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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.

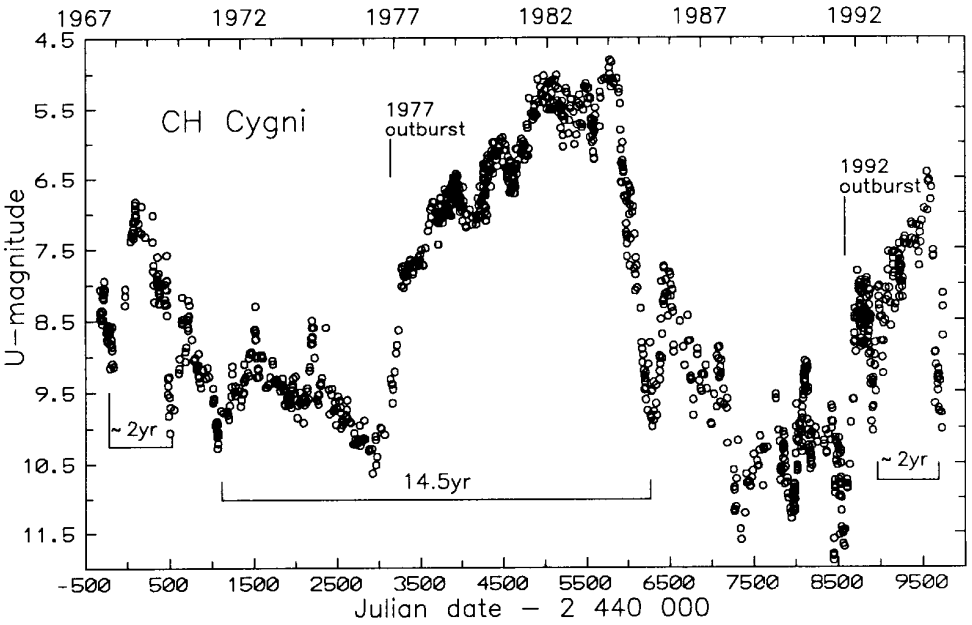

Figure 1. Historical U-light curve for CH Cyg. Eclipses in both the long- and short-period orbit are marked.

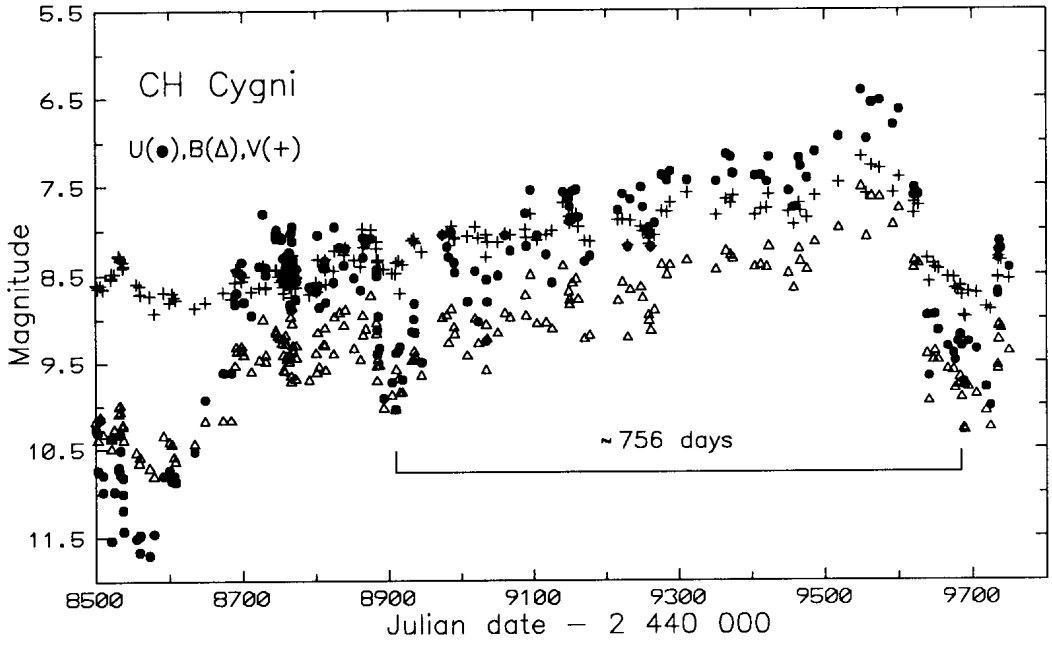

Figure 2. The UBV light curves of CH Cyg covering the current outburst. The minima correspond to the eclipses of the active component by the cool component in the 756-day period symbiotic pair.

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 2 441 130 and JD 2 446 275±75. Their positions agree perfectly with times of the spectroscopic conjunction in the *long-period* orbit – $T_{\rm conj}$ = JD 2 446 346±340, $P_{\rm orb}$=5298 ±98 days, e = 0.067, ω = 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.

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