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CH CYGNI – A TENTH MAGNITUDE STAR!

CH Cygni is a peculiar binary system in which a magnetic white dwarf accretes matter from the M giant's wind moving on a long period highly eccentric orbit (Mikołajewski et al. 1996 and references therein). It is known as the brightest symbiotic star. During 1981–1984 its V brightness was about $5^{\rm m}$, and the star was seen even by the naked eye. Recently, its brightness dropped significantly and reached almost $10^{\rm m}$ in visual, the dimmest value ever observed. Several periods of high activity separated by quiet ones have been observed since 1963. During the outbursts a hot F–A continuum and numerous emission lines dominated in the UV and optical. The late M giant in the system dominates the spectrum between active phases and shows different kinds of variability.

Photoelectric UBVRI and UBV observations were continued using the 60cm and 48cm telescopes at Toruń and Tartu observatories, respectively (see Leedjärv, Mikołajewski 1995, Mikołajewski et al. 1992). The UBVRI light curves covering the last decade are shown in Figure 1. After the 1985 eclipse (Mikołajewski et al. 1987), the star reached a quiet inactive state by the end of 1987, during which a pure M giant's $100^{\rm d}$ pulsations with an amplitude of $0\overset{\rm m}{.}7$ started to dominate the BV bands. During 1989–1991 the star showed some transitory (1–3 months) episodes of activity clearly visible in U light. Starting from the early 1992 a relatively strong and long activity period has been developing with two gaps in the ends of 1992 and 1994. An additional F–type supergiant continuum from the hot component (Kuczawska et al. 1992) has modified the light curves in all wavelengths. Kuczawska et al. have also demonstrated evidence of a flickering down to the RI bands in July 1992.

In the mid–1995 the hot continuum dropped rapidly. During the last three-four $100^{\rm d}$ pulsations of the M giant, which are of a similar shape and amplitude as were previously observed between 1987 and 1990 (Mikołajewski et al. 1992), those pulsations became the main features in the BV light curves.

Another pronounced variability of the M giant is probably connected with occupation of the star's surface by large cool spot (or spots) and the rotation of the star with a period of about 760 days (Mikołajewski et al. 1992). We have found all observed broad minima of this periodicity using all available photoelectric data (Mikołajewski et al. 1990, 1992 and references therein). In BV filters minima were observed during inactive phases, only. Only two out of 12 minima (Table 1) are not compatible with this periodicity. At least the last one (JD 2449785) is probably caused by drop of earlier observed F–type continuum of the active component. From the other minima in Table 1 we have obtained the following ephemeris:

$$\begin{array}{rl} \text{JD Min}(760) = & 2446549 + 746.8\times \text{E} \\ & \pm 30 \quad\;\; \pm 3.5 \end{array} \qquad (1)$$

The O−C values for this ephemeris are also listed in Table 1. The 747^d period is practically the same as the value of 749 days found by Hinkle et al. (1993) which they interpreted as an orbital period of an inner symbiotic pair on eccentric orbit in their triple–star model of CH Cygni.

Table 1. Observed minima of the 747^d periodicity

E	Min JD2400000+	Filters	O − C days	E	Min JD2400000+	Filters	O − C days
−9	39820	BV	−8	0	46535	VRI	−14
−8	40535	BV	−40	1	47295	BVRI	−1
(?)	(41135)	BV	(−186)	2	48030	BVRI	−13
−7	41355:	BV	+34	3	48735	RI	−54
−6	42080	BV	+12	4	49595	RI	+59
−5	42840	BVI	+25	(?)	(49785)	RI	(+249)

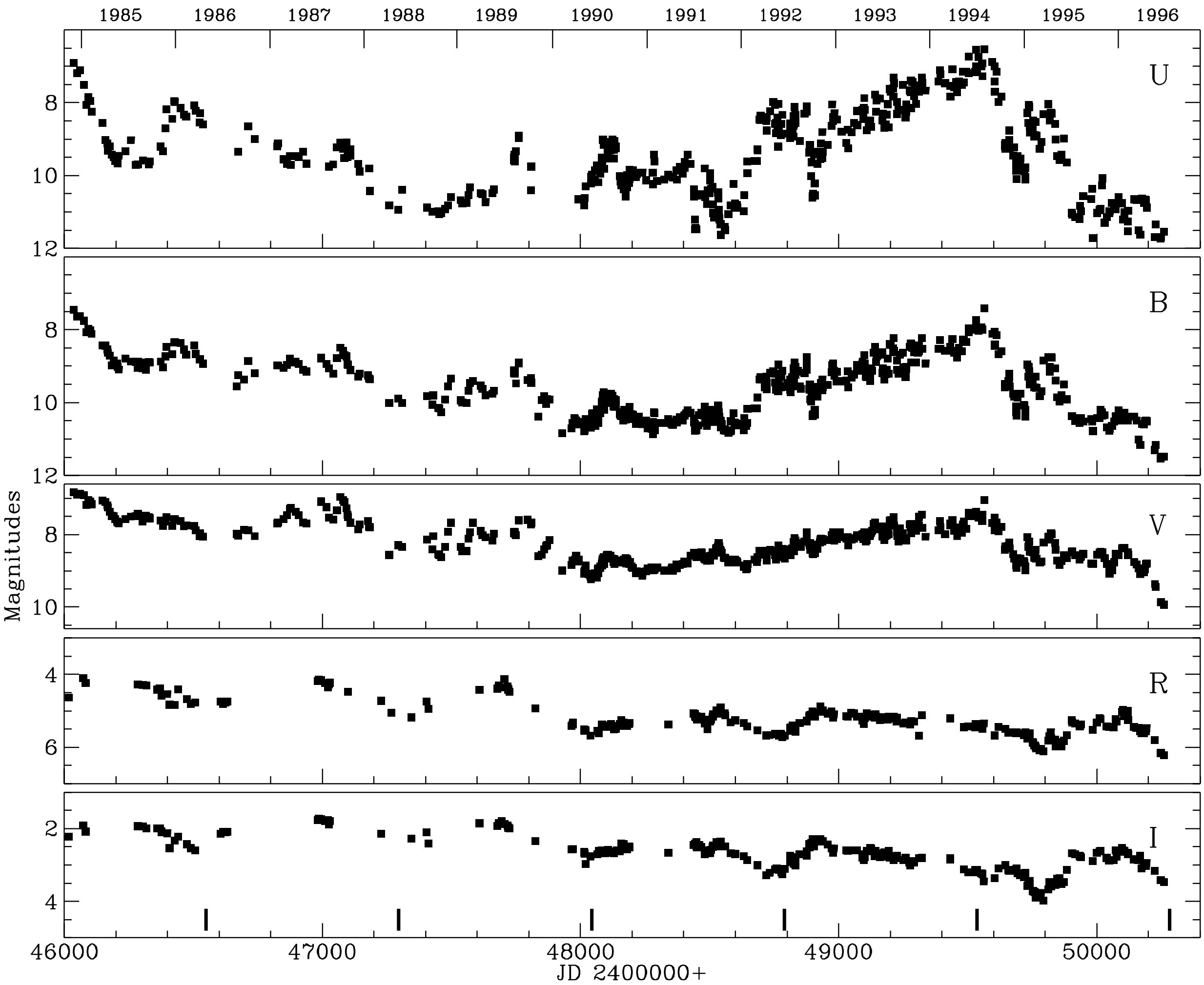

Figure 1. The UBVRI light curves of CH Cygni including the last minimum in June 1996. In the lowest box the calculated minima from ephemeris (1) are marked.

Apart from an increasing period of pulsation, Mikołajewski et al. (1990, 1992) have found another evidence of a luminosity pulse produced by a helium–flash on the AGB for the M giant in CH Cyg — a systematic decrease in the optical light on the time scale of hundred years. The rate was estimated to be about $0\overset{\mathrm{m}}{.}60$/100yr in the visual from historical data, and seems to achieve at least 1^{m}/100yr during the last decade.

In conclusion, the minimum of brightness observed in June 1996 is a result of (1) inactivity of the hot component, (2) secular decline of the M giant's brightness, and (3) coincidence of the minima of 747^{d} periodicity (rotation) and 100^{d} pulsation. In Figure 2 we show V magnitudes, together with U−B and B−V indices during last two years. We have marked two last minima with epoch $E = 4$ and $E = 5$ calculated from Eq. 1 and last four (from $e = 87$ to $e = 90$) minima predicted by the quadratic ephemeris:

$$\mathrm{JD\ Min}(100) = 2440935.3 + 102.41\mathrm{e} + 0.0140\mathrm{e}^2 \qquad (2)$$

for the M giant's pulsations (Mikołajewski et al. 1992). The last three pulsation minima are evidently visible in the V light. Observed minima confirm the systematic increase of the pulsation period, which reaches now almost 105^{d}. Taking into account the secular decrease of brightness in the optical we can predict from Eqs. (1) and (2) the next coincidence of minima in July 1998, when an even deeper minimum should be observed (if the hot component remains inactive).

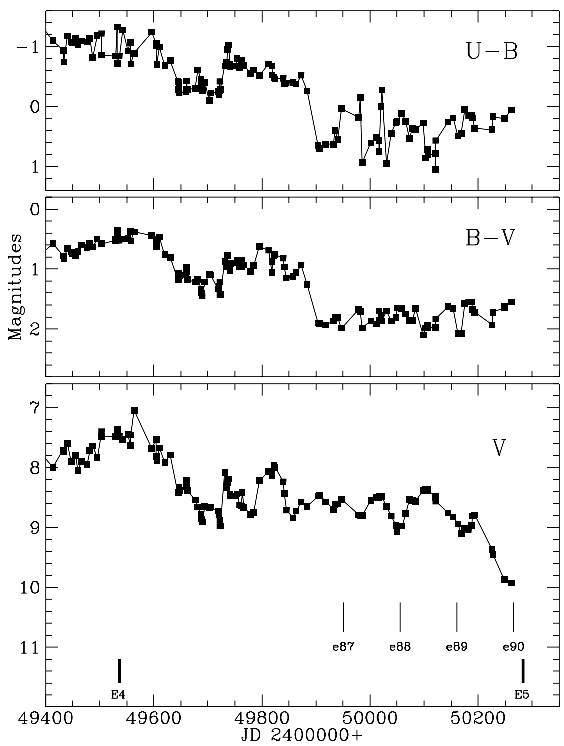

Figure 2. The V light curve and U−B and B−V indices of CH Cyg during last 2.5 years. Last epochs of minima from ephemerides (1) and (2) are marked as E and e, respectively.

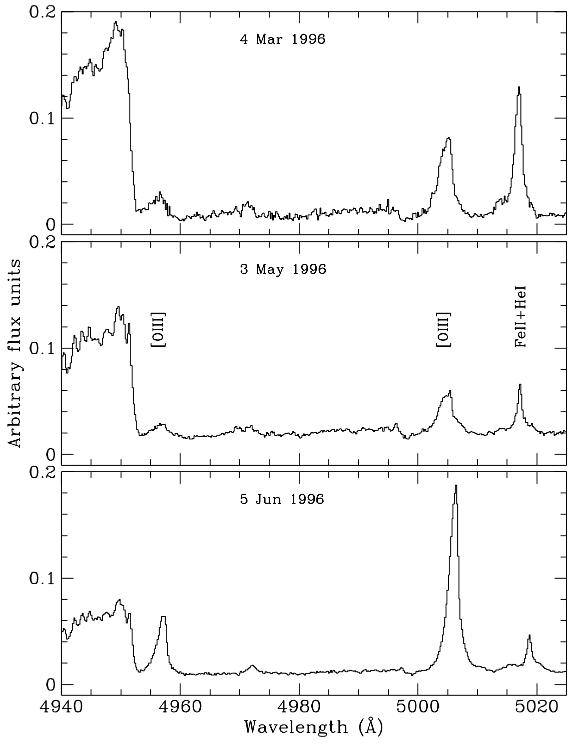

Figure 3. The [OIII] 4959 Å and 5007 Å region in the spectrum of CH Cygni.

Spectral observations during the last three years were carried out with a CCD–camera mounted in the coudé-spectrograph of the 2m telescope at NAO Rozhen. In Figure 3 the behaviour of the nebular lines of [OIII] 4959 Å and 5007 Å as well as the changes in the hot veiling continuum, during the drop of star's brightness in May–June 1996 are shown. It is obvious, that the flux in the continuum decreases during all the time and that the [OIII] nebular lines reached a maximum intensity coinciding with the light minimum in June 1996. At the same time, a nebula extended to about 30″ was observed in the optical by Corradi & Schwarz (1996). Variations in the intensity, profile shapes and strong dependence on the slit orientation for the nebular lines of [OIII] were observed in 1994 (Tomov et al. 1996). So, it is evident that there is a significant amount of relatively low density matter around the CH Cyg system, which may be responsible for the origin of the nebular lines.

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