A TURBULENT REGION IN CH Cyg?

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ABSTRACT. Photoelectric U, B, V observations of the symbiotic eclipsing binary CH Cygni made in 1983 - 1986 are published. A gradual decrease in the amplitudes of brightness variations was observed after the activity maximum in 1982 until December 1984. On Oct. 6 - 7, 1985, no rapid changes in brightness were observed at the time of the full eclipse of the hot component. After the eclipse, at the end of 1985, a sudden increase in the amplitudes of the star's brightness fluctuations was observed, especially in the U colour ($\Delta U_{max} = 0^m.35$). The possibility of observing the turbulent region of the accretion disk discussed.

ТУРБУЛЕНТНАЯ ОБЛАСТЬ В CH ЛЕБЕДЯ? В роботе опубликованны фотоэлектрические U, B, V наблюдения симбиотической затменной двойной звезды CH Лебедя выполненые в I983 - I986 гг. Наблюдалось постепенное понижение амплитуд изменений яркости после максимума активности в I982 г вплоть до декабря I984 г. 6-7 ого октября I985 г., во время полного затмения горячего компонента, никакие быстрые изменения блеска ненаблюдались. После затмения, в конце I985г., наблюдалось внезапное повышение амплитуд флуктуаций блеска звезды, главным образом в цвете U ($\Delta U_{max} = 0^m.35$). Дискутируется возможность наблюдания турбулентной области акреционного диска.

TURBULENTNÁ OBLASŤ V CH Cyg? V práci sú publikované fotometrické U, B, V pozorovania symbiotickej zákrytovej dvojhviezdy CH Cygni v období 1983 - 1986. Bol pozorovaný postupný pokles amplitúd zmien jasnosti po maxime aktivity v r. 1982 až do decembra 1984. 6./7. októbra 1985, v úplnom zákryte horúcej

zložky, neboli pozorované žiadne rýchle zmeny jasnosti. Po zákryte, koncom roku 1985, bol pozorovaný náhly vzrast amplitúd fluktuácií jasnosti hviezdy, obzvlášť v U farbe ($\Delta U_{max} = 0^m.35$). Je diskutovaná možnosť pozorovania turbulentnej oblasti akrečného disku.

1. INTRODUCTION

The present knowledge of star CH Cygni enables us to include it among the symbiotic eclipsing binaries. However, the spectroscopic and photometric behaviour of the star does not allow for a unique interpretation of many of the observed phenomena. Although some of the basic parameters of the system, preliminary elements of the binary's trajectory (Yamashita and Maehara, 1979; Skopal et al., 1986), the distance (Slovak and Africano, 1978), the spectral types of the components and some of the physical parameters of the radiating regions (e.g.,Luud and Tomov, 1984; Farragiana and Hack, 1971) have been estimated, the basic principle of the interaction between the components (the manner of mass transfer) is still not clear.

After the 1967 outburst, CH Cygni was observed photometrically by many authors. Variations of the light curve of 46 and more than 100 days were observed (Cester, 1969). After the outburst of 1967, the V light curve displayed periodic variations on a time scale of about 700 days between 1968 and 1976 (Duschl, 1983). CH Cygni reached its brightness maximum ($5^m.7$ in the V colour) after a practically monotonic increase since 1977 in 1982 (Chochol et al.,1984b; Spiesman, 1984). In 1983 a slight decrease of brightness was observed, and the values of the V-magnitude were around $5^m.8$ (Reshetnikov and Khudyakova, 1984). The sudden decrease of brightness in the visual region of the spectrum of more than 1^m was observed between 25 July and 15 August, 1984 (Mikolajewski and Tomov, 1986). The values of the U-magnitude of CH Cygni, observed between 1967 and July 1986, displayed two distinct minima of practically identical geometry, spaced at about 16 years and corresponding to the eclipse of the hot active component by a cool giant (Mikolajewski et al., in press).

Rapid changes in brightness have been observed in the U-region of the spectrum since 1967 (Martel-Chossat, 1967). Irregular variations with amplitudes ranging from $0^m.02$ to $0^m.1$ have been observed on time scales of 5 to 20 mins (Slovak and Africano, 1978). In 1982, variations of $0^m.3$ in U and of $0^m.2$ in V were also observed on a time scale of hours. Mikolajewski et al. (in press) have noted that flickerings were not observed at the time of the eclipse in August and September, 1985. On April 24, 1986, observations were made which disclosed changes in amplitude, $\Delta U = 0^m.2$ to $0^m.4$, with a typical duration of 10 to 30 minutes (Tomov et al., 1986).

2. OBSERVATIONS AND RESULTS

The values of the U, B, V photometry were obtained using a single-channel

photoelectric photometer, installed in the Cassegrain focus of the 0.6-m telescope at the Skalnate Pleso Observatory. The measurements were carried out with a 10-s integration period and reduced to the international system. In one case, on June 22-23, 1983, a 1-s integration period was used in cycles of 50 measurements cosecutively in each colour. The values observed on this night are presented in the instrumental system. The magnitudes and colours indices of the comparison stars are the same as in (Chochol et al., 1984b).

The U, B, V observations of CH Cygni are in Tab. 1. Each of the values represents an average of the observations made during a single night. The number "n" represents the number of individual observations. The values of the

Table 1.

J. D. hel	V	B-V	U-B	n	Date
2 445 566.57	5.690	0.568	-0.337	24	1983 August 20
6 047.20	6.781	0.942	-0.229	8	1984 December 12
048.22	6.779	0.941	-0.191	12	1984 December 13
049.22	6.795	0.935	-0.159	4	1984 December 14
345.31	7.322	1.489	+0.706	10	1985 October 6
378.24	7.358	1.378	-	15	1985 November 8
397.28	7.461	1.096	-0.093	13	1985 November 27
399.18	7.442	1.091	-0.143	8	1985 November 29
423.26	7.474	1.017	-0.267	13	1985 December 23
425.21	7.506	0.981	-0.188	25	1985 December 25
548.41	7.950	1.057	-0.166	9	1986 April 27
555.56	7.767	0.934	-0.367	10	1986 May 5
556.55	7.864	1.040	-0.316	10	1986 May 6
564.53	7.778	1.042	-0.127	19	1986 May 14
574.52	7.686	1.142	-0.122	7	1986 May 24
597.49	7.636	1.105	-0.213	18	1986 June 15
598.51	7.684	1.267	-0.048	5	1986 June 17
605.50	7.785	1.202	-0.143	12	1986 June 24
615.42	7.765	1.160	-0.137	5	1986 July 3
615.44	7.836	1.038	-0.186	5	1986 July 3

magnitudes of the U-filter are summarized in Fig. 1. The observed minimum is interpreted as the eclipsing of the hot component of the system (Mikolajewski et al.,in press). Fig. 2 shows the photometric variability on two nights in 1983. The amplitude in the U and V-colours does not exceed $0^m.22$. No marked difference of these fluctuations between the U, B, V-colours was observed. A similar result was also obtained by Reshetnikov and Khudyakova (1984).

A further decrease in the brightness variations was observed in December 1984. All the variations of the magnitudes observed in the U and V-colours are within the limits of $\Delta U = \Delta V = 0^m.144$ (Fig.3).

Figure 4 shows the results of the observations made during the night of Oct. 6-7, 1985, the time of the total eclipse of the hot component. No rapid changes were observed. The scatter of the values: $\Delta U_{max} = 0^m.055$, $\Delta V_{max} = 0^m.031$, $\Delta(B-V)_{max} = 0^m.031$ and $\Delta(U-B)_{max} = 0^m.030$.

After the eclipse, at the end of 1985, a sudden increase in the amplitude of the star's brightness fluctuations was observed, mainly in the U-colour. The irregular variations of the U-magnitude are within the range of $\Delta U = 0^m.35$ and of the V-magnitude within $0^m.2$ on a time scale of 10 - 20 minutes (Fig. 5).

Further observations, made in May and June 1986, indicate a decrease in the amplitudes of the rapid variations of brightness, ΔU_{max} and $\Delta V_{max} = 0^m.25$. On the night of May 13-14, 1986, a "flare" with the amplitude $\Delta U_{max} = 0^m.27$ and lasting about 25 mins was observed (Fig. 6).

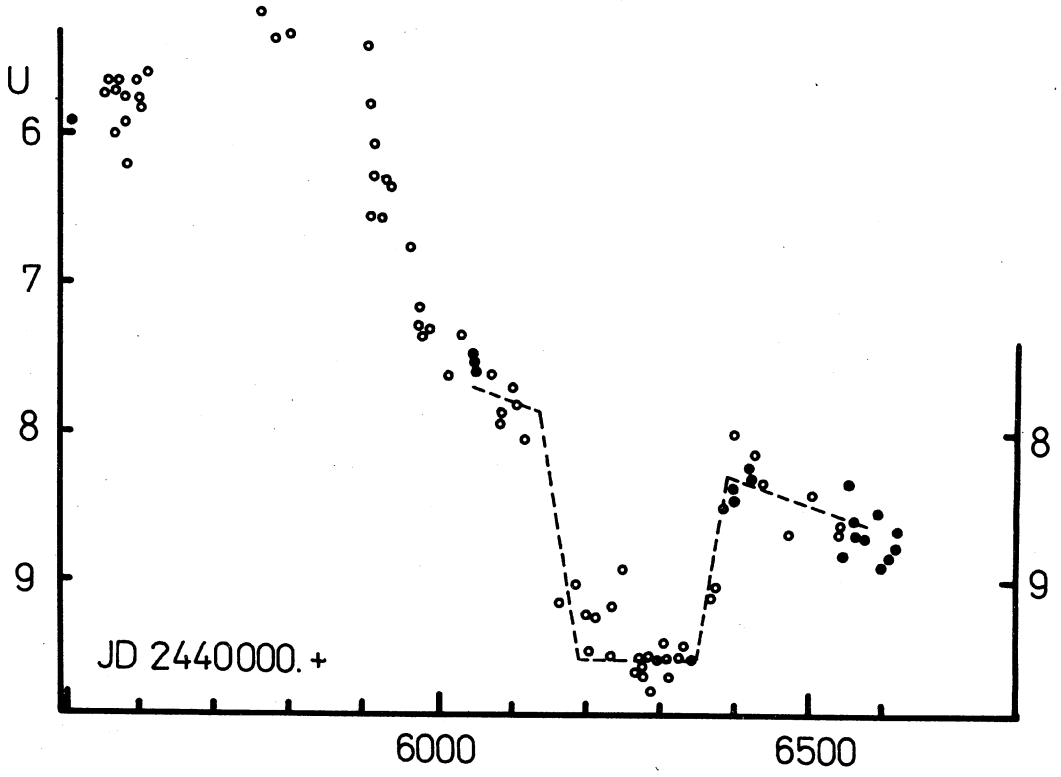

Fig. 1. U light curve of CH Cyg observed during 1983-86 taken from the paper: Mikolajewski et al. (in press). The full circles are values obtained at the Skalnaté Pleso Observatory and are discussed in text.

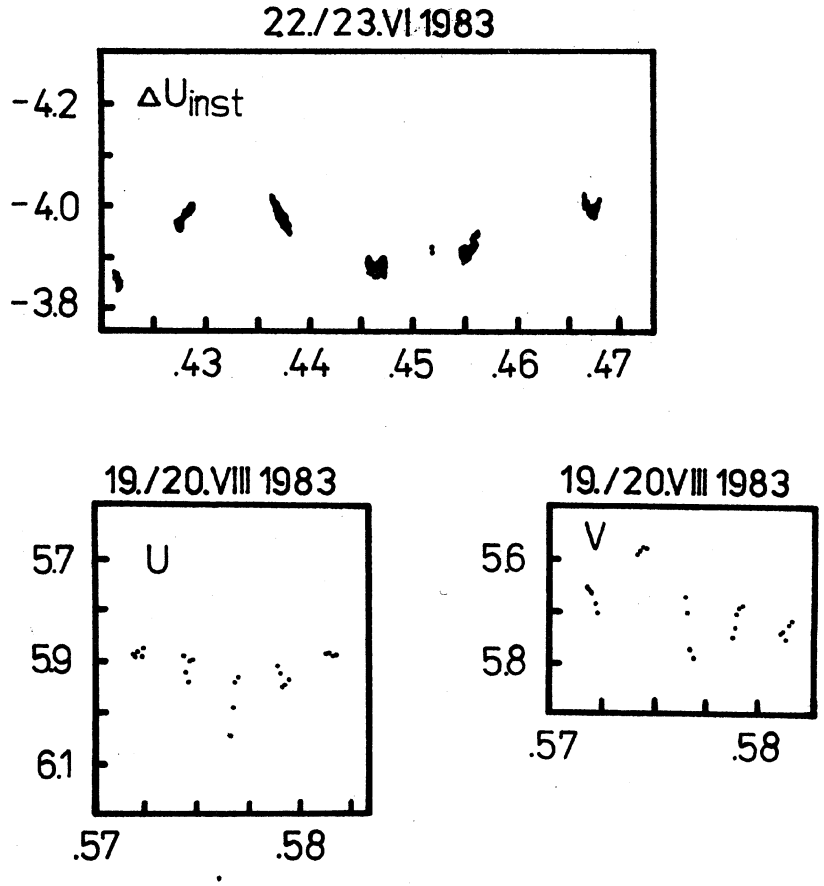

Fig. 2. The photometric variability on two nights in 1983.

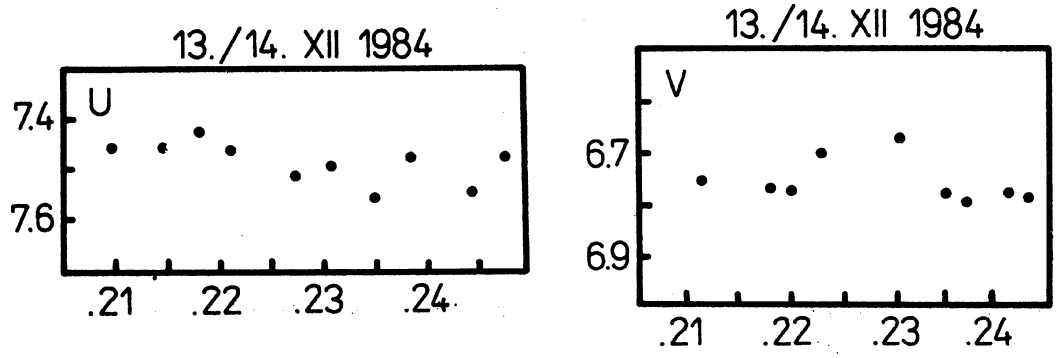

Fig. 3. The brightness variations observed in December 1984.

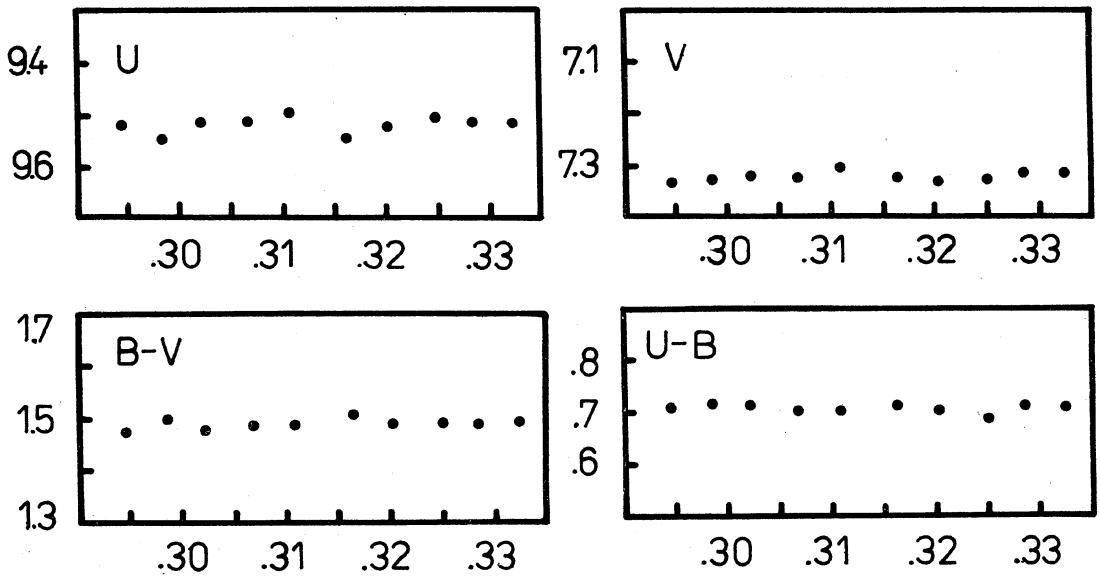

Fig. 4. The results of the observations made during the night of Oct. 6-7,1985.

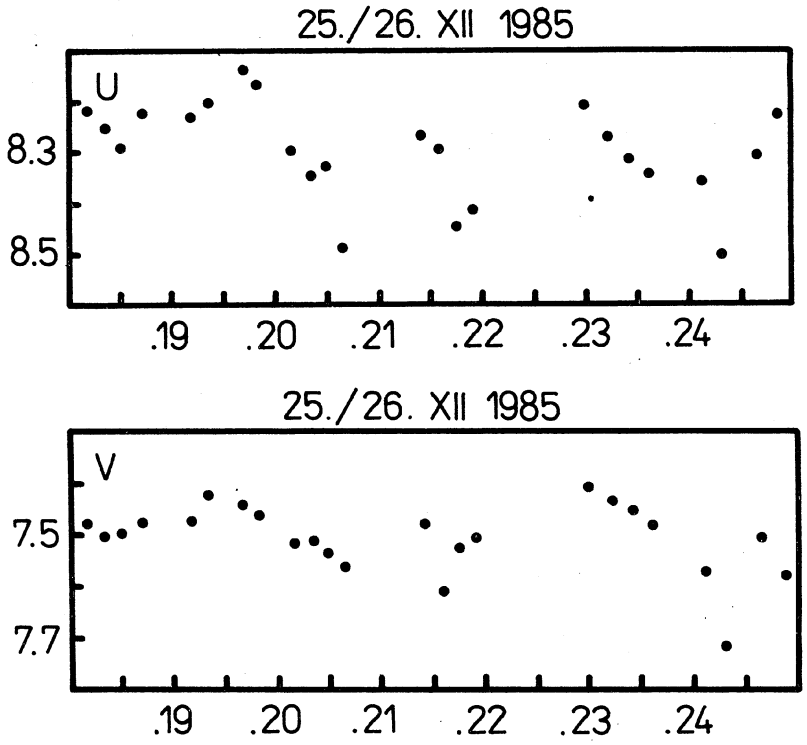

Fig. 5. At the end of 1985 the irregular variations of the U-magnitude are within the range of $\Delta U_{max} = 0^{m}.35$ and of the V-magnitude within $0^{m}.2$.

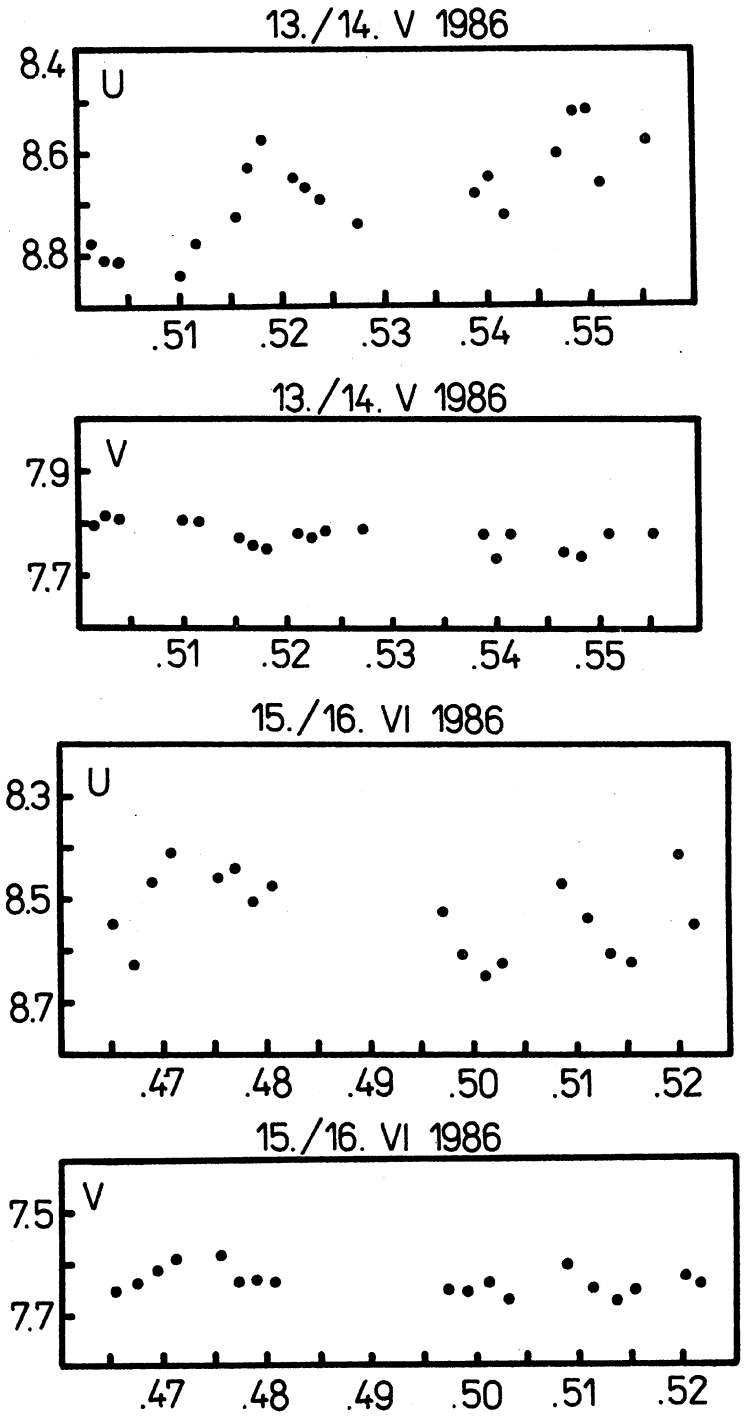

Fig. 6. The photometric variability on two nights made in May and June 1986.

3. DISCUSSION

The vanishing of flickerings and flares in the primary minimum indicates that the source of these changes is located at the hot component. Skopal et al. (in press) have shown that the maximum of activity of CH Cygni is related to its periastron passage at the end of 1982. The maximum amplitude of the brightness variations in the U-filter reached $0^m.3$ at this time (Chochol et al., 1984b). This was followed by a monotonic decrease until the 1985 eclipse, when no rapid changes were observed (Fig. 7). This trend can be explained by the

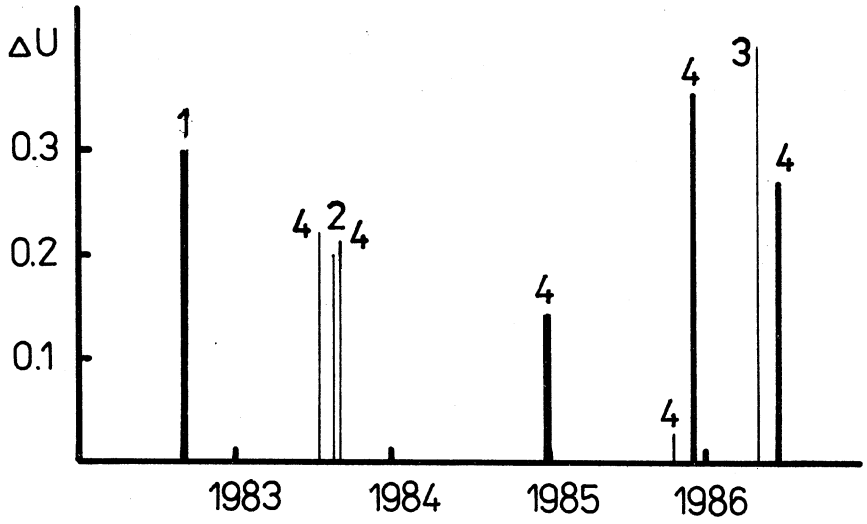

Fig. 7. The maximum amplitudes of the brightness variations in U-filter observed during 1982 - 1986. The thin lines represent the observations in separate nights, thick ones in a few nearby nights. The data are taken from: 1-Chochol et al., 1984b; Spiesman 1984. 2-Reshetnikov and Khudyakova, 1984. 3-Tomov et al., 1986. 4-This paper.

decrease in the amount of mass transferred from the active component of the active binary to the accretion disk as a result of the increasing distances between the two components. About 2 months after the eclipse, rapid brightness variations are observed again, these amount to $0^m.3$ - $0^m.35$ in the U-colour. If we accept the above deliberation, the relatively most active region of the accretion disk, i.e. the turbulent region which is a strong source of flickerings and flares, is observed very soon after the eclipse. Similar evidence of the rapid photometric variability was observed after the primary eclipse of the symbiotic eclipsing binary CI Cygni (Chochol et al., 1984a). However, the creation of this region requires the accretion disk to be penetrated by the mass being transferred. The mass transfer in 1985 and 1986 in CH Cygni has not been proved spectroscopically so far, and cannot, therefore, be assumed in advance because it involves an elliptical orbit with an eccentricity of about 0.55 (Sko-

pal et al., in press). However, Tomov et al. (1986) have reported a new increase in the activity of CH Cygni which took place in November and December 1985; they document this by the changes observed in the absorption and emission spectrum of the star and by the reappearance of rapid flickerings in CH Cygni's brightness.

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