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IUE low-resolution observations of the triple system CH Cygni: the mass transfer in the symbiotic pair*

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Abstract. We present and analyse UV low-resolution spectra of CH Cyg taken during the whole period of the International Ultraviolet Explorer (IUE) mission. Our analysis of the variation in the UV/optical hot star continuum confirmed the basic scenario of sporadic accretion in the symbiotic pair of the triple-star system as being responsible for maintaining its activity.

During active phases, the hot continuum consists of two components. The first, far-UV emission, can be associated with a region where the material from the giant star in the symbiotic pair impacts the accreting matter around the hot star. The second, seen in the near-UV ($\lambda \geq$2200 Å) and the optical UBV region, can be produced by the accretion process onto the central star. Emission here shows characteristic temperatures of 6500 – 8700 K. Both sources require an equivalent mass transfer rate of $1 - 2 \times 10^{-5}$M$_\odot$ yr^{-1} during the 1979-84 maximum, and about of 2×10^{-6}M$_\odot$ yr^{-1} in the 1992-95 active phase for derived parameters of the hot component in the triple-star system. Variation in the luminosities of both sources suggests that the basic physical principles of mass transfer in CH Cyg are similar to those of cataclysmic variables (CVs).

Key words: binaries: symbiotic – stars: individual: CH Cygni – ultraviolet: stars

1. Introduction

The symbiotic phenomenon in CH Cyg has no counterpart in any of its main features among the other symbiotics. For example, during active phases a low excitation shell spectrum develops in the optical domain, but during quiescent phases the symbiotic phenomenon totally disappears. In order to study the mass transfer process causing such transient acivity, we need to know the basic configuration of the system, which, however, is still under debate at present. If we accept a binary nature for CH Cyg (e.g. Yamashita & Maehara 1979; Skopal, Mikolajewski & Biernikowicz 1989), then the explanation of the total hot component luminosity in such a wide binary (P$_{\rm orb}$ ∼5 700 days) appears to be a crucial problem. For parameters of the suggested binary model (e.g. Mikolajewski et al. 1987), accretion onto the $\sim$ 1 M$_\odot$ white dwarf from the giant wind is lower by one order of magnitude than that required to match the observed hot component luminosity (Mikolajewska, Selvelli & Hack 1988). Skopal (1988) tried to solve this problem by assuming an asynchronous rotation of the giant star in the long-period binary, causing a considerable shrinking of the giant's Roche lobe and thus a larger mass transfer via the L_1 point. On the other hand, Mikolajewski & Mikolajewska (1988) suggested a long-term accumulation of the wind material around a rapidly rotating magnetic white dwarf before its final accretion at a high rate, following the oblique rotator model of Lipunov (1987). However, application of this sophisticated model to CH Cyg meets with serious difficulties in explaining, for example, the recurrence of, and strong difference between the active phases (see Skopal et al. 1996b for more details).

Progress in understanding the mass transfer problem in CH Cyg is offered by the recently suggested triple star-model (cf. Hinkle et al. 1993; Skopal et al. 1996a; Skopal et al. 1998), in which the 756-day period inner binary (the symbiotic pair) is entirely responsible for the observed activity. Also, multifrequency observations, from UV to the radio/mm-wave region carried out during the recent 1992-94 active phase, revealed that the stages of activity in CH Cyg arise from accretion of material from the giant component onto its companion in the symbiotic pair (Skopal et al. 1996b).

In our contribution, we analyse in more detail the behaviour in the UV/optical hot star continuum during the whole IUE operational lifetime. We show that the luminosities of the main regions, in which the transferred matter dissipates its binding

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[*] Based on observations by the *International Ultraviolet Explorer* satellite taken at the Villafranca Satellite Tracking Station of the European Space Agency

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Table 1. Journal of low-resolution IUE spectra of CH Cyg used in this paper

Spectrum	Disp.	Date			Spectrum	Disp.	Date			Spectrum	Disp.	Date		
		YY	MM	DD			YY	MM	DD			YY	MM	DD
SWP 03798	L	79	1	4	SWP 28682	L	86	7	15	SWP 52655	L	94	10	25
LWR 03378	L	79	1	4	LWP 08631	L	86	7	15	LWP 29401	L	94	10	25
SWP 04244	L	79	2	11	SWP 39351	L	90	7	31	SWP 52989	L	94	12	5
LWR 03743	L	79	2	11	LWP 18490	L	90	7	31	LWP 29646	L	94	12	5
SWP 05674	L	79	6	29	SWP 39972	L	90	10	27	SWP 54254	L	95	3	30
LWR 04918	L	79	6	29	LWP 19072	L	90	10	27	LWP 30341	L	95	3	30
LWR 05136	L	79	7	21	SWP 40450	L	90	12	24	SWP 54800	L	95	5	31
SWP 05881	L	79	7	21	LWP 19469	L	90	12	24	LWP 30812	L	95	5	31
SWP 08939	L	80	5	6	SWP 44616	L	92	5	7	SWP 55344	L	95	7	22
LWR 07687	L	80	5	6	LWP 23054	L	92	5	7	LWP 31146	L	95	7	22
SWP 15591	L	81	11	29	SWP 46325	L	92	11	24	SWP 55900	L	95	9	11
LWR 12057	L	81	11	29	LWP 24349	L	92	11	24	LWP 31446	L	95	9	11
SWP 22056	L	84	1	20	SWP 47758	L	93	5	27	SWP 56143	L	95	11	2
LWP 02674	L	84	1	20	LWP 25612	L	93	5	27	LWP 31650	L	95	11	2
SWP 27217	L	85	12	3	SWP 52403	L	94	10	14	SWP 56289	L	95	12	13
LWP 07232	L	85	12	3	LWP 29393	L	94	10	14	LWP 31817	L	95	12	13

energy to radiation, are comparable with those resulting from mass transfer in CVs.

2. Observations

This paper is based on the low-resolution UV observations carried out using the IUE satellite during its operational period 1978 – 1995; the corresponding UBV photometry was taken from the literature. Here we used a sample of 48 spectra from the VILSPA archive (Table 1), which fits best the aim of our paper. We sorted the data in time with respect to the activity of CH Cyg in the same way as Skopal et al. (1998).

3. Two-component hot star continuum

Evolution in the hot star UV/optical continuum during the 1990-95 period is shown in Fig. 1. It covers the whole 1992 – spring 1995 active phase, following quiescence, and a part of the preceding 1987-91 quiescence. The low resolution IUE spectroscopy in 1979-86 and 1987-89 was presented by Mikolajewska et al. (1988) and Selvelli et al. (1990), respectively. Skopal et al. (1996b) noted that during the recent activity the overall shape of the continuum was characterized by two contributions: one placed at the far-UV and the second one at the near-UV ($\lambda \geq$2 200 Å)/optical region. They found that the latter can be matched by a Planckian function, and suggested that such a hot star continuum could be caused by the presence of two physically different sources. In the current contribution, based on our new observations and re-analysis of the old ones, we determine the parameters of both sources more accurately.

3.1. The 1992-95 active phase

There are three IUE shifts during which spectra were taken just in the total eclipse of the optical light: two of them at the beginning of the eclipse (14/10/94 and 25/10/94) and one close to its middle (5/12/94). Corresponding fluxes in the UBV bands were estimated from the simultaneous photometry as in Skopal et al. (1996b). Comparing the profile of their UV/optical continuum to that observed out of the eclipse (e.g. 28/5/93 and 30/3/95), we can see that the near-UV/optical continuum is eclipsed first, being practically flat at the beginning of the minimum in the UBV range, while the far-UV emission bump is not depressed so much (panel b of Fig. 1). However, close to mid-eclipse, the whole hot star continuum is flat, as during quiescence (right panels of Fig. 1). This observation directly indicates the presence of two physically different radiative sources around the hot star located at or close to the orbital plane of the symbiotic pair.

3.2. The main active phase (1979-86)

The low resolution IUE spectra from 1979-86 were described and analysed by Persic et al. (1984) and Mikolajewska et al. (1988). Both groups tried to explain the UV continuum by a combination of a Kurucz model atmosphere (log g = 1-2, $T_{\rm eff}$ = 8 500 - 9 000 K) and hydrogen recombination and free-free emission. However, in the period of maximum brightness (1981-84) the presence of a strong f-b + f-f continuum is not supported by observations. Mikolajewska et al. (1987) published several spectra from the period 1982-86 showing a flat continuum around the Balmer jump on 31/5/82 and 6/6/83. Also on spectrograms taken during the 1981-84 period (Skopal et al. 1989) the Balmer discontinuity was flat. The Balmer jump in emission appeared after the sudden drop in the star's brightness, in mid-1984 (e.g. Mikolajewska et al. 1987). Therefore we re-analyze the spectra from 1979-84 here.

We used the continuum fluxes as published by Mikolajewska et al. (1988) for the best exposed IUE spectra. From (near-)simultaneous UBV photometry we estimated fluxes in the U, B and V bands for the hot component radiation. We subtracted the average magnitudes of the 1971-77 quiescent phase (U=9.5, B=9.0, V=7.5) from those observed at maximum activity by the

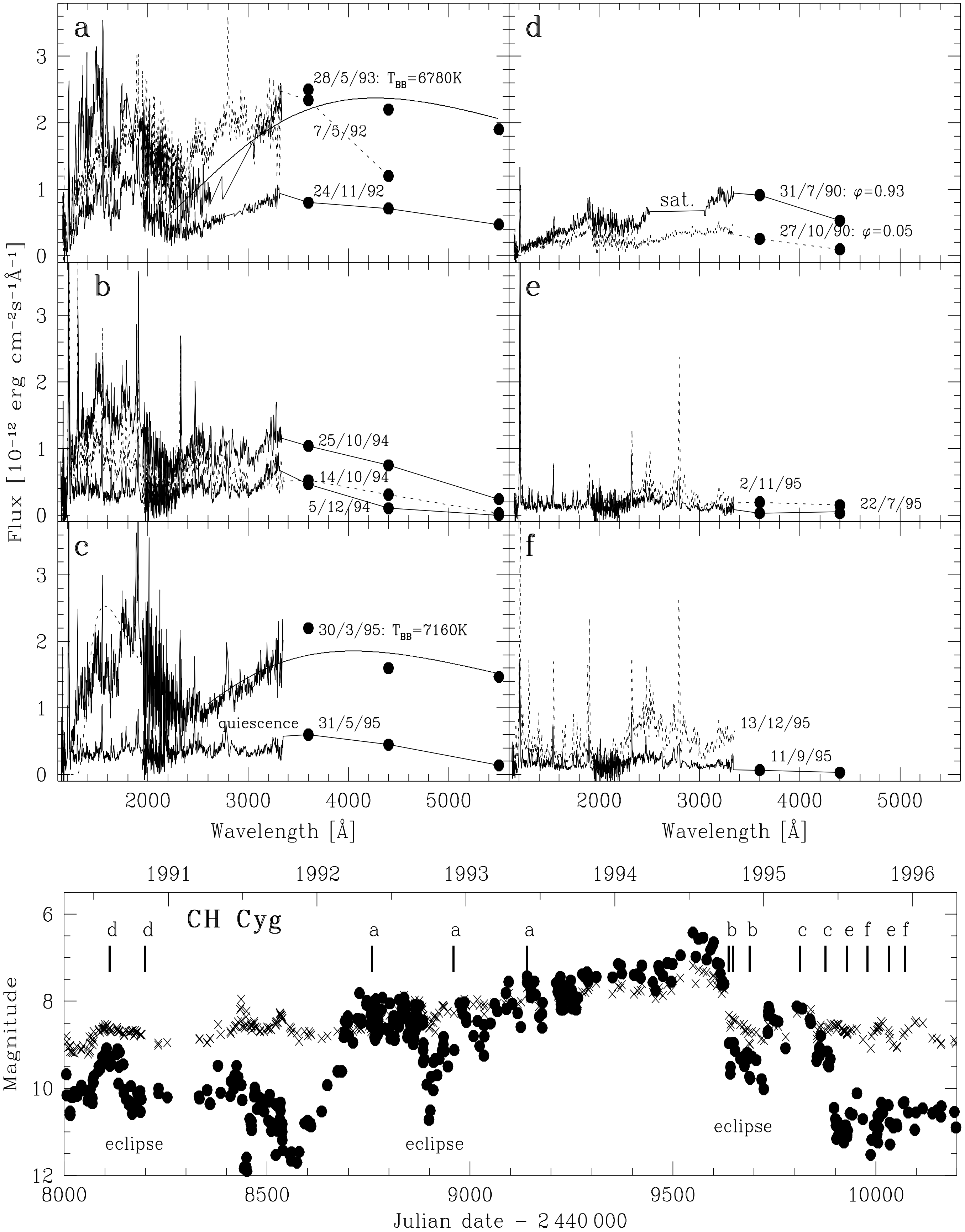

Fig. 1. Development of the hot star UV/optical continuum (λ1200 – 5500 Å) during the 1992-95 active phase (left panels) and that preceding and following quiescence (right panels). The bottom panel shows a part of the U(●) and V(×) light curve covering the period of these spectroscopic observations. Timing of the IUE observations is marked by vertical bars. Eclipses in the inner binary are denoted by "eclipse"

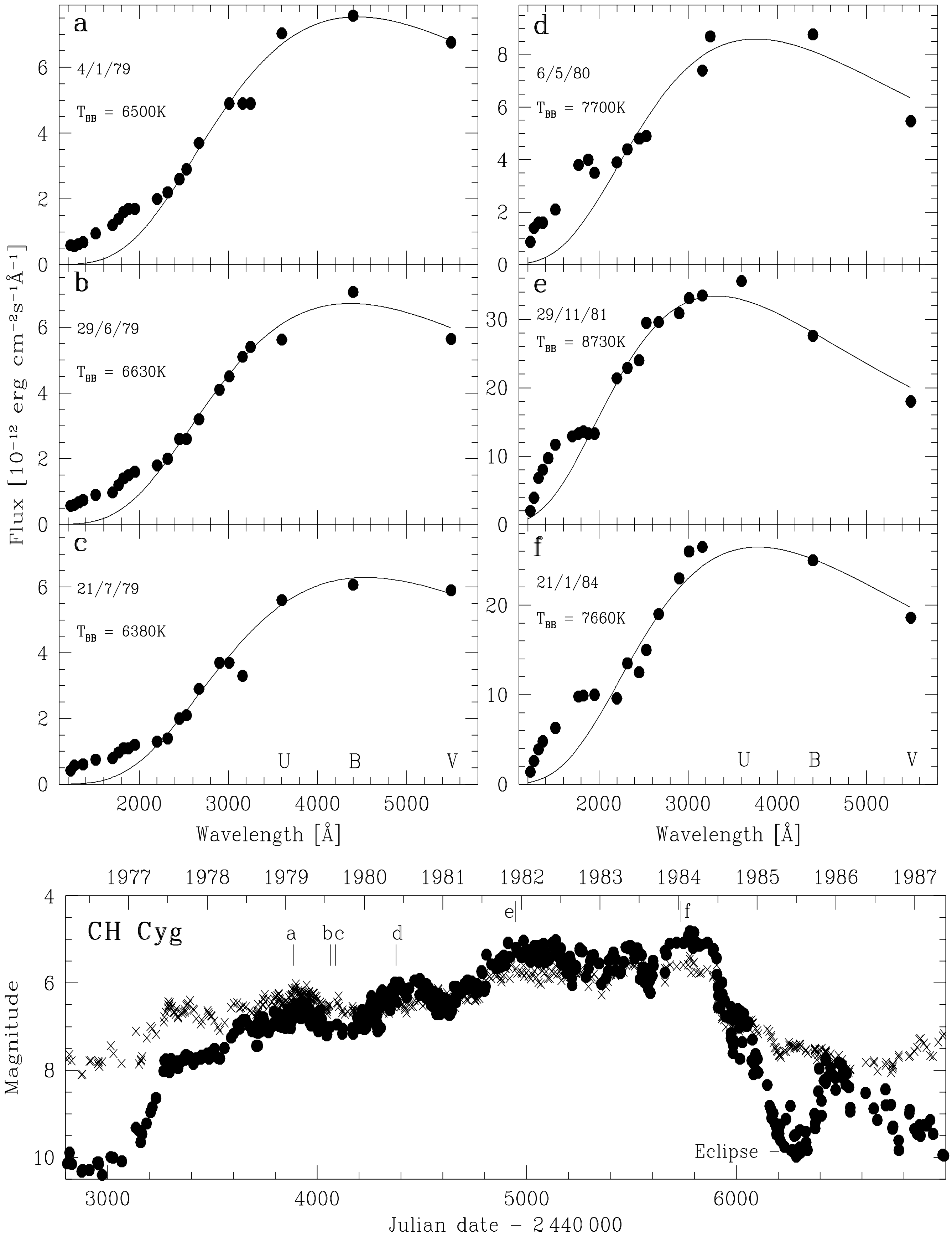

Fig. 2. As in Fig. 1, but for the period of the main 1979-84 active phase. The IUE spectra here are represented by the continuum fluxes estimated by Mikolajewska et al. (1988). The eclipse in the outer binary is denoted by "Eclipse"

Table 2. Parameters of the hot continuum during active phases of CH Cyg for the distance of 270 pc

Date	$T_{\rm eff}$	k	$L_{\rm BB}$	$R_{\rm eff}$	$\dot{M}_{\rm acc}$	$L_{\rm UV}$	$L_{\rm imp}$	$(L_{\rm UV}/L_{\rm BB})$
	[K]	[10^{-18}]	[$L_{\odot}$]	[$R_{\odot}$]	[$10^{-5} M_{\odot} {\rm yr}^{-1}$]	[$L_{\odot}$]	[$L_{\odot}$]	
04/01/79	6500±50	1.57±0.07	116±9	8.5±0.5	0.74±0.10	1.8±0.4	2.6±0.8	0.016±0.005
11/02/79	6850±45	1.55±0.05	140±8	8.4±0.5	0.89±0.05	1.5±1.0	3.1±0.8	0.011±0.008
29/06/79	6630±55	1.28±0.05	102±7	7.7±0.5	0.65±0.04	1.5±0.3	2.3±0.7	0.015±0.004
21/07/79	6380±50	1.45±0.04	99±6	8.1±0.3	0.62±0.04	1.2±0.3	2.2±0.2	0.012±0.004
06/05/80	7700±55	0.77±0.03	112±8	5.9±0.5	0.71±0.05	3.3±0.9	2.5±0.7	0.030±0.010
29/11/81	8730±20	1.61±0.02	384±8	8.6±0.5	2.45±0.04	7.3±0.7	8.5±0.8	0.019±0.002
21/01/84	7660±20	2.46±0.03	348±8	10.6±0.3	2.22±0.04	7.3±0.8	7.7±0.8	0.021±0.003
07/05/92	8650±200	0.10±0.02	23.0±7	2.2±0.4	0.15±0.04	2.1±0.3	1.9±1.1	0.091±0.041
28/05/93	6780±100	0.40±0.04	34.9±6	4.3±0.6	0.22±0.04	3.6±0.7	2.8±0.9	0.103±0.038
30/03/95	7160±175	0.24±0.03	26.0±6	3.3±0.6	0.17±0.03	2.7±0.6	2.2±1.0	0.104±0.047

same method as used by Skopal et al. (1996b). Conversion into fluxes was provided according to Henden & Kaitchuck (1982). Resulting fluxes of the hot continuum during the 1979-84 maximum are shown in Fig. 2. The flux in the near-UV/optical region was a factor of about 10 higher than that observed in the 1992-95 active phase, and thus partly masked the second fainter source in the far-UV region. However, fitting the near-UV/optical continuum by a Planckian function clearly let us recognize the presence of the two separate sources in the spectrum even during the 1979-84 active period.

3.3. Parameters of the hot continuum

In accordance with our fitting of the near-UV/optical continuum by a Planckian function, the observed black-body flux is $k \times (\sigma/\pi)\, T_{\rm eff}^{4}\, {\rm erg\,cm^{-2}\,s^{-1}}$, where k is a normalising parameter of the fits. The corresponding bolometric luminosity, $L_{\rm BB}$, was determined for a distance to CH Cyg of 270 pc (Viotti et al. 1997). In addition, we determined an effective radius, $R_{\rm eff}$, which represents the radius of a black-body emitting sphere producing the observed luminosity. However, the outer radius of the accreting plasma could be much larger than the $R_{\rm eff}$ radius, as the outer regions should be considerably cooler than the inner regions. In addition, an extended cooler layer of material in front of the source of the continuum is indicated by a strong shell absorption spectrum which developed in 1982-84 together with complex very broad line profiles, seen also in the recent, 1992-95, active phase. From this point of view, it is not clear how and where the infalling mass impacts or penetrates the outer zone of the accreting plasma dissipating its kinetic energy to radiation.

To determine the flux of the far-UV source, we first investigated the question of whether its radiation is subject to Rayleigh scattering. An example of a best fit model, using the Rayleigh scattering function, of the observed continuum on 30/3/95 is shown in Fig. 1c (broken line). It needs enormously high $n_{\rm H} \sim 10^{24}\,{\rm cm^{-2}}$, which is inconsistent with that required to explain the observed X-ray spectrum in 1992, $n_{\rm H}$(X-ray) = a few $\times\ 10^{20}\,{\rm cm^{-2}}$ (Leahy & Volk 1995). The fit is also poor – in the region 1 200 to 1 400 Å the observed continuum is far from that predicted by Rayleigh scattering. Thus, we conclude that Rayleigh scattering does not significantly affect the far-UV continuum of CH Cyg. As a result we estimated its flux by integration the far-UV continuum after subtracting the contribution of the near-UV/optical emission, and determined the corresponding luminosity, $L_{\rm UV}$, for d=270 pc. The parameters for individual observing dates are introduced in Table 2.

We also note that both components vary simultaneously: an increase/decrease in the first source's emission is followed by a proportional change in the second source's emission (Table 2, Fig. 4, Sect. 4.4).

4. On the nature of the hot continuum

In this section we discuss the nature of the hot continuum as a result of an accretion process in the symbiotic pair of CH Cyg. The main arguments supporting the accretion process as being responsible for the active phases are as follows:

(i) Multifrequency observations of CH Cyg during its recent (1992-94) active phase suggested that the luminosity of the hot continuum during stages of activity comes from a sporadic accretion of material transferred from the giant star onto a low mass main-sequence dwarf in the symbiotic pair of the triple-star system (Skopal et al. 1996b).

(ii) Mass transfer onto the active star was directly indicated by variable redward-shifted absorption components (∼+30 to 100 km s^{-1} with respect to the active star) in hydrogen and metal lines observed during the 1981-84 maximum (see Fig. 5, 6a of Skopal et al. 1989; Fig. 1 of Yoo & Yamashita 1984; Hack et al. 1988; and also Yoo 1984).

(iii) According to fundamental parameters of the CH Cyg system estimated by Skopal (1997), the giant star in the symbiotic pair can fill its critical surface in a phase interval of ∼0.15 around periastron passage.

(iv) It is probable that the cool component in the symbiotic pair is a pulsating AGB star (Mikolajewski et al. 1996; Iijima 1997; Skopal, in preparation), thus a larger variation in the continuum during, and sporadically out of active phases is observed (see bottom panel of Fig 1 - the light curve, and the spectrum on 13/12/95 in Skopal et al. 1998).

However, the accretion process has not been treated theoretically for symbiotic binaries ($P_{\rm orb} \approx$ years, $q = M_{\rm donator}/M_{\rm accretor} > 1$, separation of the components $a \approx$

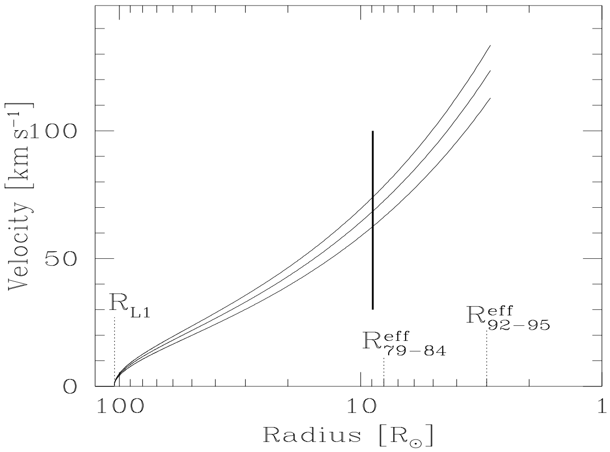

Fig. 3. Velocity of the material falling from the L_1 point in the gravitational field of the $0.12 \pm 0.02\,\mathrm{M}_\odot$ central mass (r=0). The thick bar represents an interval of the observed RVs with respect to the active star during the 1981-84 maximum (see text)

1-3 AU), but only for CVs ($P_{\rm orb} \approx$ hours, $q < 1$, $a \approx$ 1-3 $\mathrm{R}_\odot$). Drastic differences in the fundamental parameters between these two groups of interacting binaries will probably result in a significant difference of geometry of the transferred material in the Roche lobe of the accretor. Therefore a direct comparison of the mass transfer in CVs with CH Cyg can meet with some difficulties. For example, the observed shape of the light curve, sporadic infall and outflow of the material during active phases, as well as changes in the profile of the minima caused by eclipses in the symbiotic pair (bottom panel of Fig. 1), reflect a complex geometry of the transferred matter around the hot star. On the other hand, the double-peaked emission profiles of hydrogen lines, which developed during the 1978-84 maximum, can be matched with those of an accretion disk (e.g. Robinson et al. 1994).

As a result we shall test the accretion process in CH Cyg by trying to find if the main regions in which the transferred matter gives up its binding energy to radiation in CVs have also a plausible counterpart in the mass transfer process in CH Cyg.

4.1. The near-UV/optical component

Following an accretion scenario, we suggest that the near-UV/optical "black-body" component of the hot star spectrum has its origin in the accreting plasma around the central star (by analogy with the accretion disk in CVs). The source of its energy is liberated gravitational energy of the accreted material, and its luminosity can be estimated as

$$L_{\rm acc} \sim \frac{1}{2}\,G\,\frac{M_{\rm acc}\,\dot{M}_{\rm acc}}{R_{\rm acc}}, \tag{1}$$

where $\dot{M}_{\rm acc}$ is the mass accretion rate and $M_{\rm acc}$, $R_{\rm acc}$ are the mass and the radius of the accreting object, respectively. From Eq. 1, we determined $\dot{M}_{\rm acc}$ for $L_{\rm acc} \equiv L_{\rm BB}$ (according to the above interpretation), $M_{\rm acc} = 0.12\,\mathrm{M}_\odot$ (Skopal 1997) and $R_{\rm acc} \sim 0.12\,\mathrm{R}_\odot$ according to $R/R_\odot \propto M/M_\odot$ being in force for a main-sequence star (e.g. Habets & Heintze 1981).

4.2. The far-UV component

This part of the hot continuum could represent emission caused by the impact of the mass transfer stream with the accreting material around the central star (by analogy with the bright spot in CVs). The maximum total luminosity of such a region is then

$$L_{\rm imp} \sim \frac{1}{2}\,\dot{M}_{\rm imp}\,V_{\rm imp}^2, \tag{2}$$

where $V_{\rm imp}$ is the velocity of the infalling material at the outer radius relative to the accreting plasma. To evaluate this luminosity we adopted $\dot{M}_{\rm imp} = \dot{M}_{\rm acc}$ as results from analysis of the near-UV/optical emission component (Sect. 4.1, Table 2) and $V_{\rm imp} = 65\,\mathrm{km\,s^{-1}}$, which represents an average value of RV with respect to the hot star observed during the 1981-84 active phase as mentioned above. To estimate $V_{\rm imp}$ for the recent, 1992-95, active phase, we calculated the velocity $v(r)$ of the matter infalling from the L_1 point ($R_{L1} = 105\,\mathrm{R}_\odot$ according to parameters suggested by Skopal 1997) in the gravitational field of the $0.12 \pm 0.02\,\mathrm{M}_\odot$ central mass (free fall in the stationary case). The result is plotted in Fig. 3, showing a good agreement of our computed $v(R_{\rm eff})$ with that observed during the 1981-84 maximum. For the recent active phase we used $V_{\rm imp}$=125 km s^{-1} corresponding to the observed effective radius of $\sim$3 $\mathrm{R}_\odot$ at that time (Table 2, Fig. 3).

Although we used a very simplified description of the accretion process in CH Cyg, the computed, $L_{\rm imp}$, and the observed, $L_{\rm UV}$, luminosities agree within their uncertainties, i.e.

$$L_{\rm imp} \sim L_{\rm UV}, \tag{3}$$

in the active phases of CH Cyg (Table 2, columns 7 and 8). Thus, the equivalence of both luminosities in Eq. (3), confirms the basic scenario on the nature of active phases to be right.

4.3. Possible source of the soft X-ray radiation

Pursuing the analogy with mass transfer in CVs, there can be recognized a region, located very close to the stellar surface, in which gas moving at Keplerian velocities is decelerated down to the surface velocity of the star (the so called boundary layer in CVs). For the above-mentioned parameters of the accretor in CH Cyg, such a region should emit in soft X-rays. If it is optically thin (this could particularly be the case in the 1992-95 active phase) then the shock temperature for gas accreting onto the stellar surface is $\sim 1 - 3 \times 10^6$ K (Eq. 2.57b of Warner 1995), which matches that observed in 1992 by the ROSAT satellite. Analysing the X-ray spectrum from 1992, Leahy & Volk (1995) found that there is a hot plasma in the system with a temperature of 0.33 keV ($\sim 4\ 10^6$K), with an emission measure corresponding to a small region, of order of, or less than the size of a white dwarf (they used a distance to CH Cyg of d = 170 pc). We note here that for parameters of a white dwarf this region should actually radiate in the hard X-ray region, with energies $\sim$20 keV.

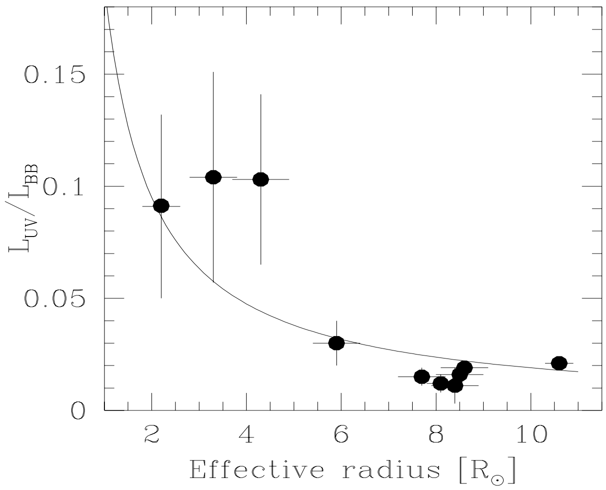

Fig. 4. Comparison of the observed and calculated $L_{\rm UV}/L_{\rm BB}$ luminosities.

4.4. Accretion as a transient event in CH Cyg

The symbiotic phenomenon in CH Cyg arises only during active phases. In quiescence it practically disappears (cf. right panels of Fig. 1). Thus, the source of the hot continuum must be transient and associated with the activity in the system. This gives us an opportunity to test the mass transfer in CH Cyg by studying *variations* in the $L_{\rm UV}/L_{\rm BB}$ quantities during different active periods. For example, we can immediately see larger differences between the maximum (1979-84) and the recent (1992-95) phases of activity:

$$(L_{\rm UV}/L_{\rm BB})_{1992-95} > (L_{\rm UV}/L_{\rm BB})_{1979-84}. \quad (4)$$

Taking into account that Eq. (2) can be written as

$$L_{\rm imp} \sim G\,\frac{M_{\rm acc}\,\dot{M}_{\rm imp}}{R_{\rm out}}, \quad (5)$$

we get

$$L_{\rm UV}/L_{\rm BB} \sim 2\,R_{\rm acc}R_{\rm eff}^{-1}, \quad (6)$$

as results from Eq. (1) and (3), and adopting $\dot{M}_{\rm imp} = \dot{M}_{\rm acc}$, $R_{\rm out} = R_{\rm eff}$. This relation then explains Eq. (4) as due to different sizes of the accretion region during these two active phases. Fitting the observed luminosity ratios $L_{\rm UV}/L_{\rm BB}$ by Eq. (6) gives

$$R_{\rm acc} = 0.09 \pm 0.02\,{\rm R}_\odot,$$

which is close to our assumed value $R_{\rm acc} = 0.12 \pm 0.02\,{\rm R}_\odot$. A larger deviation of the 1992-95 values from the fit (Fig. 4) is in part caused by a poor determination of the component luminosities during recent activity (fainter by a factor of about 10 than those at the maximum), and in part by using Eq. (5), which can be seriously in error if much of the kinetic energy is not dissipated at $R_{\rm eff}$, which seems quite likely (see also Sect. 3.3 and the beginning of Sect. 4). We note here that our fitting of the near-UV/optical emission with a Planckian function probably overestimates the hot continuum beyond the V band (and thus also $R_{\rm eff}$), where the red giant dominates the spectrum during 1992-95 (cf. Fig. 4 of Skopal el al. 1996b). In spite of the complexity of the real situation, the evolution in the luminosity ratio $L_{\rm UV}/L_{\rm BB}$ matches the theoretical trend predicted by a simplified form of Eq. (6). As a result, we believe that the basic physical principles of the mass transfer in CH Cyg are comparable with those elaborated for CVs.

5. Conclusions

The main results of this paper can be summarized as follows:

1. The two component hot continuum observed during active phases of CH Cyg can result from the impact (far-UV component) and the accretion (near-UV/optical component) of the infalling material from the red giant onto its companion in the symbiotic pair of the triple-star system. The observed luminosities of both sources are powered by a mass transfer rate of $1-2\times10^{-5}{\rm M}_\odot\,{\rm yr}^{-1}$ during the 1979-84 maximum, and $\sim 2\times10^{-6}{\rm M}_\odot\,{\rm yr}^{-1}$ in the 1992-95 active phase.
2. Variation in the observed $L_{\rm UV}/L_{\rm BB}$ luminosities during different active phases can be matched approximately by a simplified formula derived from the basic physical principles of mass transfer in CVs.
3. The spectra taken during quiescence demonstrate that the contribution of the hot component itself to the UV/optical continuum is negligible. Therefore the denotation ‘hot’ is used here only according to the accepted terminology of symbiotic stars.
4. The mass transfer, as described in this paper, can take effect only for fundamental parameters of the hot component following the triple-star model of CH Cyg.

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