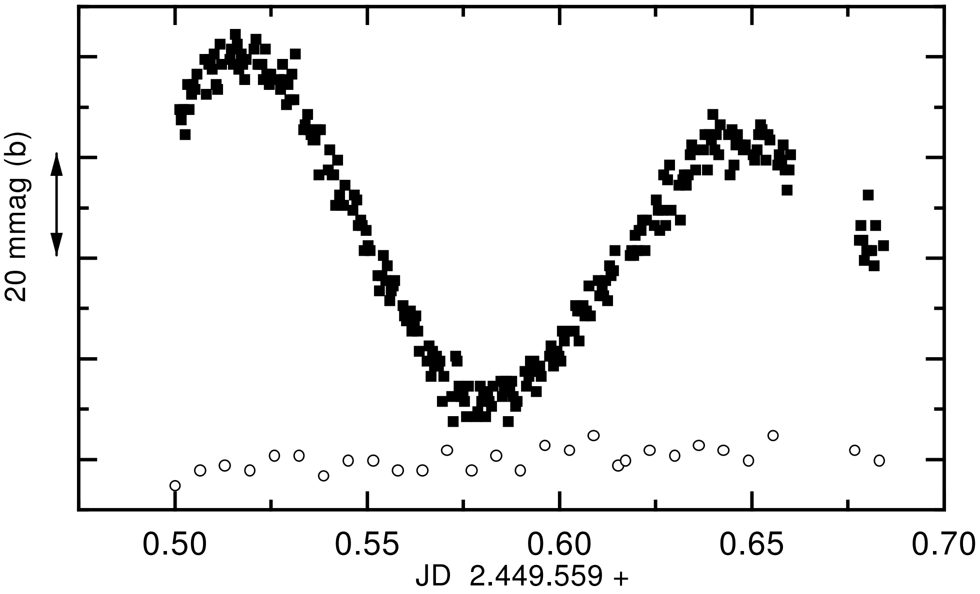

Figure 1. Light curves for Strömgren b of HD 142994 (top) and HD 143181 (bottom) for the night of 25/26 July 1994

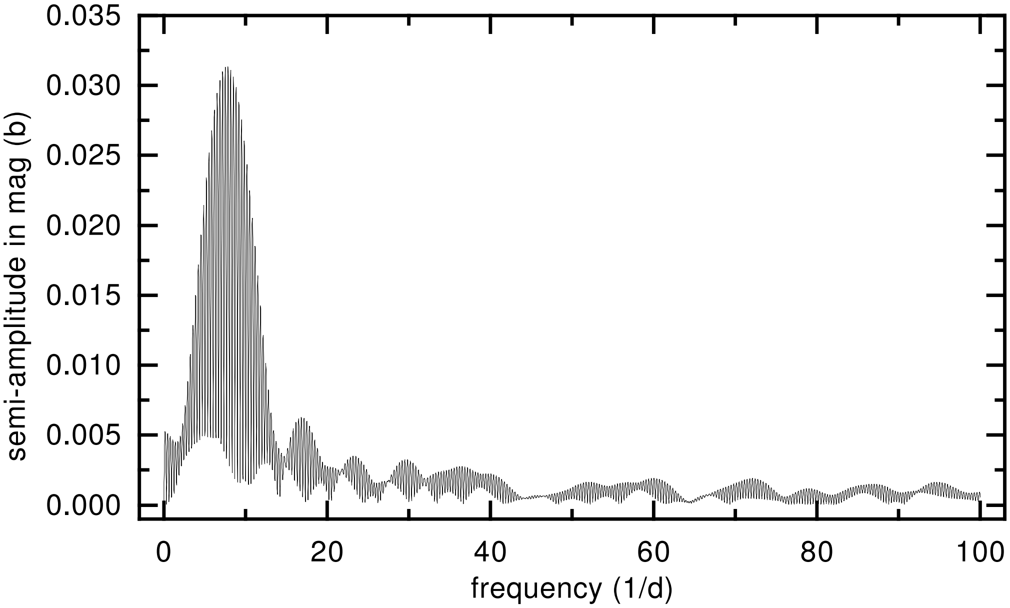

Figure 2. Amplitude spectrum of the differential data (HD 142994 – HD 143181) for both nights and for Strömgren b

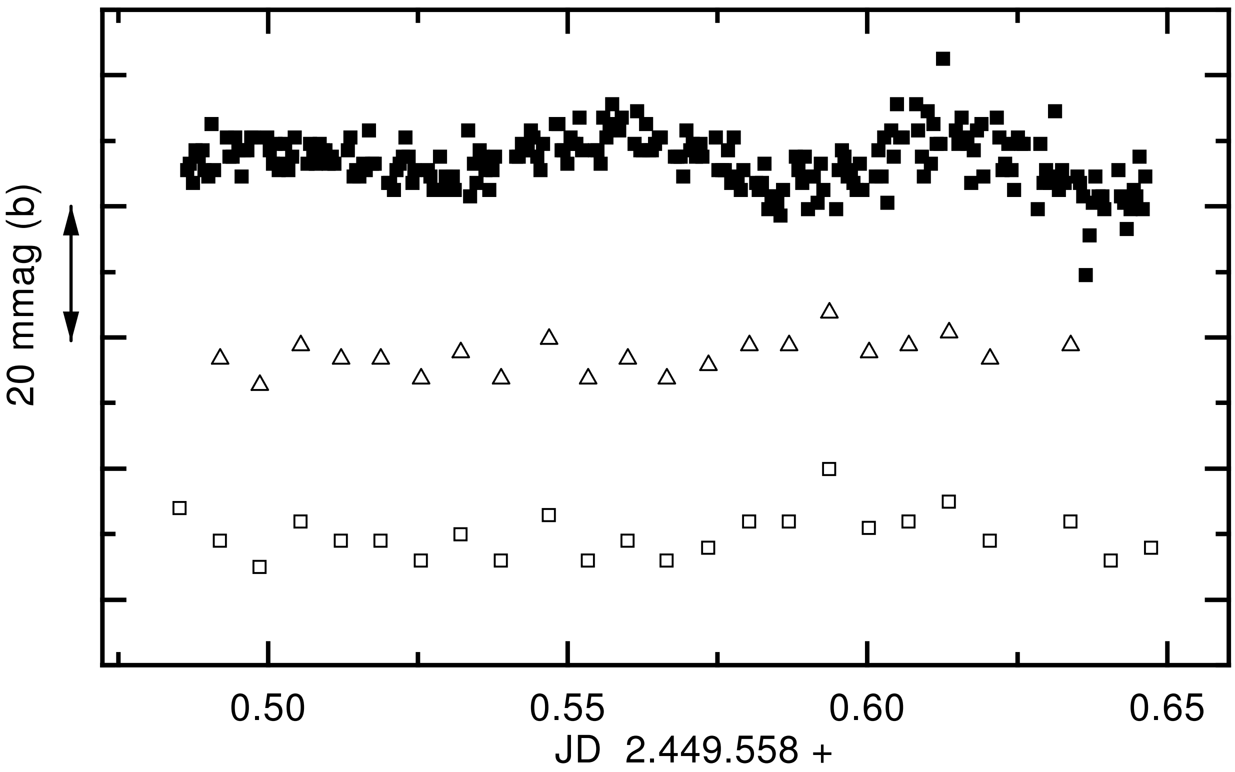

Figure 3. Light curves for Strömgren *b* of HD 142703 (top), HD 142640 (center) and HD 143333 (bottom) for the night of 23/24, July 1994

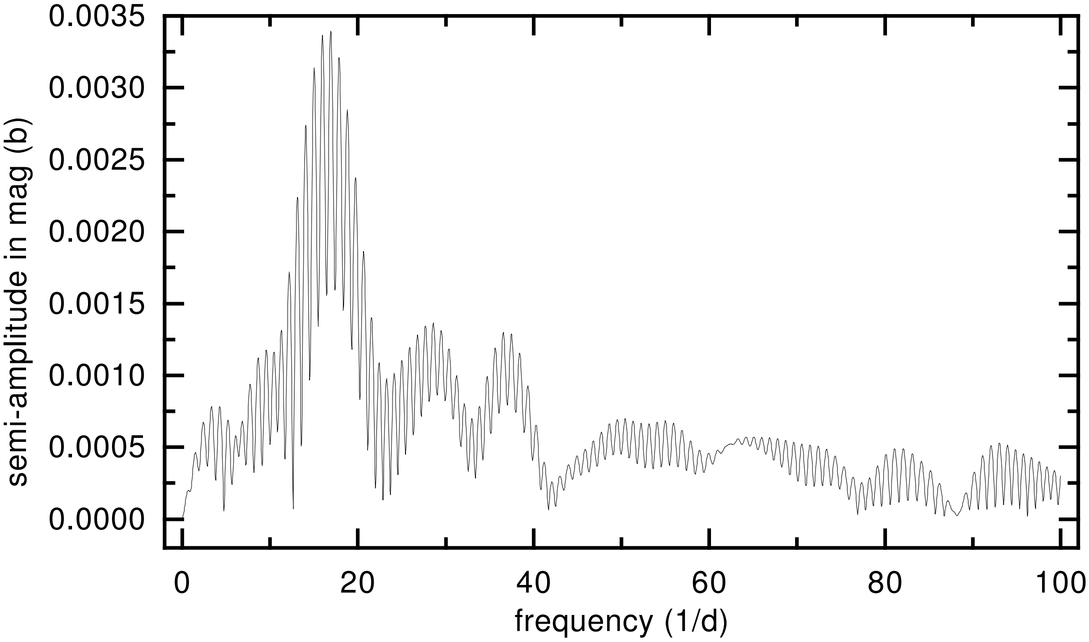

Figure 4. Amplitude spectrum of the differential data (HD 142703 – HD 142640) for both nights and for Strömgren *b*

Our new observations result in a frequency of about 16.5 c/d (P=87 minutes) for *b* and a semi-amplitude of slightly more than 3 mmag for *b* and *v*, which is less than what we found in 1993. The derived period happens to be about twice the period found in 1993 (P=46 min) which again may be caused by inadequate data sets aggravated by multiperiodicity. Presently, we can only state that there is no doubt about the photometric variability of HD 142703. A full analysis of this variable star can only be based on improved data, preferably obtained within a multi-site observing campaign.

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E. PAUNZEN
U. HEITER
W.W. WEISS
Institut für Astronomie
Türkenschanzstr. 17
A-1180 Wien, Austria
E-mail: PAUNZEN@ASTRO.AST.UNIVIE.AC.AT

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THE ACTIVE STAR RE0041+342

The sky was surveyed in the extreme ultraviolet by the satellites ROSAT (Pounds et al. 1993) and EUVE (McDonald et al., 1994) and from the catalogues of these sources I have been looking for brightness variations in the F, G, and K spectral type stars. This is a report about one of these stars namely RE0041+342=BD+33°94.

The automated 0.5-m. telescope, R filter and CCD camera of the Climenhaga Observatory of the University of Victoria was used to make these photometric observations (Robb et al., 1992).

The frames had the bias subtracted and were flat-fielded in the usual manner using IRAF. The magnitudes were found from aperture photometry using the PHOT package of DAOPHOT (Stetson 1987). The coordinates of each star for photometry were found from inspection of a few frames taken at the beginning, middle and end of the night. These positions were used as initial positions for the Gaussian centering option which precisely centered the 6 arc second aperture on each star for each frame.

The mean and standard deviation of the comparison=BD+33°95 minus check star R magnitude differences are 3.437 ± 0.017 ensuring the constancy of both stars at this level. Due to the small field of view first order extinction effects were negligible and no corrections have been made for them. No corrections have been made for the colour difference between the stars to transform it to a standard system.

A spectrum of RE0041+342 was obtained using the Dominion Astrophysical Observatory's 1.8-m. telescope and 2131B spectrograph on the 6 January 1994 UT, with a dispersion of 1.5 Angstroms per pixel. It is shown in Figure 1 with a spectrum of HR 1099, a well known RS CVn star of spectral type K0V, and a spectrum of Beta Cancri, classified as K4III (Yamashita et al. 1978). Pounds et al. (1993) report a spectral type of Ge. RE0041+342 has obvious emission in the Ca H and K lines indicating an active chromosphere. This emission would tend to make one cautious about using the hydrogen lines to make a classification, since such an active star often has some hydrogen emission as well. Inspection of the G-Band and the Fe I 4272 and Cr I 4290 lines lead me to classify the star as a K3Ve.

Photometric observations of RE0041+342 were begun on Julian Date 2449315 and are plotted in Figure 2. It is obvious that there was a large brightening of the star at 4 hours UT. This star was monitored on 23 nights and at no time was a similar brightening observed. The cause of the brightening then must be a large flare. UV Ceti type flare stars have a spectral type of late K or M and flares generally of a few minutes duration but small amplitudes in the red region of the spectrum.

Very energetic flares have been seen on the close binary star V711 Tau = HR 1099, by Zhang et al. (1990) reporting an amplitude of 0.18 in V and a duration of 4.5 hours and by Henry and Hall (1991) reporting an amplitude of 0.424 in V and a duration of 6 or 7

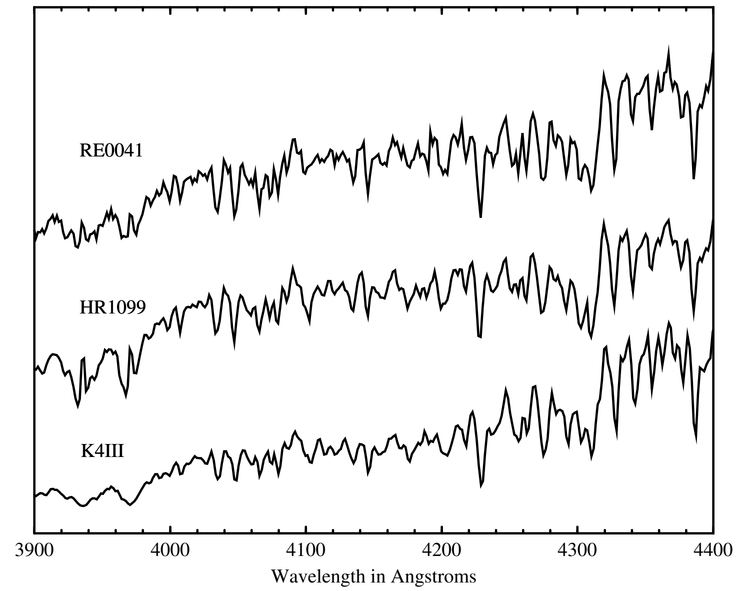

Figure 1. Spectra of RE0041+342, HR1099, and Beta Cancri

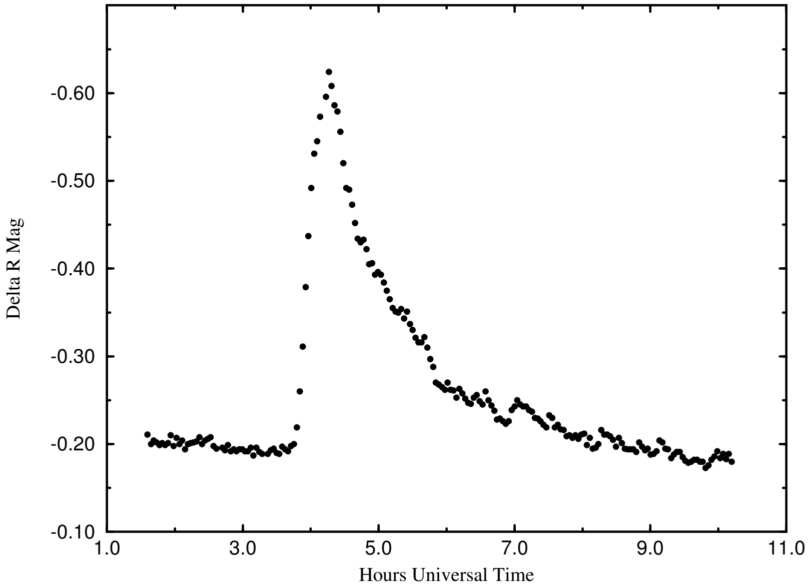

Figure 2. Differential R magnitude as a function of Universal Time for RE0041+342 on 24 Nov 1993

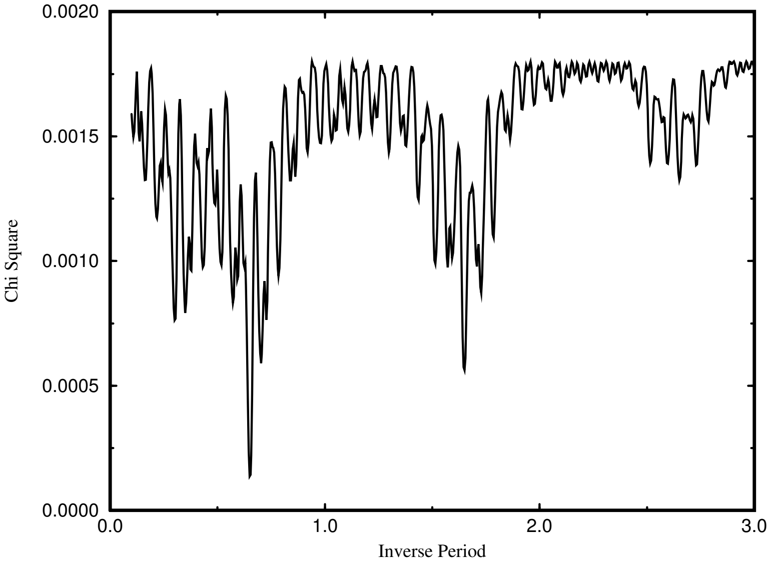

Figure 3. Periodogram of the August 1994 data

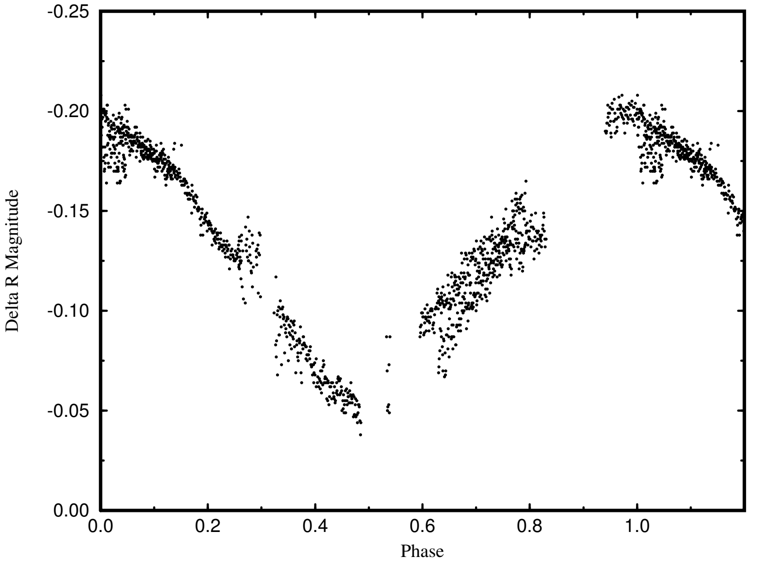

Figure 4. Differential R magnitude phased on a period of 1.536 days for August 1994

hours. An even larger flare may have been the one seen on FK Comae (G2III) reported by Morris and Milone (1983). The R band amplitude of the flare on RE0041+342 was 0.39 magnitudes and its duration was about 3 hours. Thus the flare observed on RE0041+342 was exceptionally large but not unique.

During the winter of 1993-1994 variations of brightness from night to night were obvious and the few long nights showed that the period of the variation must be more than a few hours. However periodograms of this data were inadequate to reveal a believable period. Observations were made on eight more nights in the summer of 1994 and a sine curve fit to this data reveals a minimum chi squared at a period of 1.536 ± 0.025 days as seen in Figure 3.

A plot of the differential R magnitudes for the summer 1994 data phased at this period is shown in Figure 4. In spite of six of the nights being observed in one week, there is some variation in the mean brightness from night to night. The winter data phased on this period show a similar light curve with a slightly different shape. Three more nights were observed in September 1994 and showed no detectable variation and a mean difference in R magnitude of -0.14. So the variations are probably caused by starspots and differential rotation or spot evolution cause the brightness variations to change on a monthly time scale. Since the brightness variations are not strictly periodic, the period found is only approximately that of the rotation of the star.

RE0041+342 is a rapidly rotating K4V star with active regions on its surface causing brightness variations, EUV emission, Ca H and K emission, and flares. The author wishes to thank David Balam for assistance in obtaining the spectra at the DAO.

R. M. ROBB
Visiting Astronomer at the
Dominion Astrophysical Observatory
and the
Climenhaga Observatory
of the Dept. of Physics and Astronomy
University of Victoria
Victoria, BC, CANADA, V8W 3P6
Internet: robb@uvphys.phys.uvic.ca

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HS VIRGINIS – A DWARF NOVA WITH 8-DAY OUTBURST CYCLE LENGTH

HS Vir was discovered as an ultraviolet excess object PG 1341−079 and was subsequently confirmed by spectroscopy to be a cataclysmic variable by Green et al. (1982, 1986). They reported two magnitude variability, but its nature remained little revealed. Some authors have classified this object as a nova-like star, others as a dwarf nova with a small amplitude.

Photographic photometry was undertaken by Osminkin (1985), who showed existence of relatively frequent short, faint outbursts, and presence of a bright (~12.8 mag) outburst. Unfortunately Osminkin's observations were so sparsely done that the materials were not enough to determine the outburst parameters or the dwarf nova subtype. Howell et al. (1990) tried to get the orbital period of this system by photometry made during quiescence, but the result remained inconclusive.

Another important observation was carried out by Ringwald (1993). He obtained a number of radial velocity mesurements, and derived the best estimate of the orbital period of 0.0836 day (with possible aliasing problems), which is just below the lower edge of the period gap. This suggests that HS Vir may be a candidate of SU UMa-type dwarf nova (for a review, see Warner 1985). One problem of this suggestion is that HS Vir has much smaller outburst amplitude (mostly 1 mag) which makes a clear contrast to usual SU UMa-type dwarf novae. However, recent discovery of a new subgroup of low outburst-amplitude SU UMa-type dwarf novae, named ER UMa stars or RZ LMi stars (Kato and Kunjaya 1995; Nogami et al., 1995; Robertson et al., 1995; Misselt and Shafter 1995; hereafter ER UMa stars) has called our attention to HS Vir with a similar outburst amplitude.

Observations were carried out using a CCD camera (Thomson TH 7882, 576 × 384 pixels) attached to the Cassegrain focus of the 60 cm reflector (focal length=4.8 m) at Ouda Station, Kyoto University (Ohtani et al., 1992). To reduce the readout noise and dead time, an on-chip summation of 2×2 pixels to one pixel was adopted. An interference filter was used which had been designed to reproduce the Johnson V band. The exposure time was between 30 and 120 s. The frames were first corrected for standard de-biasing and flat fielding, and were then processed by a microcomputer-based automatic-aperture photometry package developed by one of the authors (T.K.). The differential magnitudes of the variable were determined using a local standard star [C_1: $13^{\mathrm{h}}43^{\mathrm{m}}24\overset{\mathrm{s}}{.}84$ $-08^\circ1'25\overset{''}{.}2$ (J2000.0), V=12.2: The position and magnitude were taken from the Guide Star Catalog]. The constancy of this comparison was checked against several stars in the same field (C_2 and C_3; see Figure 1).

The resulting general light curve is given in Figure 2. The light curve first clearly established the dwarf-nova nature of HS Vir, with a very stable outburst cycle length of

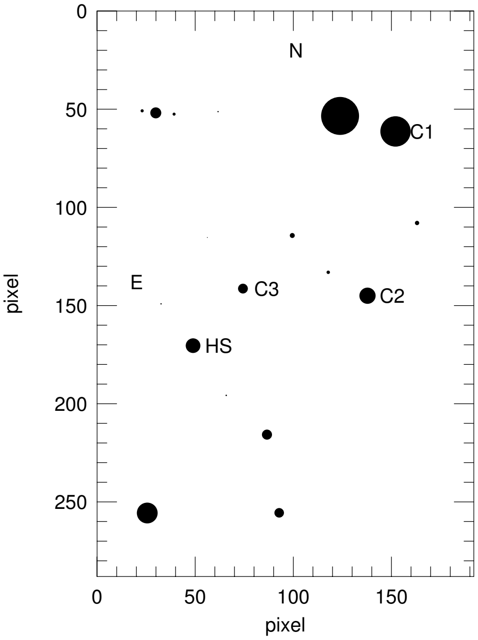

Figure 1. Field map of HS Vir. The field of view is about 6×9 arcmin. The variable (HS), comparison (C_1) and check stars (C_2 and C_3) are marked. The C_2 and C_3 were measured to be fainter than C_1 by 2.72±0.01 and 3.85±0.01 mag, respectively.

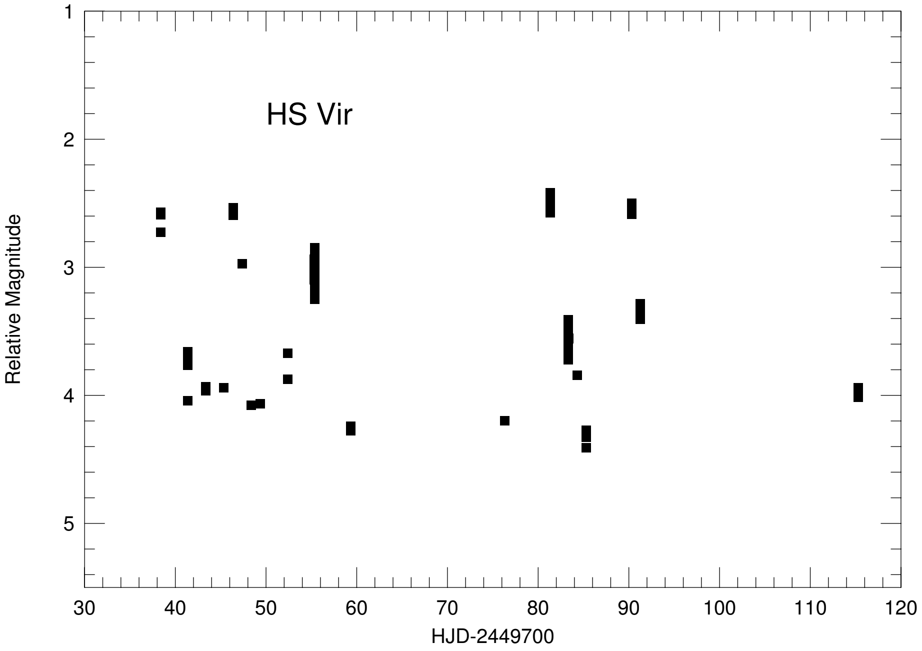

Figure 2. *V*-band light curve of HS Vir. The zero point of the relative magnitudes corresponds to *V*=12.2. Regular short outbursts spaced by 8 days are evident.

8 days. The observed amplitudes of outbursts were 1.1–1.8 mag, which are clearly smaller than those of usual dwarf novae. Other important points are the shortness of outbursts (one or two days), and the rapid decline up to 1.1 mag d^{-1} from the outburst peak. The shortness and the rapid decay of outbursts are very characteristic of normal outbursts of SU UMa-type dwarf novae. The shortest known recurrence time of normal outbursts in SU UMa stars had been 8 days in YZ Cnc, before the discovery of ER UMa stars. This value of HS Vir closely matches that of YZ Cnc, except outburst amplitudes, which are more similar to those of ER UMa stars. Although we have not yet detected superoutburst nor superhumps in this system, a search for these phenomena would surely bring the long confusing history of HS Vir to an end, and would prove the position of HS Vir among a group of low outburst-amplitude SU UMa-type dwarf novae, i.e. YZ Cnc, ER UMa stars and V503 Cyg (Harvey et al., 1995).

A record of the brightest outburst on JD 2443667 by Osminkin (1985), although severely undersampled, shows that this outburst lasted more than three days, and this outburst may be identified as a superoutburst. Confirmation of superoutbursts and superhumps, and determination of supercycle (recurrence time of superoutbursts) will be a next important step toward full understanding of this rather peculiar dwarf nova.

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Taichi KATO
Daisaku NOGAMI
Seiji MASUDA
Ryuko HIRATA
Dept. of Astron., Faculty of Sci.
Kyoto University
Sakyo-ku, Kyoto 606-01 Japan

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TIMES OF MINIMA OF EIGHT ECLIPSING BINARIES

We report times of minima of eccentric eclipsing binaries derived from photometric observations made at Ege University Observatory in Turkey and at Cerro Tololo Interamerican Observatory (CTIO) in Johnson B and V filters, and at the High Altitude Maidanak Observatory in Uzbekistan in Johnson U,B,V,R filters. Heliocentric times of minimum were estimated for each filter by using the method of Kwee and Van Woerden (1956) as adapted to a Macintosh computer. The adopted time of minimum was then the average over all filters. In all cases the times of minimum in different filters was concordant. Uncertainties in the times of minima were estimated from the values of standard error computed by the method and from the differences in times derived from the various filters used. Primary eclipses are designated as type 1 eclipses, and secondary eclipses as type 2.

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Claud H. SANDBERG LACY
Department of Physics
University of Arkansas
Fayetteville, Arkansas 72701
USA

Cafer IBANOGLU
Z. TUNCA
S. EVREN
C. AKAN
V. KESKIN
Ege University
Bornova-Izmir
Turkey

Mamnun ZAKIROV
G. ARZUMANYANTS
R. ISHANKULOV
V. KHARCHENKO
High Altitude Maidanak Observatory
Astronomical Institute
Tashkent 700052
Uzbekistan

Reference:
Kwee, K.K., and van Woerden, H., 1956, *B.A.N.*, **12**, 327

Star	JD of Min −2400000	Type	Observatory
IT Cas	49539.3517 ± 0.0008	1	Maidanak
	49578.3208 ± 0.0008	1	Maidanak
	49580.4645 ± 0.0007	2	Maidanak
	49582.2160 ± 0.0006	1	Maidanak
PV Cas	49185.4198 ± 0.0007	2	Ege
	49192.4169 ± 0.0010	2	Ege
	49199.4214 ± 0.0005	2	Ege
	49213.4274 ± 0.0005	2	Ege
	49214.3002 ± 0.0006	1	Ege
	49220.4276 ± 0.0008	2	Ege
	49249.3055 ± 0.0005	1	Ege
	49256.3077 ± 0.0002	1	Ege
	49277.3135 ± 0.0004	1	Ege
	49529.3793 ± 0.0006	1	Maidanak
	49570.5228 ± 0.0003	2	Ege
	49578.3945 ± 0.0004	1	Ege
	49592.3961 ± 0.0006	1	Maidanak
EK Cep	49195.5084 ± 0.0002	1	Ege
	49204.3642 ± 0.0001	1	Ege
	49255.4783 ± 0.0010	2	Ege
	49567.4431 ± 0.0003	1	Ege
	49607.2935 ± 0.0002	1	Ege
V541 Cyg	49560.2668 ± 0.0008	1	Maidanak
V364 Lac	49223.4042 ± 0.0005	2	Ege
	49278.4195 ± 0.0005	1	Ege
	49594.5363 ± 0.0006	1	Ege
FS Mon	49727.8277 ± 0.0003	2	CTIO
FT Ori	41575.5136 ± 0.0003	1	Ege
	41675.5043 ± 0.0005	2	Ege
	49721.5833 ± 0.0007	2	CTIO
	49724.7338 ± 0.0003	2	CTIO
	49725.6427 ± 0.0001	1	CTIO
GG Ori	48590.3086 ± 0.0007	1	Maidanak
	48911.4212 ± 0.0007	2	Maidanak
	48948.4090 ± 0.0012	1	Maidanak
	49366.1968 ± 0.0010	1	Maidanak
	49717.6624 ± 0.0002	1	CTIO

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A LIST OF VARIABLE STARS SIMILAR TO γ Dor

In this note we compile data on stars that appear to constitute a new class of variable stars. These stars typically have spectral types near F0 and luminosity classes of V or IV-V. They are variable up to 0.1 mag in V on a time scale of 0.5 to 3 days – an order of magnitude longer than the fundamental radial pulsation period for stars of this density. Some exhibit two or more frequencies. The evidence is that these stars are variable owing to non-radial g-mode pulsations. Given that γ Dor was the first one found to be variable (Cousins & Warren 1963), it has been suggested that they be known as "γ Doradus stars". Our list is a consequence of the rapidly growing scientific interest in these stars. For instance, multi-longitude campaigns are planned for four of the stars during 1995; these are necessary to avoid aliasing of the frequencies of variation for stars with $\approx$ 1 day periods.

In Tables 1, 2, and 3, respectively, we give various data on the bona fide members of the group, on other candidates, and on one star formerly regarded as being of the γ Dor type. The coordinates are equinox 2000. The photometric periods are given in days. The projected rotational velocities v sin i are in km s^{-1}. Table 1 is only for stars with a considerable amount of available data. Table 2 contains all objects we found in the literature which were reported to be related with the γ Dor phenomenon. In the tables we provide Strömgren photometry from Hauck & Mermilliod (1990) supplemented by new observations of Handler (1995). In the references we include only published papers. We do note, however, that Zerbi (private communication) informs us there is a paper in preparation on NGC 2516 which provides evidence for additional four γ Dor candidates in that cluster.

Table 1. Bona Fide Members

Star	HD	$< V >$	$(b-y)$	m_1	c_1	β
RA	DEC	Sp	Period(s)	$v \sin i$	Remarks	References
	224945	6.9	0.192	0.147	0.719	2.743
00:02:02.4	−02:45:59	(F0)	1.072, 1.495	55		11, 12, 14
γ Dor	27290	4.25	0.201	0.173	0.658	2.742
04:16:01.0	−51:29:21	F0 V	0.733, 0.757	62		2, 3, 21
9 Aur	32537	5.00	0.217	0.152	0.642	2.723
05:06:40.7	+51:36:01	F0 V	1.258, 2.895	18	1	4, 13, 16
2 Pup B	62683	6.89	0.201	0.165	0.634	2.727
07:45:28.7	−14:41:09	A8 V	1.92 or 0.48			20
	164615	7.06	0.230	0.178	0.624	2.715
18:01:32.9	+11:17:08	F2 IV–V	0.815	60		9, 10
	224638	7.2	0.198	0.157	0.680	2.726
23:59:34.5	−01:51:02	(F0)	1.233, 1.460	24		11, 12, 14

Table 2. Other Candidates

Star	HD	$< V >$	$(b-y)$	m_1	c_1	β
RA	DEC	Sp	Period(s)	$v \sin i$	Remarks	References
	23375	8.58	0.228	0.172	0.719	2.765
03:45:34.4	+24:27:50	A9 V	> 0.2	75		1
NGC 2516 C52		10.29	0.278	0.176	0.673	2.761
7:55:52	−60:24:37		0.2-0.4		2	5
NGC 2516 C69		11.21	0.282	0.117	0.739	2.761
7:56:19	−60:36:59		0.2-0.4			5
NGC 2516 C93		11.13	0.263	0.144	0.797	2.776
7:54:25	−60:30:40		0.2-0.4			5
NGC 2516 C96		11.23	0.257	0.151	0.720	2.766
7:54:13	−60:35:09		0.2-0.4			5
τ^1 Hya	81997A	4.60	0.296	0.164	0.448	2.661
9:29:08.4	−02:46:07	F6 V	(days)	25		18
	106103	8.12	0.264	0.160	0.449	2.675
12:12:24.9	+27:22:49	F4 V	(0.83)	6	3	19
γ Vir	110379/80	3.48	0.242	0.152	0.522	2.708
12:41:41.4	−01:26:58	F0 V	?	28	4	23
	111829	9.46	0.228	0.100	1.000	2.806
12:53:41.3	−74:53:46	A1 IV-V	1.8 ?		5	8
	117777	9.25				
13:32:03.3	+28:35:05	F2 V	(1)			22
BS 8799	218396	5.99	0.181	0.142	0.678	2.745
23:07:28.3	+21:08:05	A5 V	0.510	45		17

Table 3. Star formerly on the list

Star	HD	$< V >$	$(b-y)$	m_1	c_1	β
RA	DEC	Sp	Period(s)	$v \sin i$	Remarks	References
	96008	6.74	0.209	0.165	0.703	2.727
11:03:43.7	−51:21:11	F0 V	0.309873	85	6	6, 7, 15

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Remarks to Tables 1–3:

1. 9 Aur was designated V398 Aur in the latest name-list of variable stars (Ref. 13 above).
2. Cluster membership doubtful (Ref. 5 above); Strömgren indices suggest high metallicity, thus the absolute magnitude of the star in Figure 1 could be too low
3. Period uncertain due to aliasing
4. The magnitudes and colors given are for the slightly brighter of the two nearly identical components.
5. Note correct HD number
6. Shown to be an ellipsoidal binary (Ref. 15 above)

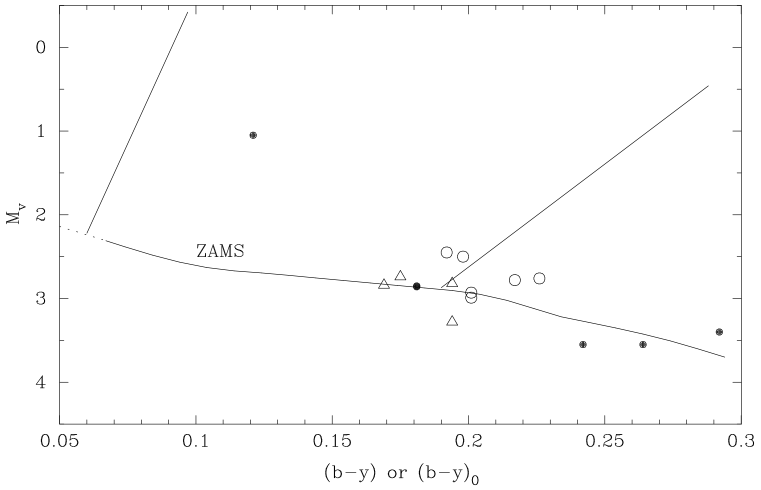

Figure 1. Color-magnitude diagram of the stars similar to γ Dor. Circles: stars from Table 1. Triangles: NGC 2516 stars. Dots: other candidates from Table 2. The Zero Age Main Sequence is adopted from Crawford (1975, 1979), while the borders of the instability strip are taken from Breger (1979).

In Figure 1 we give a color-magnitude diagram of the bona fide members and the other candidates. For field stars and doubtful members of clusters, we calculated the unreddened colors and absolute magnitudes from the Strömgren photometry by applying the calibrations of Crawford (1975, 1979).

The authors would appreciate receiving from other observers further data and news of new candidates, since this list will be continuously updated.

Some information in the table was obtained from the SIMBAD data retrieval system, a data base of the Astronomical Data Centre, Strasbourg, France.

Acknowledgements: L. Mantegazza kindly supplied a program for calculating dereddened colors and absolute magnitudes from uvbyβ photometry.

K. KRISCIUNAS*
G. HANDLER**

* Joint Astronomy Centre, 660 N. A'ohōkū Place, University Park, Hilo, Hawaii 96720, USA, e-mail: kevin@jach.hawaii.edu

** Institut für Astronomie, Türkenschanzstraße 17, A-1180 Wien, Austria
e-mail: handler@astro.ast.univie.ac.at

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PERIODS AND TYPES FOR SIX RED VARIABLES

Kaiser (1991, 1992) reported the photographic discovery of several new variable stars and the rediscovery of several variables listed in the New Catalogue of Suspected Variable Stars (Kholopov et al., 1982). I have examined these stars on Harvard patrol plates of the Damon blue series (IIa-O) from 1973-1989. This report presents the results for six DHK variables of late spectral type. Except when noted, magnitudes of comparison stars were estimated with an image scale calibrated to photoelectric B magnitudes in nearby fields of the Guide Star Photometric Catalogue (Lasker, Sturch et al., 1988). Equatorial coordinates and alternate identification in various catalogues can be found in the 71st and 72nd Name Lists of Variable Stars, as cited.

DHK 18=TT Sextantis

Spectral type M4. Designated TT Sex in the 71st Name List (Kazarovets et al., 1993). Observed on 202 plates, using a comparison star sequence extended from the two comparison stars for BV 715=RU Sex cited by Strohmeier et al. (1965). Observed range 10.4-11.9 ptg. The light curve (Figure 1) gives a superficial impression of semiregular variations, but detailed plots of each season's data show that no two cycles are similar. DFT analysis found only a weak frequency peak near 700 days, but this period is expressed by only one cycle on the light curve (centered at JD 2446000). Altogether, these observations suggest that variations are of the slow irregular type.

DHK 24=V1060 Tauri

Spectral type C4II. Designated V1060 Tau (Kazarovets et al., 1993). Observed on 163 plates, range 10.3-11.8 ptg. The discovery report (Kaiser, 1992) gave this variable an uncertain assigment to the slow irregular class (Lb:). DFT analysis found a strong frequency peak at P=1163 days and a second, moderately strong peak at P=527 days. Therefore, this star appears more likely to be SR type with long and perhaps multiple periods.

DHK=V704 Cassiopeiae

Spectral type M1. First noted by Espin (1894). Recently designated V704 Cas in the 72nd Name List (Kazarovets and Samus, 1995). Observed on 175 plates, range 11.4-12.1 ptg. The light curve (Figure 1) shows distinct semiregular variations, with the amplitude of each cycle ranging from 0.2-0.7 magnitude. DFT analysis indicates a period of 379 days, which supersedes the estimate of 350: days in the discovery report.

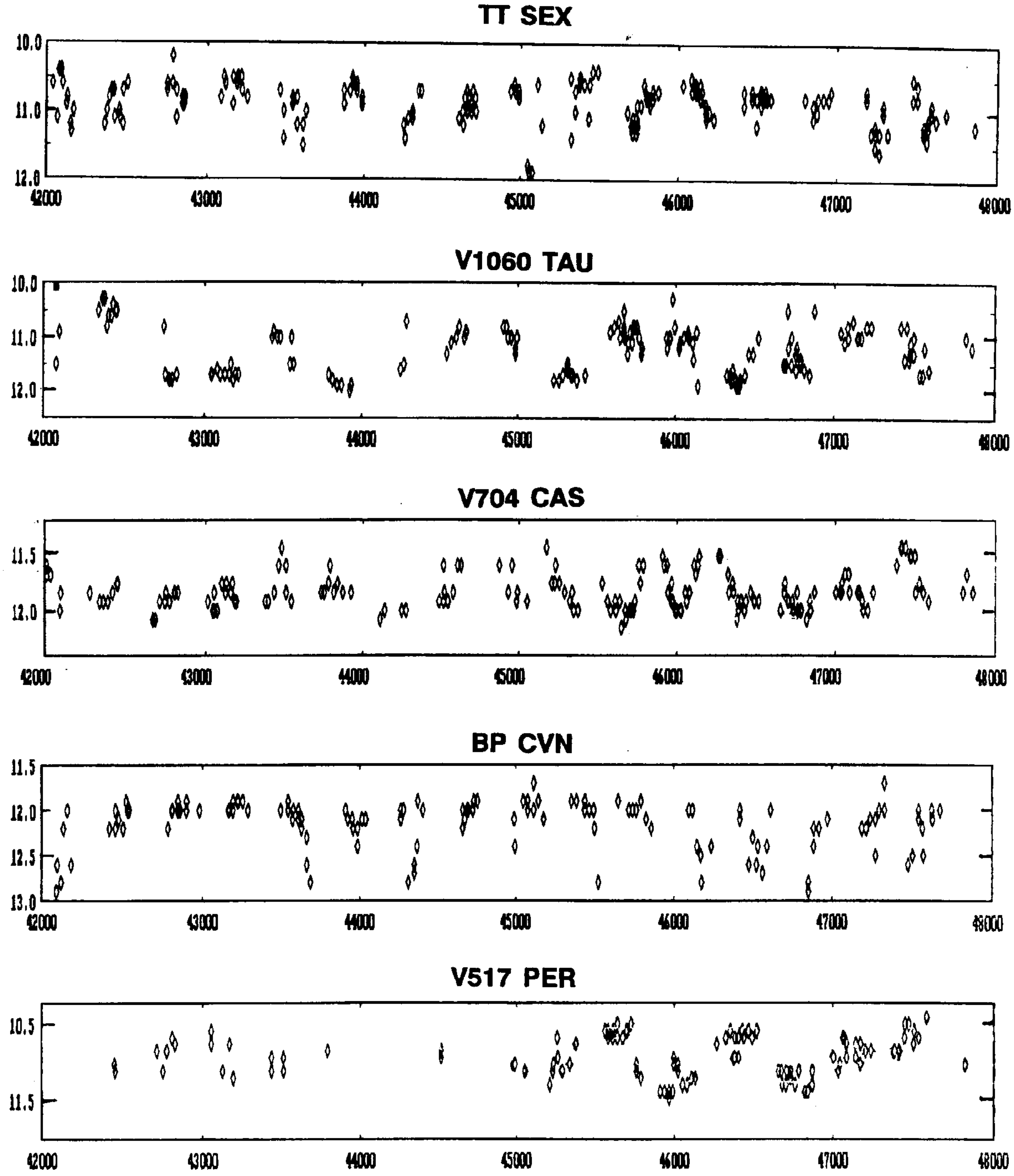
TT SEX
10.0
11.0
12.0
42000
43000
44000
45000
46000
47000
48000
V1060 TAU
10.0
11.0
12.0
42000
43000
44000
45000
46000
47000
48000
V704 CAS
11.5
12.0
42000
43000
44000
45000
46000
47000
48000
BP CVN
11.5
12.0
12.5
13.0
42000
43000
44000
45000
46000
47000
48000
V517 PER
10.5
11.5
42000
43000
44000
45000
46000
47000
48000

Figure 1

DHK 26=BP Canum Venaticorum

Spectral type K5. Observed on 139 plates. Recently designated BP CVn (Kazarovets and Samus, 1995). Variability was first reported by Weber (1963), who found a range of 11.4-12.1 ptg. I adopted his comparison sequence but found it necessary to add two fainter stars to accommodate my observed range of 11.9-12.8 ptg. The light curve (Figure 1) shows semiregular variations generally characterized by steep minima and broad maxima. DFT analysis found a strong frequency peak at P=317 days, which supersedes the preliminary estimate of 300: days in the discovery report.

DHK 27=V517 Persei

Spectral type M8. Recently designated V517 Per (Kazarovets and Samus, 1995). Observed on 113 Damon plates, using comparison star magnitudes interpolated from the HU Per sequence of Meshkova (1940) less than 1 degree east of this new variable. Observed range 10.5-11.4 ptg. DFT analysis found a strong frequency peak at P=860 days, which is expressed by two prominent cycles on the light curve (Figure 1). However, additional observations from 125 RH series plates, 1931-1952, show only a weak frequency peak at 1067 days and no sign of a period near 860 days. This star is probably a slow irregular variable with characteristic cycles of 800-1100 days and minor variations of shorter durations.

DHK 28=LM Pegasi

Spectral type M2. Recently designated LM Peg (Kazarovets and Samus, 1995). Observed on 166 plates, range 10.6-11.3 ptg. DFT period search found a weak frequency peak equivalent to a period of 72 days, which supersedes the estimate of 150: days in the discovery report. A light curve is not included here; a forthcoming report will present photoelectric photometry that supports the new period. This star appears to be a typical small-amplitude, short period, red semiregular variable.

Some of the information in this report was obtained from SIMBAD, database of Strasbourg, France, Astronomical Data Center. I wish to thank Dr. Martha Hazen for the opportunity to use the Harvard College Observatory plate collection for this project.

David B. WILLIAMS
9270-A Racquetball Way
Indianapolis, IN 46260 USA

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BH Cas IS AN ECLIPSING BINARY

The variability of BH Cas was discovered by Beljawsky (1931) and confirmed by Kukarkin (1938) who classified it as possibly W UMa–type with period ~ 0.5 days. Ahnert and Hoffmeister (1943) found no star in the region of BH Cas with the proposed variation. Metcalfe (1994) published observations supporting the variability of BH Cas.

In Figure 1, observations of BH Cas obtained in the V–band on the nights of 8 October 1994 (squares) and 19 February 1994 (triangles) are shown. The comparison star was GSC 03665 00784 with a measured apparent visual magnitude of 13.61 ± 0.02.

The light curve confirms that BH Cas is an eclipsing binary of W UMa–type, counter to the conclusion of Ahnert and Hoffmeister. The period is $P \sim 0.39$ days, and the HJD epochs of primary and secondary minimum are $T_1 = 2449767.6661$ and $T_2 = 2449634.7378$ respectively. Observations in the B– and R– bands indicate that (B−V)≈ 0.6 and (V−R)≈ 0.3.

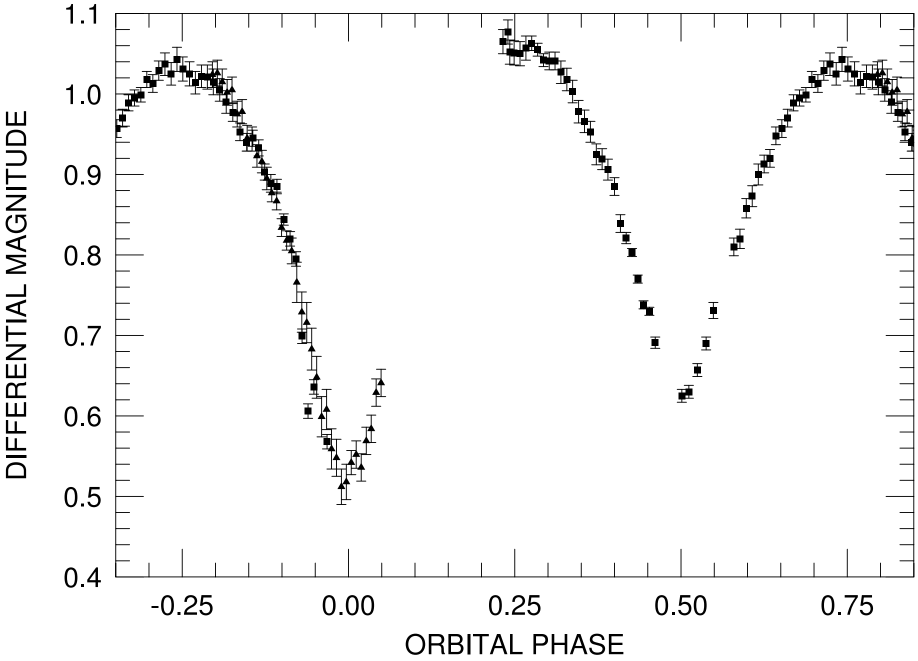

Figure 1

Future efforts at Steward Observatory will be concentrated on improving the V–band light curve and determining a more precise period. Collaboration is especially needed for reconstruction of the B– and R–band light curves. Observers at greatly different longitudes than Steward ($L_w \simeq 7^h\ 23\overset{m}{.}8$) would be most welcome. For finder charts or additional information, please contact the undersigned.

T.S. METCALFE
Steward Observatory
University of Arizona
Tucson, Arizona, USA
tmetcalf@astro.as.arizona.edu

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NSV 7020 Boo = BV 100 : RR ab VARIABLE

Geier, Kippenhahn and Strohmeier (1955) discovered the variability of the star NSV 7020 Boo = BV 100. They reported brightness variations on a short time scale. Filatov (1960) gave photographic observations of the star, stating 12 epochs of maximum light. Finally, Götz and Wenzel (1964) communicated the spectral type of the variable (F4). They also remarked that they found a pair of stars of similar brightness and spectral type at the given location. According to the bibliographical file on variable stars kept at Sonneberg Observatory, Germany, no other source of information on NSV 7020 Boo is known.

One of us (LM) observed NSV 7020 Boo photographically in 1985 with the 25 cm Ritchey–Chrétien reflector of the public observatory ("Sternwarte Eschenberg") in Winterthur, Switzerland. His 100 observations were secured on 10 nights over a timespan of 85 days. These observations have never been published. They showed convincingly that NSV 7020 Boo = BV 100 is an RRab type variable. But unfortunately, the period of variation could not be determined, because only one–rather uncertain–time of maximum light (JD(max,hel) = 2446210.579 ± 0.010) was observed.

In the course of an observational stay at the Rosemary Hill Observatory of the University of Florida, RD reobserved NSV 7020 Boo photoelectrically in 1993. The details of the instrumental setup were reported elsewhere (Diethelm, 1993). A total of 71 observations in V and 32 measurements in B were secured between JD 2449104 and JD 2449125. As reported by Götz and Wenzel (1964), NSV 7020 Boo is the following of a close pair of stars. We used the leading member of the pair as the comparison star. We found this star to be constant to within the accuracy of our photometry by occasional checks using the standard star HR 6092. From this differential photometry B = 11.99 ± 0.02 and V = 11.61 ± 0.02 can be deduced for the primary comparison star.

The short time base of only 21 days prevents the determination of accurate elements of variation for the star from the photoelectric data. The period value of P = 0.45845 days yields the smoothest light curve in V, while the photographic data are best represented by a period of 0.45912 days. We have assumed that 6328 pulsations have taken place between the photographic maximum determined by LM and the photoelectric maximum observed by RD (JD 2449111.674 ± 0.004) for the computation of the provisional elements

$$\mathrm{JD(hel,max)} = 2449111.675 + 0.458455 \times \mathrm{E}. \tag{1}$$

Figures 1 and 2 show the photoelectric V and B−V light curve folded with the elements given in (1).

The photoelectric data yield the following basic parameters describing the light curve of NSV 7020 Boo:

ΔV: 11.59-12.76 V; ΔB: 11.71-13.08 B; M−m = $0\overset{\mathrm{P}}{.}15$.

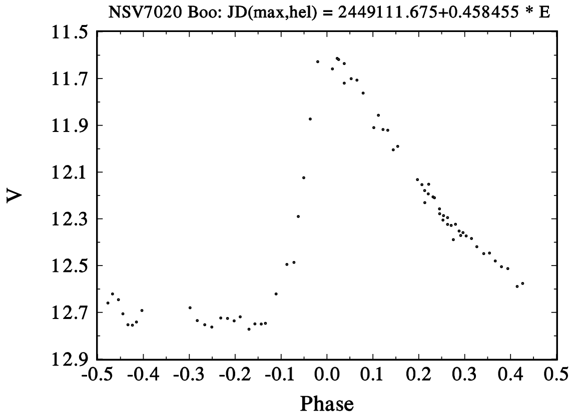

Figure 1. Photoelectric V light curve of NSV 7020 Boo

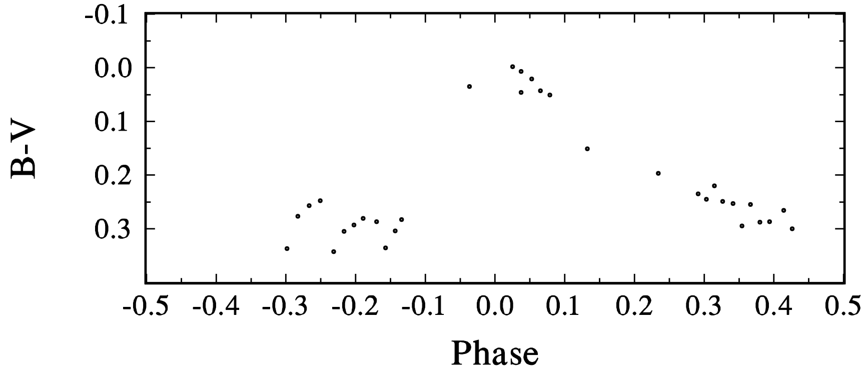

Figure 2. Photoelectric B−V colour curve of NSV 7020 Boo

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R. DIETHELM
BBSAG
Rennweg 1
CH-4118 Rodersdorf
Switzerland
e-mail: diethelm@astro.unibas.ch

L. MOSER
Stockhornstrasse 15
CH-3510 Konolfingen
Switzerland

References:

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ORBITAL PARAMETERS OF SIX SPECTROSCOPIC BINARY CEPHEIDS

Our observations of Cepheid radial velocities using a CORAVEL-type photoelectric correlational spectrometer (Tokovinin, 1987) started in 1987. The results for 1987–1991 were presented in the form of a catalog of Cepheid radial velocities (Gorynya et al., 1992a). This catalog contains about 1500 observations of nearly 80 galactic Cepheids. Our observations were continued, and in 1992–1994 we obtained more than 2100 radial velocity measurements for 87 Cepheids. Thus, our data base of original accurate (typical r.m.s. error about 0.5 km/s) radial velocity measurements contains more than 3600 observations for 107 Cepheids. We have also compiled a data base of all published radial velocity measurements for Cepheids; for Cepheids of our programme, this data base quotes a little more than 3800 observations. Our programme aims to gather good coverage of radial velocity curves, optimally for each year of observations of a star. As the result, these data are well suited for the search and study of spectroscopic binary Cepheids. It is well known that spectroscopic binarity is a common phenomenon among classical Cepheids (Szabados, 1995).

We were able to confirm a number of earlier known spectroscopic binaries. Moreover, we have discovered several new ones: MW Cyg (Gorynya et al., 1992b), VZ Cyg (Samus et al., 1993), BY Cas (Gorynya et al., 1995).

The present paper is devoted to new determinations of orbital elements for six Cepheids with long series of radial velocity measurements available. We used our measurements along with published data extracted from our data base.

In calculations of orbital elements the pulsational curve was approximated by trigonometrical series of the order from 1 to 5, with light elements taken from our data base. The search for orbital periods used our standard software for analyzing periodicities of variable stars. The quality of approximation may be seen in the orbital and pulsational radial velocity curves presented in Figures 1a-b. We ascribed to each data point (both in the orbital and the pulsational curves) half of individual residual of radial velocity.

Table 1 presents the results of our computation of orbital elements. N and n are respectively the total number of velocity observations used and the number of our original velocity measurements for each star. We estimate the error of orbital periods as $\pm 3 - 5$ days, that of pericenter epochs, as ± 10 days, that of orbital eccentricities, as ± 0.02, that of V_γ, as ± 0.5 km/s.

Table 1
New Orbital Elements for 6 Cepheids

	FF Aql	BY Cas	VZ Cyg	MW Cyg	S Sge	V350 Sgr
T_0, JD 24...	45381	49384	49294	47997	48687	49103
P_{orb}, d	1433	563	725	441	676	1467
e	0.09	0.22	0.05	0.04	0.18	0.31
ω, deg	327	288	332	91	202	292
V_γ, km/s	–16.0	–58.7	–15.1	–12.8	–9.6	+11.2
K, km/s	+5.0	+9.1	+6.5	+5.8	+15.4	+10.3
$f(M)$	0.018	0.040	0.020	0.009	0.243	0.142
N	162	14	67	180	200	135
n	69	14	58	131	83	79

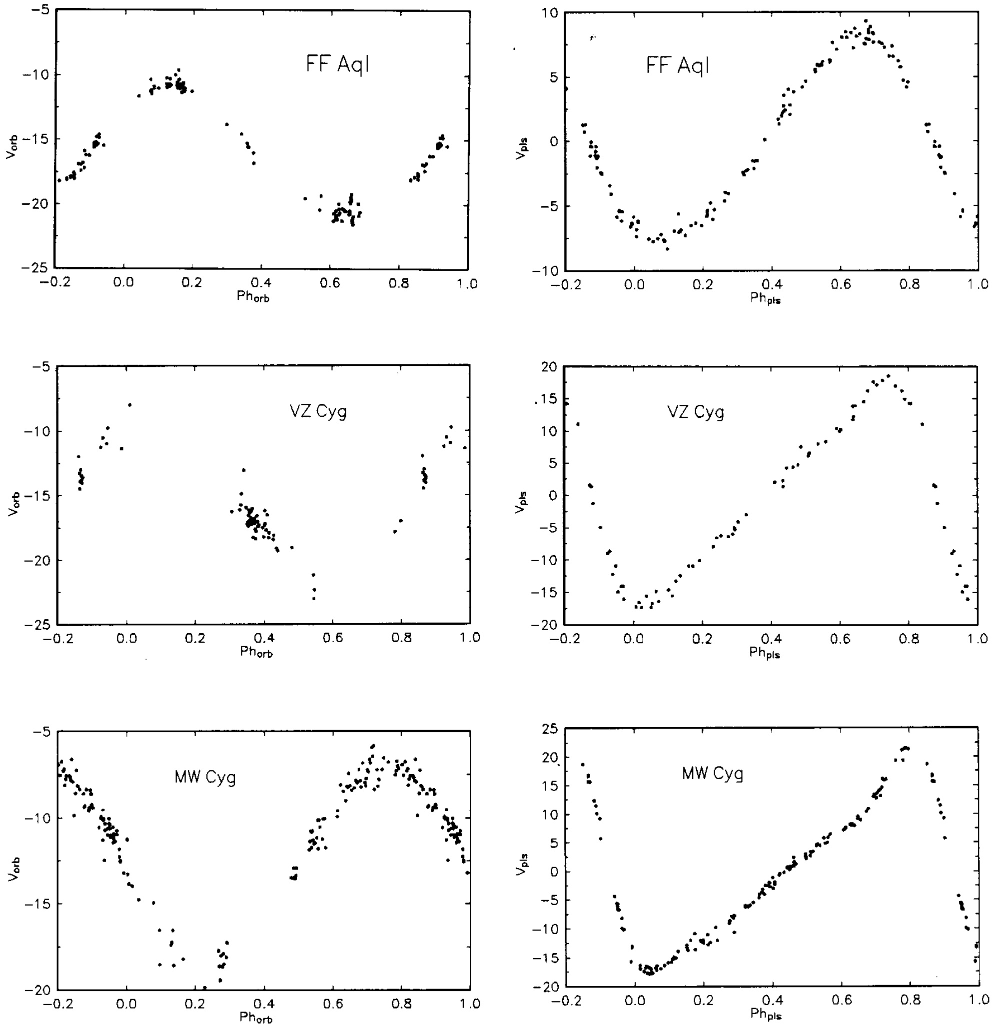

Figure 1a. FF Aql, VZ Cyg, MW Cyg – decomposition of the radial velocity data into orbital (left) and pulsational (right) components.

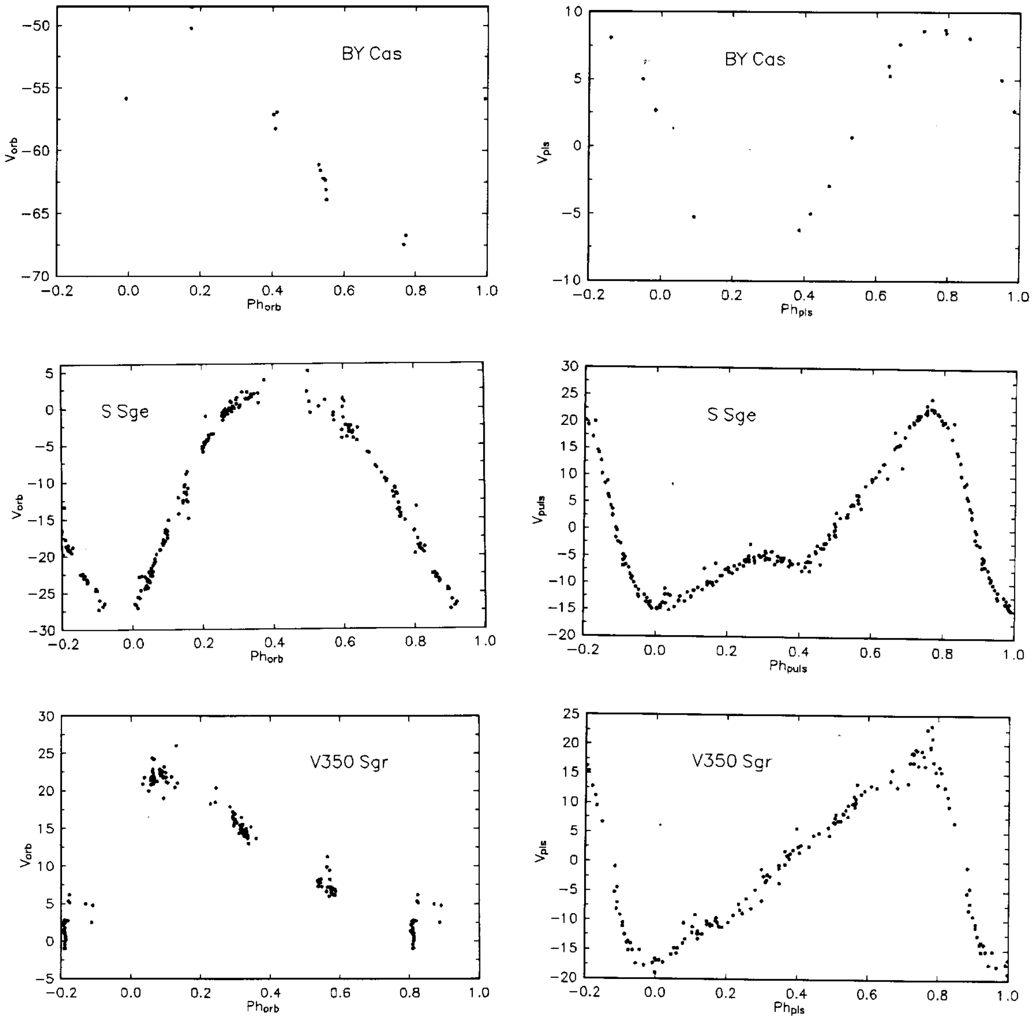

Figure 1b. BY Cas, S Sge, V350 Sgr – decomposition of the radial velocity data into orbital (left) and pulsational (right) components.

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N.A. GORYNYA
N.N. SAMUS
Institute of Astronomy
of Russian Academy of Sciences
48, Pyatnitskaya Str.
Moscow 109017, Russia

L.N. BERDNIKOV
A.S. RASTORGOUEV
M.E. SACHKOV
Sternberg Astronomical Institute
13, Universitetskij Prosp.,
Moscow 119899, Russia

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PHOTOELECTRIC OBSERVATIONS OF THE T Tau TYPE VARIABLE BZ Sgr

BZ Sgr was included in our program of photoelectric observations of Cepheids because it was listed in GCVS–IV as a possible type II Cepheid. Recently it was found that this star was a T Tau type variable (Gregorio–Hetem et al., 1992).

Table 1

JD hel 2400000+	V	$U-B$	$B-V$	$(V-R)_c$	$(R-I)_c$
49521.9180	12.416	–	0.813	–	–
49522.8532	11.454	–	0.765	–	–
49522.8589	12.129	–	1.113	–	–
49534.8826	11.228	–	0.922	0.717	0.710
49536.7958	11.389	–0.214	0.978	0.576	0.704
49543.8489	11.415	–0.096	0.978	0.708	0.741
49545.7986	11.420	–0.325	0.946	0.729	0.694
49558.8643	11.433	–0.335	0.956	0.719	0.745
49559.8604	11.370	–	1.035	–	–
49561.8530	11.927	–	1.045	0.773	0.798
49564.8471	10.731	–	0.736	0.616	0.656
49624.1843	12.336	–	1.242	0.895	–
49625.1853	11.502	–	1.050	0.767	–
49631.1532	12.924	–	1.300	0.974	–
49632.1654	12.087	–	1.259	0.838	–
49633.1678	11.956	–	1.251	0.819	–
49634.1601	12.193	–	1.255	0.876	–
49809.8911	12.219	–	1.239	0.794	0.834
49810.8859	12.509	–	1.276	0.895	0.809
49811.8923	11.507	–	0.969	0.711	0.757
49813.8810	11.748	–	1.078	0.771	0.795
49814.8712	11.896	–	0.945	0.713	0.758
49817.8844	13.020	–	1.129	0.975	0.953
49818.8754	12.400	–	1.054	0.820	0.853
49821.8861	12.226	–	1.097	0.854	0.833
49822.8847	12.195	–	1.149	0.855	0.861
49823.8723	12.603	–	1.086	0.893	0.958
49825.8869	11.756	–	1.036	0.762	0.768

Our photoelectric $UBV(RI)_c$ measurements were carried out at CTIO. Las Campanas and Mt. Maidanak observatories from June 1994 to March 1995. Everywhere 60–cm reflectors were used, and 28 observations were obtained. These observations are listed in Table 1. The accuracy of the individual data is near 0.01 mag in all filters.

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L.N. BERDNIKOV
O.V. VOZIAKOVA
Sternberg Astronomical Institute
13, Universitetskij prosp.
Moscow 119899, Russia

D.G. TURNER
St. Mary's University
923 Robie st.
Halifax, NS B3H 3C3, Canada

Reference:

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