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V485 Centauri: the Shortest Period SU UMa Star*

by

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ABSTRACT

We report CCD observations of the dwarf nova V485 Cen during its 1997 superoutburst. The long lasting outburst with characteristic slope, brightness dip and presence of clear superhumps give evidence that V485 Cen belongs to the group of SU UMa-type variables. The superhump period is equal to $0\overset{d}{.}042156 \pm 0\overset{d}{.}000004$ ($60\overset{m}{.}7$). Thus, V485 Cen has the shortest known period among SU UMa-type stars, with a period as much as 25% shorter than previously known objects. The analysis of times of superhump maxima gives clear evidence for the increase of superhump period with $\dot{P}_{\rm sh} = 28.3 \times 10^{-5}$. This fact confirms the hypothesis that the shortest periods SU UMa variables contrary to other stars of this type have positive values of $\dot{P}_{\rm sh}$.

Key words: *binaries: close – novae, cataclysmic variables – Stars: individual: V485 Centauri*

1. Introduction

Cataclysmic variable stars are binary systems containing white dwarf primary and late-type main sequence, low mass secondary. The secondary fills its Roche lobe and loses material through the inner Lagrangian point toward the white dwarf primary. In case of non-magnetic systems falling material forms a disc around the white dwarf.

Dwarf novae are a subclass of cataclysmic variable systems (for recent reviews see Warner 1995 and Osaki 1996). Usually they are divided into three additional classes. The first one is called U Geminorum (or SS Cygni) type stars. Objects belonging to this type are characterized by orbital periods in the range 3–10 hours and by having outbursts with an amplitude from 2 to about 8 mag which last a few days, separated by a few weeks period of quiescence. The mechanism of such outbursts is a thermal instability in the disc which causes episodes of enhanced mass

* Based on observations obtained with the 1.3 m Warsaw telescope at the Las Campanas Observatory of the Carnegie Institution of Washington

transfer from the disc into the primary. The second subgroup are Z Camelopardalis stars. The periods of these objects are in the same range as U Gem-type variables but additionally during the outbursts one can observe so-called "standstills". It is believed that Z Cam stars lay on the border line between stars with thermally stable and unstable discs.

The stars belonging the the third group are called SU Ursa Majoris systems. They have orbital periods in range 80–120 minutes and from time to time they show additional, slightly brighter and longer lasting outbursts called superoutbursts or super-maxima. A characteristic feature of the superoutbursts is presence of "tooth-shape" periodic light oscillations called superhumps. The periods of superhumps are 1%–9% longer than the binary orbital periods. The amplitude of light modulations is typically in the range 0.1–0.4 mag.

In the Catalog and Atlas of Cataclysmic Variables (Downes and Shara 1993) variable star V485 Centauri is classified as U Geminorum type nova. The magnitude range of variability is given as 12.9–17.9 mag. The first photometric and spectroscopic study of this star made by Augusteijn *et al.* (1993) revealed clear photometric oscillations with the period $0\overset{d}{.}041096$ (59.0 min) and amplitude about 0.3 mag. The spectra presented in the same paper were fairly typical for cataclysmic variables and showed clear Hα, HeI and CaII emission lines. Due to the presence of hydrogen lines Augusteijn *et al.* (1993) excluded the hypothesis that V485 Cen is a double-degenerate AM CVn system. Also the value of the period was too long for the rotational period of the white dwarf primary which is observed in the intermediate polars. The main conclusion of that paper was that V485 Cen contains hydrogen-deficient main-sequence star and the observed brightness oscillations reflect the orbital period of the system.

The second paper with more extensive quiescent photometry and spectroscopy of V485 Cen was published by Augusteijn *et al.* (1996). They confirmed the 59 min periodicity is the orbital period of the system and gave its more exact value equal to $0\overset{d}{.}040995001$. They also gave an estimate of a few parameters of the system. The mass ratio q defined as $M_{\rm WD}/M_{\rm sec}$ was estimated to be about 2.6 (lower limit for a mass of the white dwarf was $M_{\rm WD} \approx 0.7{\rm M}_\odot$ and a lower limit of the mass of the secondary $M_{\rm sec} \approx 0.14{\rm M}_\odot$), the inclination was equal to $i = 20 - 30°$ and mass transfer from the secondary $\dot{M}$ was estimated between 1×10^{-10} and 1×10^{-9} ${\rm M}_\odot$/year.

In the middle of May 1997 we were notified by Rod Stubbings (*VSNET-alert* no. 908) that a new outburst of V485 Cen had just begun. In the present paper we report on results of CCD photometry of V485 Cen performed during that outburst.

2. Observations and Data Reduction

The entire set of observations presented in this paper was carried out at Las Campanas Observatory in Chile, which is operated by Carnegie Institution of

Washington. Data were collected with the 1.3 m Warsaw telescope equipped with a 2048 × 2049 SITe thinned CCD with a scale $0\overset{''}{.}417$/pixel. For the purpose of observing of V485 Cen we used only part of CCD chip trimming it to 512 × 512 pixels. The detailed description of the system used is given by Udalski (1997).

Observations of V485 Cen were collected as a subproject of the Optical Gravitational Lensing Experiment (OGLE-2). The main goal of the OGLE-2 project is a search for dark matter in our Galaxy using microlensing phenomena (Paczyński 1986, Udalski *et al.* 1992). When atmospheric conditions are poor (seeing > 1.6", cirrus clouds) and photometry of dense stellar regions is not reliable some subprojects like described in this paper are conducted.

We have monitored V485 Cen in B, V and I filters on 14 nights from May 16 through June 2, 1997. The exposure times varied between 60 and 300 seconds, depending on atmospheric conditions and the brightness of the star. Dead time between the consecutive frames was about 20 seconds. Journal of observations with duration of each run, filters used and exposure times is given in Table 1.

Table 1

Journal of the CCD observations of V485 Cen

Date 1997	Time of start HJD 2450000. +	Length of run (h)	Filter	Exp. Time (sec)
May 16/17	585.5286	3.2	B,V,I	60
May 18/19	587.7642	1.1	I	60
May 19/20	588.4735	4.0	V,I	60
May 20/21	589.4684	5.7	V,I	60
May 21/22	590.4893	4.3	V,I	60
May 22/23	591.4569	5.8	I	60,90
May 23/24	592.4646	5.0	V,I	60
May 24/25	593.4539	1.9	V,I	90,120
May 25/26	594.5252	-*	I	180,300
May 27/28	596.5169	1.2	I	180
May 27/28	596.6380	0.8	I	180
May 30/31	599.5640	2.1	V,I	90
May 31/01	600.4396	1.3	I	90
June 01/02	601.4681	1.0	I	180
June 02/03	602.4490	1.0	I	180

* - only 6 measurements made

The data reduction (debiasing and flatfielding) was performed using IRAF[1]

[1] IRAF is distributed by National Optical Observatories, which is operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with National Science Foundation.

software. The profile photometry was done with the DAOphotII package. All data were differentially reduced using a comparison star located $\sim$ 50" W and $\sim$ 10" S with respect to the variable star. According to Augusteijn *et al.* (1993) the V brightness of the comparison star is 15.04 ± 0.02 mag and its color $B - V = 0.64 \pm 0.04$. Because our V-band is very close to the standard Johnson's band we simply added Augusteijn *et al.* (1993) value to our differential measurement to have absolute scale.

Mean errors during the first stage of outburst were between 0.005 and 0.01 mag depending mainly on atmospheric conditions. During a brightness dip and the second stage of outburst errors were in the range 0.007–0.030 mag except for the night May 25/26 when only six exposures through thick cirrus clouds were made and errors were about 0.15 mag. Seeing varied from $1\farcs1$ on the best night to $2\farcs1$ during the worse run.

3. Long-term Behavior of V485 Cen

Based on observations made by members of the Variable Star Section of the Royal Astronomical Society of New Zealand, Augusteijn *et al.* (1993) mentioned that about twenty outbursts of V485 Cen were observed with a duration between 1 and 7 days.

Long-term behavior of V485 Cen during May 1997 outburst is presented in Fig. 1. Rough estimate of the zero point on the magnitude axis is 15.0 mag. The first observations were made on May 17.024 UT. Certainly the outburst began a little earlier because the first positive detection of this star in outburst was made by Rod Stubbings at 9:16 UT on May 15 (*VSNET-alert* no. 908).

During the period May 16/17 – May 23/24 we observed linear decline of the brightness of the star with the rate 0.11 mag/day. Very rapid drop of brightness occurred on May 24/25 when the star faded by more than 0.5 mag in comparison to previous night. During two further nights brightness reached level by more than 3 mag below the maximum. Unfortunately due to bad weather conditions we do not have any observations from nights May 28/29 and 29/30. After this break we observed the star again on May 30/31 and it was brighter over 1.5 mag in comparison to measurements made on May 27/28. It is clear that V485 Cen showed about 2 mag brightness dip – a characteristic feature seen in light curves of some SU UMa stars.

Since May 30/31 to June 1/2 the decline of brightness was much steeper than during the first stage of superoutburst and its rate was equal to $\sim$ 1.1 mag/day.

It is clearly visible from Fig. 1 that May 1997 outburst lasted at least 16 days. In comparison with durations of other outbursts reported by observers from New Zealand this time is relatively long.

All above facts, *i.e.*, long lasting outburst with plateau and the $\sim$2 mag brightness dip are the evidences for calling this eruption superoutburst. As we will see

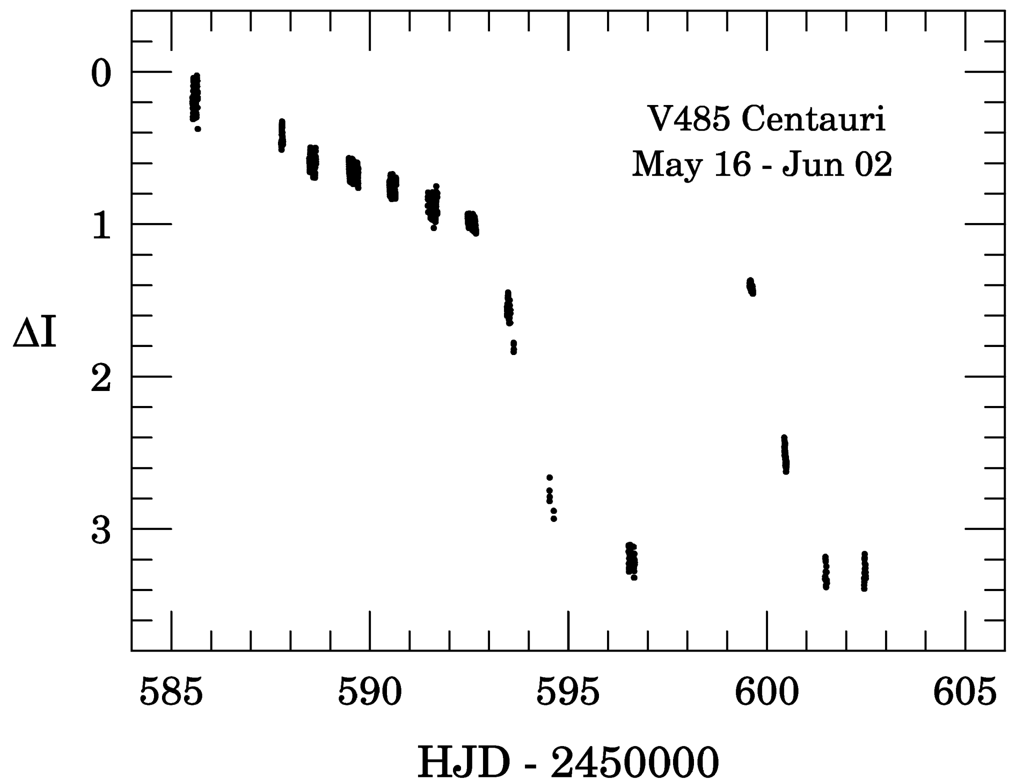

Fig. 1. The general behavior of V485 Cen during its 1997 superoutburst.

in the next Section another property characteristic for superoutburst – superhumps, was also detected.

4. Superhumps

Fig. 2 presents nightly I-band light curves of V485 Cen for eight first nights. The first run from May 16/17 is separated from other nights by one night and next seven runs from May 18/19 to 24/25 are consecutive. The superhumps with their characteristic shape of steeper increase to the maximum and slower decrease are clearly visible on each night. Their amplitude is about 0.25 mag on May 16/17 and decreases slowly to 0.1 mag on May 23/24. During the last night presented in Fig. 2 the amplitude increases to about 0.15 mag.

To obtain the value of superhump period we have used the Lomb–Scargle (Lomb 1976, Scargle 1982) method of Fourier analysis for unevenly spaced data. Before the calculation of power spectra we have removed the nightly mean and a longer-scale change trend from each individual run. The resulting periodogram is shown in Fig. 3. The highest peak is detected at frequency 23.7254 cycles/day which corresponds to a period $0\overset{d}{.}04215 \pm 0\overset{d}{.}00009$. Additionally at frequency 47.443 cycles/day the first harmonic of main periodicity is clearly visible.

We also determined 27 times of maxima of superhumps. They are listed in

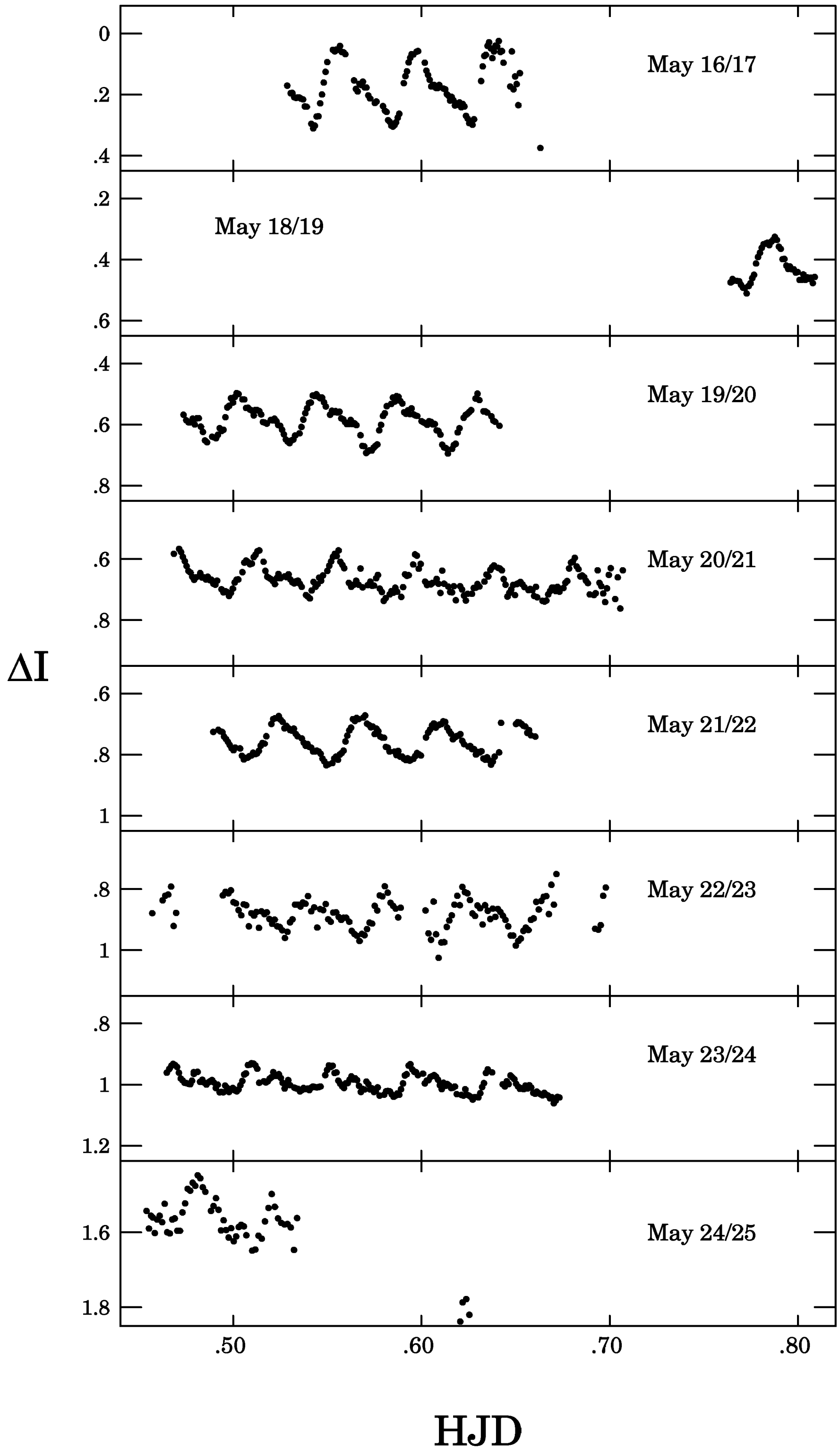

Fig. 2. The light curves of V485 Cen observed during eight nights of the first stage of superoutburst.

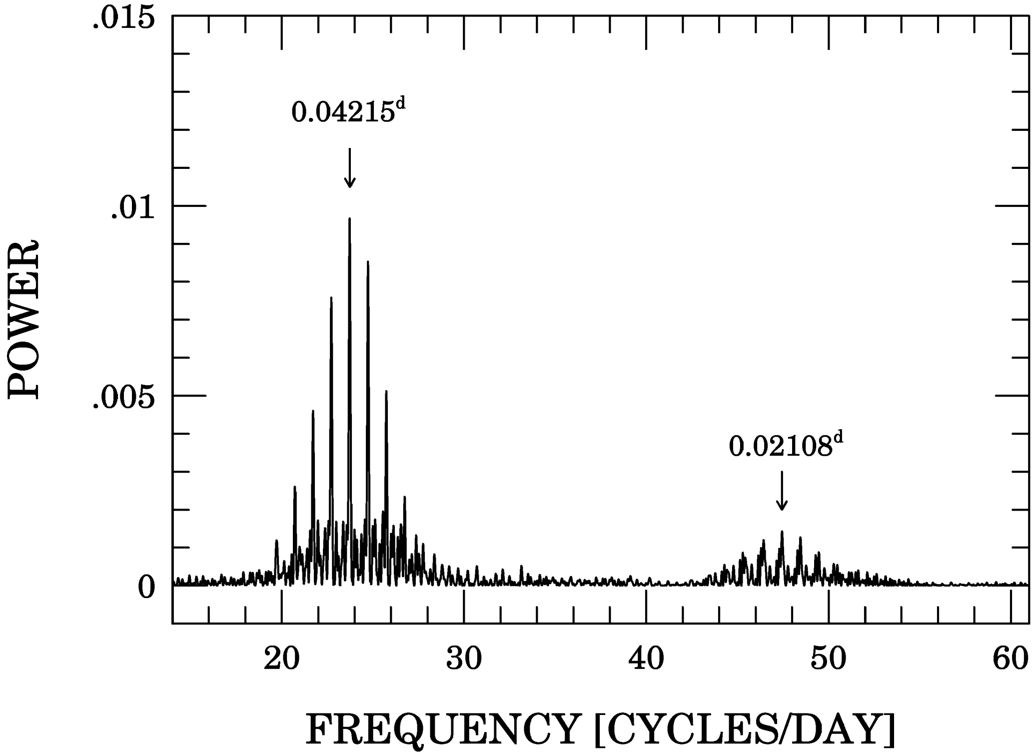

Fig. 3. Power spectra of eight nights of observations shown in Fig. 2. The arrows mark periods $0.^d04215$ and $0.^d02108$.

Table 2. The best linear fit to these maxima computed by least squares method is given below:

$$\begin{aligned} \mathrm{HJD_{Max}} &= 2450585.5522 + 0.042156\,E \\ &\pm\ 0.0005 \pm 0.000004 \end{aligned} \qquad (1)$$

This value is in very good agreement with the period obtained from Fourier transform but its accuracy is much better, so we may conclude that the superhump period of V485 Cen is equal to $0.^d042156 \pm 0.^d000004$ ($60.^m7$). Preliminary value of superhump period of V485 Cen, equal to 57.7 min, reported by Olech (1997) was based on one observing run only, and therefore turned out to be slightly incorrect. Thus, V485 Cen has the shortest known period among SU UMa-type stars. The shortest orbital and superhump periods were previously observed in WZ Sge and AL Com and were $81.^m6$ and $82.^m3$ for WZ Sge and $81.^m6$ and $82.^m6$ for AL Com (Patterson *et al.* 1981, Patterson *et al.* 1996, Howell *et al.* 1996), respectively.

Knowing the value of the superhump period we used our V-band measurements to plot phased V-band light curves of V485 Cen for five nights of superoutburst. Result is shown in Fig. 4. Phase 0.0 corresponds to HJD=2450585.5553. Two cycles are shown for clarity.

The superhump period given in ephemeris (1) is a mean value averaged from eight nights of superoutburst. In Table 2 we also list the $O-C$ values calculated

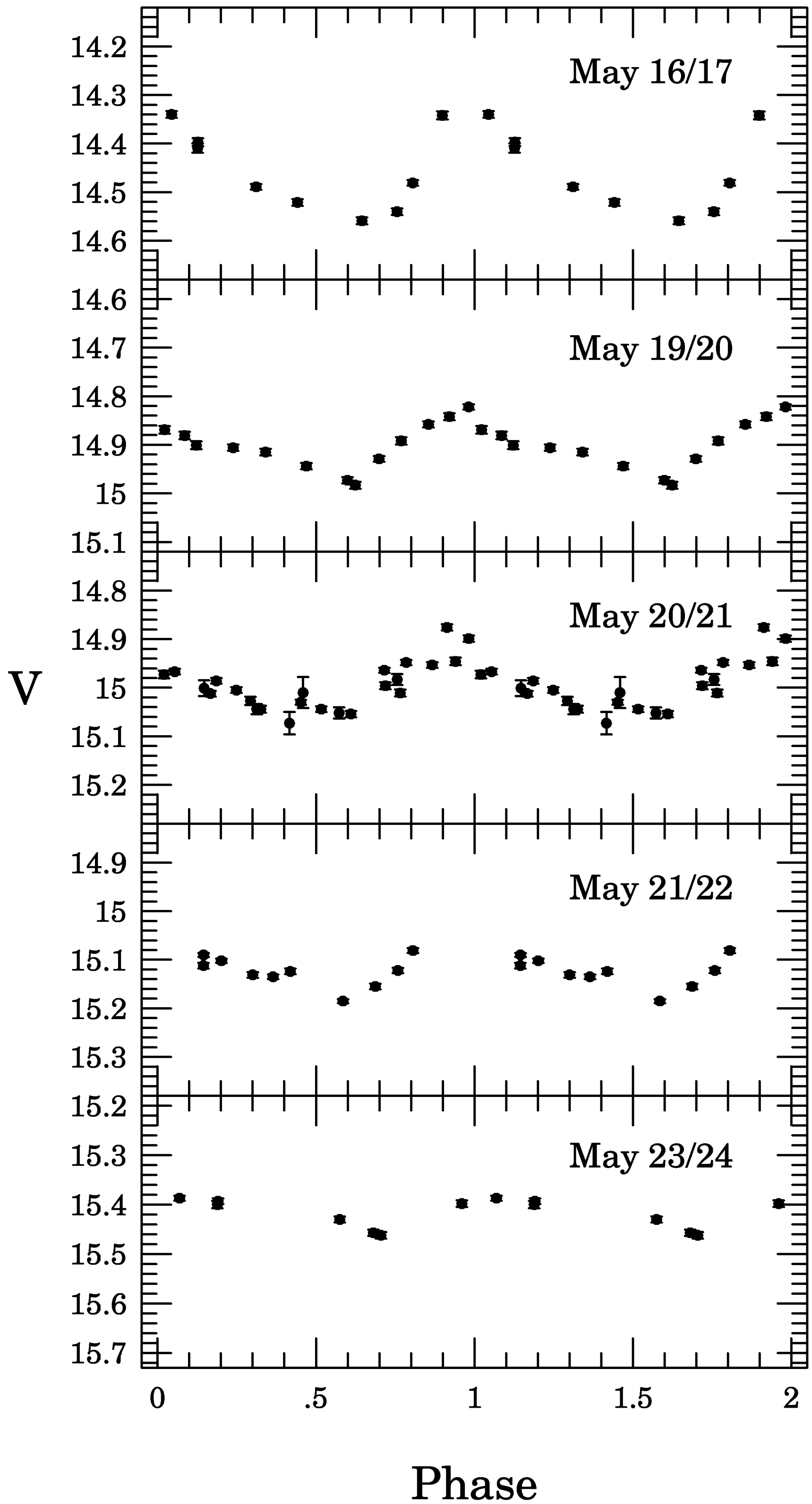

Fig. 4. *V*-band light curves of V485 Cen during five nights of the first stage of superoutburst phased with the period $0\overset{d}{.}042156$.

Table 2

Times of Superhump Maxima of V485 Cen

HJD 2450000. +	E	$O-C$ cycles	HJD 2450000. +	E	$O-C$ cycles
585.5553	0	0.0738	590.5234	118	–0.0767
585.5973	1	0.0695	590.5667	119	–0.0478
585.6386	2	0.0507	590.6096	120	–0.0304
587.7878	53	0.0319	590.6512	121	–0.0449
588.5021	70	–0.0241	591.5398	142	0.0035
588.5444	71	–0.0217	591.5800	143	–0.0116
588.5870	72	–0.0101	591.6214	144	–0.0290
588.6296	73	0.0000	592.4685	164	0.0652
589.4707	93	–0.0478	592.5102	165	0.0535
589.5138	94	–0.0246	592.5519	166	0.0420
589.5542	95	–0.0666	592.5939	167	0.0391
589.5970	96	–0.0521	592.6356	168	0.0290
589.6393	97	–0.0478	593.4812	188	0.0869
589.6810	98	–0.0579			

with the ephemeris (1). These residuals evidently indicate an increase of the period. The quadratic ephemeris obtained as the best least squares fit to the same 27 maxima listed in Table 2 is the following:

$$\begin{array}{rl} \mathrm{HJD_{Max}} = & 2450585.5555 + 0.042047\,E + 5.96\times10^{-6}E^2 \\ & \pm\ 0.0006 \pm 0.000012 \quad \pm\ 0.63 \end{array} \qquad (2)$$

The increase of the superhump period is shown in Fig. 5, where we have plotted the $O-C$ residuals taken from Table 2. The solid line in Fig. 5 presents the fit corresponding to the quadratic ephemeris (2).

As it was already pointed out by Semeniuk *et al.* (1997) it might suggest that the SU UMa stars with the shortest orbital periods exhibit increasing superhump periods contrary to the other objects from this group which derivative of superhump period is negative (see Patterson *et al.* 1993).

5. Interpulses

Beginning from night of May 23/24 we observed clear secondary superhumps (sometimes called interpulses) located on the light curve of the star between maxima of ordinary superhumps. In the upper panel of Fig. 6 we plotted again light curve form May 23/24 and marked interpulses by arrows. Additionally in the lower panel we plotted the light curve from May 23/24 phased with the period $0^{\mathrm{d}}_{.}042156$. In both panels interpulses are clearly visible.

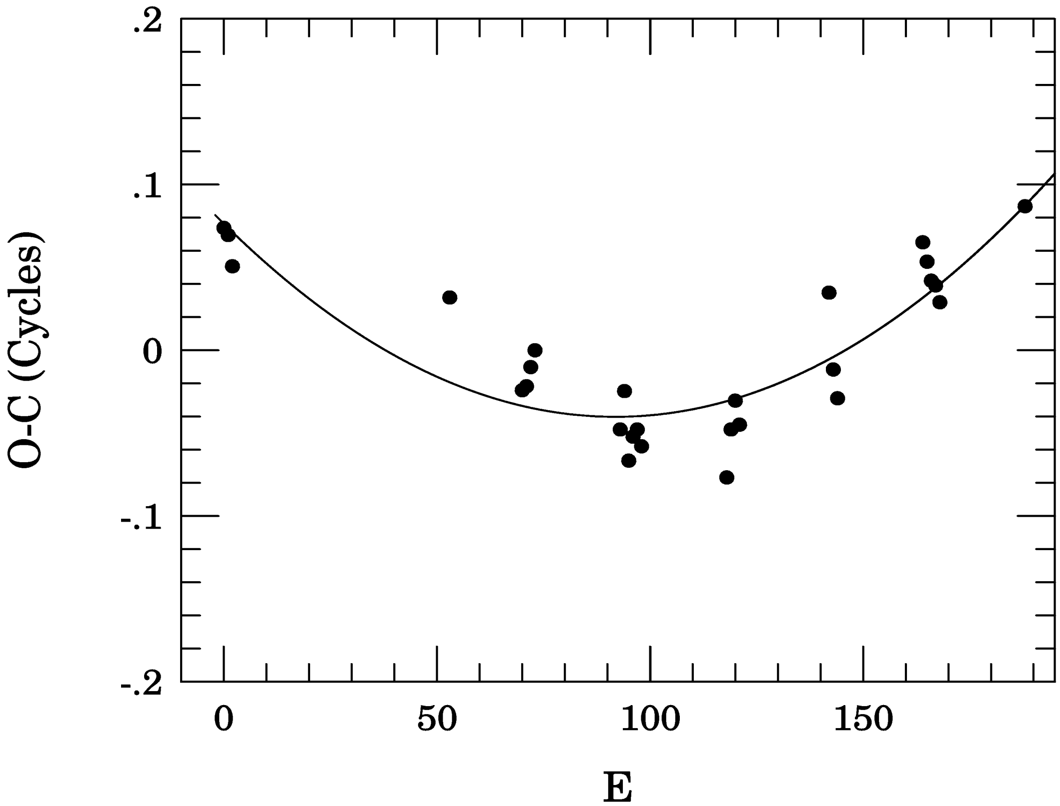

Fig. 5. $O - C$ values for times of superhump maxima calculated with the linear ephemeris (1). The solid line presents the fit corresponding to the quadratic ephemeris (2).

One additional interpulse was also detected on May 24/25, but this was the last night before the brightness dip occurred and after that moment interpulses were not observed. The moments of maxima of detected interpulses are listed in Table 3.

Table 3

Times of Interpulse Maxima of V485 Cen

HJD 2450000. +	E cycles	HJD 2450000. +	E cycles
592.4777	0	592.6067	3
592.5227	1	592.6480	4
592.5633	2	593.4905	24

Similar interpulses were also observed in other SU UMa stars like SW UMa (Semeniuk *et al.* 1997) or SU UMa itself (Udalski 1990). It was suggested (Schoembs and Vogt 1980, Warner 1995) that late superhumps in VW Hyi may develop out

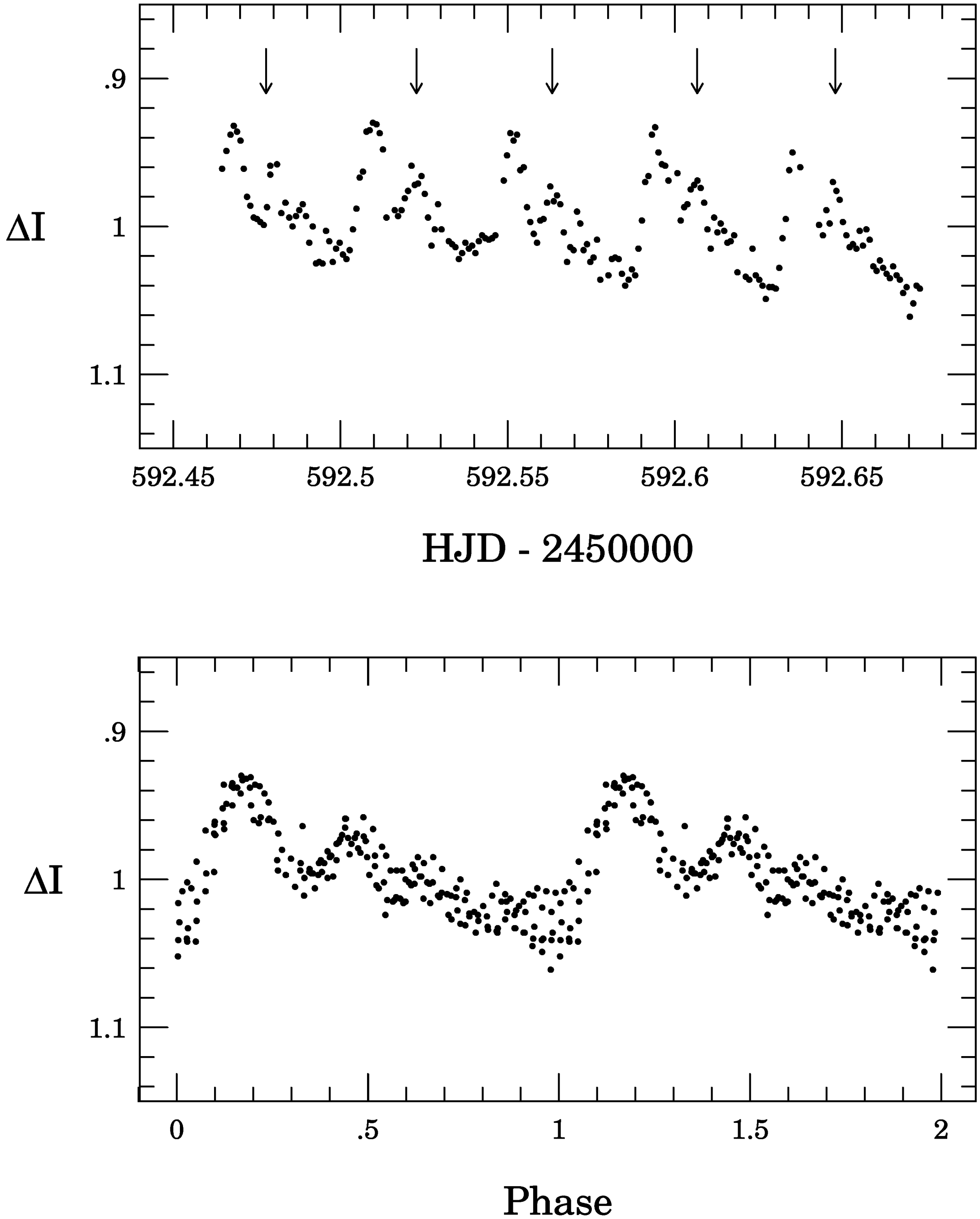

Fig. 6. *Upper panel:* The light curve of V485 Cen observed on May 23/24. The arrows mark positions of interpulses. *Lower panel:* The light curve of V485 Cen from May 23/24 phased with the period $0\overset{d}{.}041256$.

of such interpulses. However, we did not have possibility to study this hypothesis because of the brightness dip, which started on the second night in which we observed interpulses.

6. Post–Dip Behavior

We have collected 5 observing runs during and after the brightness dip in light curve of V485 Cen. The observations made during the first night, that is May 27/28, showed that star faded over 3 mag below its maximum brightness. After two nights we detected the star at brightness only 1.4 mag below the maximum. Apparently the brightness dip ended and the second stage of superoutburst began. This stage lasted only 2 or 3 days because on June 1 the star was again over 3 mag below the maximum brightness.

Fig. 7 presents nightly light curves of V485 Cen from May 27 to June 2, *i.e.*, during and after the brightness dip. The periodic light oscillations with amplitude from 0.05 mag to 0.25 mag are clearly visible. It is obvious that at this time light variations showed double humped structure with two humps (one with higher amplitude than the other) present at each cycle.

Again to obtain the value of the period of these variations we have used the Lomb–Scargle (Lomb 1976, Scargle 1982) method of Fourier analysis. Before the calculation of power spectra we have also removed the nightly mean and a longer-scale change trend from each individual run. The resulting periodogram is shown in Fig. 8. The highest peak in the power spectrum corresponds to frequency 48.782 cycles/day, *i.e.*, $0\overset{d}{.}020499 \pm 0\overset{d}{.}00003$. Due to the double structure of light modulations the real value of the period should be twice of that. We also detect a peak at 24.352 cycle/day which corresponds to $0\overset{d}{.}04106 \pm 0\overset{d}{.}00009$ and which is within errors twice the value of $0\overset{d}{.}020499$.

From the light curves presented in Fig. 7 we determined 8 times of maxima of higher peaks. They are marked by arrows and additionally listed in Table 4.

Table 4

Times of Orbital Maxima of V485 Cen

HJD 2450000. +	E cycles	HJD 2450000. +	E cycles
596.5194	0	599.6336	76
596.5601	1	600.4565	96
596.6425	3	601.4783	121
599.5937	75	602.4644	145

The best linear fit to these maxima calculated by the least squares method gives the following ephemeris:

$$\begin{aligned} \mathrm{HJD_{Max}} &= 2450596.5192 + 0.040996\,E \\ &\pm 0.0006 \pm 0.000007 \end{aligned} \qquad (3)$$

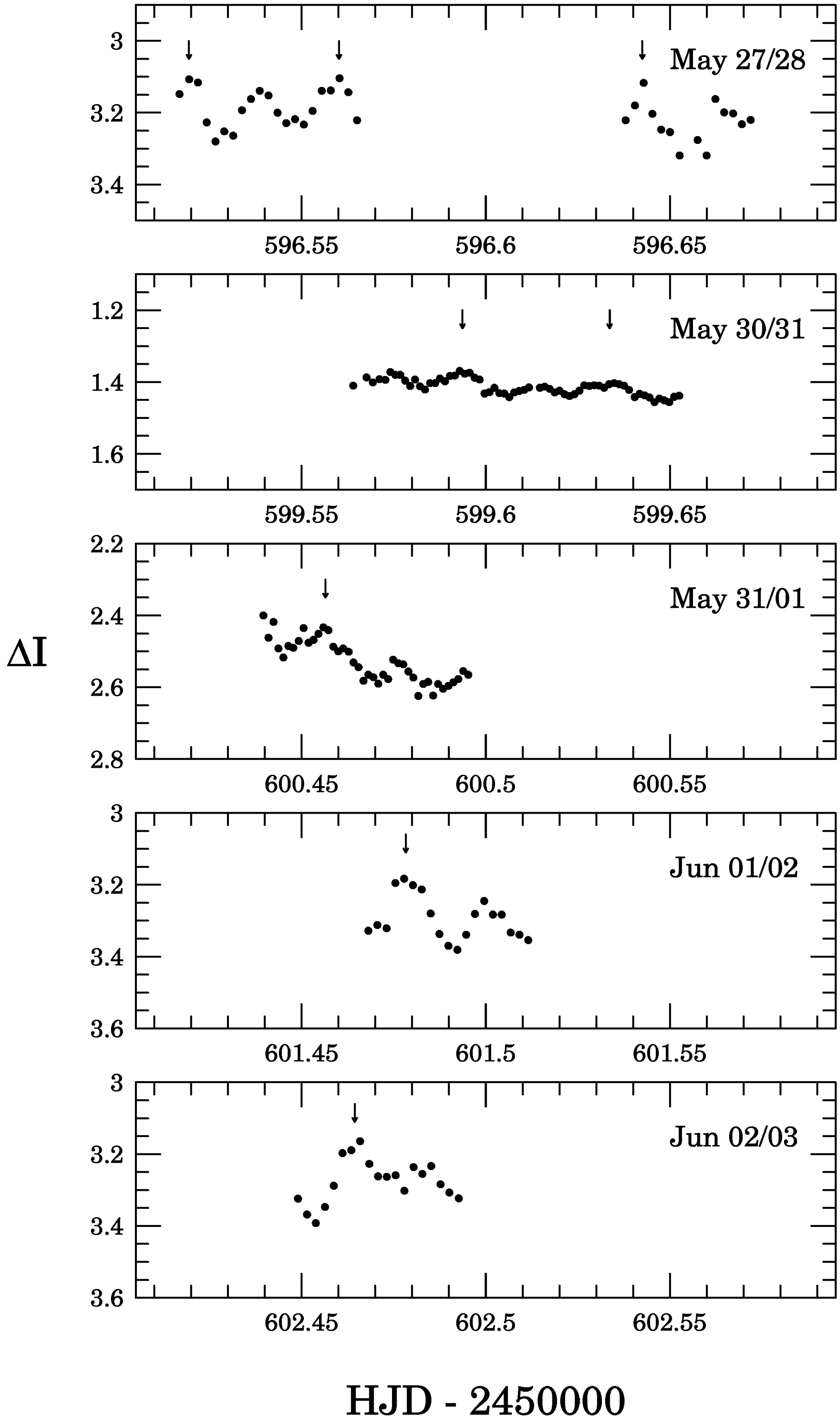

Fig. 7. The light curves of V485 Cen observed during and after the brightness dip *i.e.*, during the second stage of superoutburst and in quiescence. We marked by arrows the moments of maxima listed in Table 4.

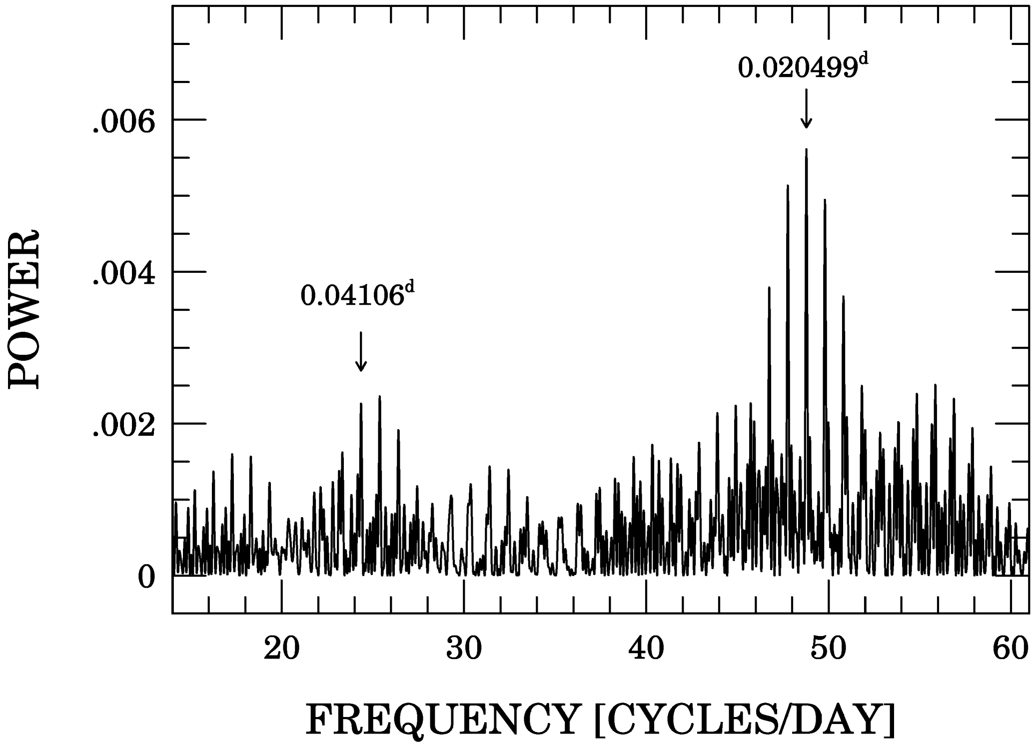

Fig. 8. Power spectra of five nights of observations shown in Fig. 7. The arrows mark periods $0\overset{d}{.}04106$ and $0\overset{d}{.}020499$.

which is in very good agreement with the value of period obtained from Fourier spectrum.

We can summarize that during the five nights from May 27 to June 2 the light curve was dominated by double humped structure with a period $0\overset{d}{.}0409961 \pm 0\overset{d}{.}0000066$ ($59\overset{m}{.}0$). This is in excellent agreement with the value of orbital period of V485 Cen given by Augusteijn *et al.* (1996) and equal to $0\overset{d}{.}040995001$.

7. Discussion

Recently a few groups published their results concerning 1995 superoutburst of AL Comae Berenices (Pych and Olech 1995, Kato *et al.* 1996, Howell *et al.* 1996, and Patterson *et al.* 1996). The conclusions were in all cases very similar – AL Com is a twin star of previously well studied dwarf nova WZ Sge. Both objects have one of the shortest known orbital periods among SU UMa stars, both show very rare superoutburst with amplitude about 8–9 mag and almost no ordinary outburst. Both also show a 2–3 mag brightness dip in the light curve, and in both stars dominant feature during quiescence is very symmetrical double hump with the period equal to the orbital period of the system and full amplitude of 0.12 mag. Up to now there are only two dwarf novae with orbital wave of that shape. Additionally AL Com during the main stage of superoutburst, when ordinary superhumps were clearly visible, showed increase of the period of superhumps. There is only one known SU UMa star, except for AL Com, with positive superhump period derivative. That object is SW UMa (Semeniuk *et al.* 1997) and it is also characterized by very short orbital and superhump periods and long time between superoutbursts.

Our CCD photometry of 1997 superoutburst of V485 Cen indicates that the star belongs to the SU UMa type variables and shows features very similar to those observed in the above mentioned stars. We found that present superoutburst of V485 Cen lasted at least 16 days and it is the only one superoutburst known for this object. Before, only ordinary outbursts with duration between 1 and 7 days were observed (Bateson 1979, 1982).

During the first stage of superoutburst we detected clear periodic light modulations called superhumps characteristic for SU UMa stars. Their period was equal to $60\overset{m}{.}705 \pm 0\overset{m}{.}006$. Thus, V485 Cen has the shortest known period among SU UMa type stars, as much as 25% shorter than previously known objects (superhump periods above mentioned stars are about 82 min). As it was shown by Paczyński (1981) and Paczyński and Sienkiewicz (1981) the theoretical value of minimal orbital period of system containing hydrogen-rich secondary is about 81 minutes. That was in very good agreement with observational results because the shortest orbital periods of SU UMa stars were about 81 min. Short values of superhump period equal to $60\overset{m}{.}705$ and orbital period equal to $59\overset{m}{.}03$ (Augusteijn *et al.* 1996, this work) observed in V485 Cen may suggest that this star belongs to a group of AM CVn systems containing degenerate helium secondary. However, the detection of hydrogen emission lines in spectrum of V485 Cen (Augusteijn *et al.* 1993, 1996) excludes this possibility. The only remaining possibility is that the secondary star in V485 Cen is not degenerate, but a hydrogen deficient main-sequence star. Theoretical calculations made by Sienkiewicz (1984), Nelson *et al.* (1986) and Tutukov and Yungelson (1996) imply that depending on opacities and hydrogen fraction in the secondary used in calculations the limiting value of minimal orbital period is between 60 and 80 min. According to Paczyński and Sienkiewicz (1981) absolute minimal orbital period for a non-degenerate secondary with critical mass equal to $0.084 M_{\odot}$ is about 49 min.

The period excess defined as $(P_{\rm sh} - P_{\rm orb})/P_{\rm orb}$ is equal to 0.028 for V485 Cen. It is known that SU UMa stars show linear relation between the period excess and orbital period with the smallest excesses at short orbital periods (Stolz and Schoembs 1981). The periods excesses for the shortest period SU UMa stars like WZ Sge, AL Com, HV Vir and SW UMa are 0.008, 0.011, 0.011 and 0.024, respectively. It is clearly visible that V485 Cen does not follow the Stolz and Schoembs' relation. According to Fig. 1 of Molnar and Kobulnicky (1992) there is another exception from this rule – T Leo, which period excess is considerably too large for its orbital period. On the other hand, calculations made by Whitehurst (1988) show that there is also a linear relation between period excess and mass ratio of the system defined as $q = M_{\rm sec}/M_{\rm WD}$. Observational results seem to confirm these calculations without any exceptions as can be seen in Fig. 2 of Molnar and Kobulnicky (1992). Assuming that V485 Cen is similar to T Leo in the sense that it follows only the relation between period excess and q we can roughly estimate its mass ratio. From linear relation obtained by Molnar and Kobulnicky (1992), for period excess equal to 0.028, q should be around 0.17. This value is in disagreement with estimate made by Augusteijn *et al.* (1996). From spectroscopy they obtained $M_{\rm WD}/M_{\rm sec}$ about 2.6, that is $q \approx 0.38$. According to Molnar and Kobulnicky (1992 and references therein) the absolute upper limit for q for SU UMa stars is equal to 0.33 and is very likely less than 0.22. For higher values of the mass ratio q it is hard to obtain tidal instability of accretion disc caused by effect of 1:3 resonance which is believed to be a cause of presence of superhumps. Detection of superhumps in V485 Cen implies that its mass ratio should be smaller than 0.33. Our rough estimate equal to 0.17 is very close to the optimal value $q = 0.16$ for which there is the highest possibility of developement of superhumps (Molnar and Kobulnicky 1992).

We have also demonstrated that the value of the superhump period increases during the superoutburst. The period derivative $\dot{P}_{\rm sh}$, obtained from a parabolic fit to the $O - C$ diagram, is equal to 28.3×10^{-5}. Such a rate of the superhump period change is more than two times greater than the typical value for SU UMa stars. Moreover the SU UMa stars generally show decreasing superhump periods during the plateau phase of superoutbursts. All SU UMa stars with measured superhump period changes listed by Patterson *et al.* (1993) have negative $\dot{P}_{\rm sh}$. The newly discovered exceptions from that rule are AL Com (Howell *et al.* 1996, Patterson *et al.* 1996) and SW UMa (Semeniuk *et al.* 1997) both having the shortest orbital periods among SU UMa stars and longest intervals between superoutbursts. The discovery of positive value of $\dot{P}_{\rm sh}$ in V485 Cen confirms hypothesis of Semeniuk *et al.* (1997) that the SU UMa stars with the shortest orbital periods and the longest superoutburst recurrence times exhibit increasing superhump periods contrary to the other SU UMa stars whose $\dot{P}_{\rm sh}$ have negative values.

The first stage of superoutburst ended with over 2 mag brightness dip which lasted 2–3 days. During the dip and later when star brightened for 2–3 days we observed double humped light variations with the period $59\overset{\rm m}{.}03 \pm 0\overset{\rm m}{.}01$, which is exactly equal to the orbital period of the system (Augusteijn *et al.* 1993, 1996). These modulations were also seen after the end of the superoutburst. There are only two other cataclysmic variable stars known with orbital waves similar to the observed. These are WZ Sge and AL Com – again both having the shortest orbital periods among SU UMa stars and the longest intervals between superoutbursts.

Kato *et al.* (1996), Howell *et al.* (1996), and Patterson *et al.* (1996) interpreted a brightness dip in the light curve of AL Com as an effect of propagating cooling wave in the disc. This cooling wave due to the large amount of material which still exists in the disc is not stable and is reflected by a heating wave which starts the next normal outburst which subsequently triggers the second fainter superoutburst. This hypothesis was partially confirmed by detection of superhumps in the post-dip light curve of AL Com. In case of V485 Cen we did not observe superhumps in the post-dip light curve, but we detected clear orbital humps. This may suggest that brightening of the star after the dip was a normal outburst. Situation is, however, unclear because observations of Augusteijn *et al.* (1993) did not reveal any modulations during regular normal outburst and their observations during quiescence also did not show any double humped structure.

Augusteijn *et al.* (1996) gave an estimate of the mass transfer from the secondary in V485 Cen between $1 \times 10^{-10} M_\odot$/y and $1 \times 10^{-9} M_\odot$/y. From theoretical calculations (see Osaki 1996 and references therein) we know that such a large values of $\dot{M}$ are characteristic for systems called "permanent superhumpers" – dwarf novae below the "period gap" which are in permanent superoutburst. The values of $\dot{M}$ obtained for systems such as WZ Sge, AL Com or SW UMa are around $\dot{M} \approx 2 \times 10^{-11} M_\odot$/y, in other words a few times smaller than estimate of Augusteijn *et al.* (1996). According to the fact that V485 Cen often shows normal outbursts its mass transfer should be slightly higher than in systems like WZ Sge and AL Com. This is in good agreement with theoretical calculations made by Nelson *et al.* (1986) who, for system with secondary containing 50% of hydrogen, obtained minimal period equal to $P_{\rm orb} = 0\overset{\rm h}{.}99$, mass of the secondary $M_{\rm sec} = 0.057 M_\odot$ and mass transfer rate $\dot{M} = 0.58 \times 10^{-10} M_\odot$/y.

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