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# A STUDY OF THE MICROVARIABLE STAR V1674 CYGNI

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V1674 Cyg (BD +34°3816) was discovered as a microvariable star by Walker and Quintanilla (1978) (WQ) during their study of the X-ray binary Cyg X-1 (V1357 Cyg), which is located 53″ South. The star had shown both long time non-periodic variations (in the range of $10^{\rm m}_{.}555$–$10^{\rm m}_{.}570$ B), and periodic variations with the components $P_1 = 1^{\rm d}_{.}3608$ ($A_1 = 0^{\rm m}_{.}0037$) and $P_2 = 0^{\rm d}_{.}8055$ ($A_2 = 0^{\rm m}_{.}0032$). Karitskaya and Goranskij (1996) confirm the variability in the range of $10^{\rm m}_{.}012$–$10^{\rm m}_{.}035$ V with one of two possible periods, $P_1 = 4^{\rm d}_{.}223$ or $P_2 = 1^{\rm d}_{.}3009$. Lyuty (1972), Rössiger and Luthardt (1989) considered this star to be constant, and selected it as a comparison star for their photometry of Cyg X-1. Some observers use this star for comparison purposes due to its colour close to that of Cyg X-1, or due to lack of other available stars in small CCD fields. So the knowledge of photometric behaviour of V1674 Cyg will be useful to treat the earlier observations of Cyg X-1.

We monitored V1674 Cyg in the course of our photometric study of Cyg X-1 during four seasons in 1995–1998 (JD 2450009–51040). The observations were carried out with the 100 cm reflector of Tien-Shan observatory (Kazakhstan) using the four-channel WBVR photometer with dichroic beam-splitters (Kornilov, 1998), and with the 48 cm reflector of Mt. Maidanak observatory (Uzbekistan) using a single-channel UBVR photometer. The comparison and check stars were BD +34°3812 (A2) and BD +35°3895 (A0). A total of 581 BVR observations were taken in 89 nights. Additionally we have U and instrumental ultraviolet (w) band measurements. A small systematic difference between the two data sets was found in the mean magnitudes, and eliminated. The observations have the accuracy equal to 3–5 mmag in each of B, V and R bands (three nights with lower accuracy were averaged and also used in the calculations). The frequency analysis in B, V and R bands shows, in general, similar results, because the colour changes are almost within detection limits. So here we show only 'smoothed B band measurements' calculated with the formula $B_s = (B + V + R + \langle B - V\rangle + \langle B - R\rangle)/3$, to decrease the noise in the set.

Figure 1a shows the amplitude spectrum of V1674 Cyg which covers the range of periods between $0^{\rm d}_{.}1$ and $1000^{\rm d}$. The spectrum resembles that calculated by WQ after eliminating the non-periodic variations in WQ data. Both spectra have double peaks,

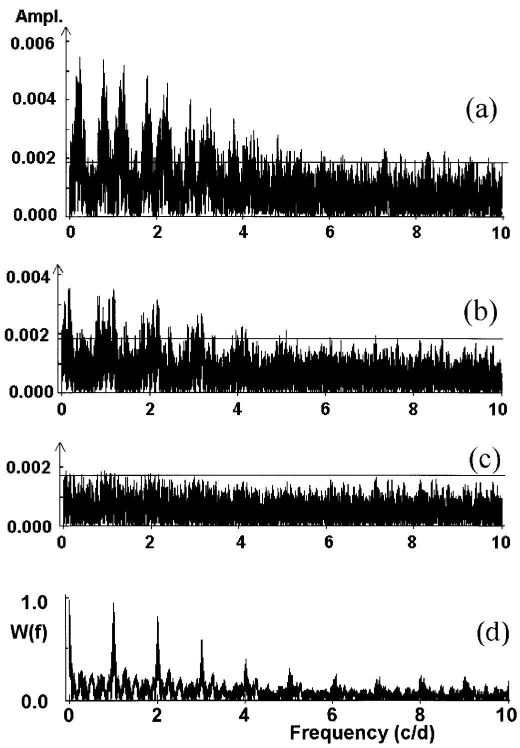


**Figure 1.** The amplitude spectra of the initial set (a); of the residual set after prewhitening for $P_1$ (b); of the residual set after prewhitening for $P_1$ and $P_4$ (c); spectral window (d).

their height being 30 per cent larger in our spectrum. Undoubtedly, the star is a periodic variable. We made a digital experiment described by Terebizh (1992) to estimate the statistical significance of the peaks in the spectrum. For each time of an observational data point, we chose an accidential magnitude from the list of observations. So we mixed the list of star magnitudes for the given list of times of observations. The mixed chaotic set preserves the distributions of magnitudes and times of the initial set. The horizontal line marks the highest amplitude level of 1.8 mmag for the chaotic set's spectrum achieved in $10^5$ realizations of light curves with the trial periods, so the probability of accidental appearance of peak with this amplitude is less than $10^{-5}$. The largest peaks of the real set have the amplitude of 5.4 mmag. So they are reliable with a probability more than 99.999 per cent.

The periods of the three predominating peaks are the following: $P_1 = 4\overset{d}{.}272\pm0\overset{d}{.}002$, $P_2 = 1\overset{d}{.}3007\pm0\overset{d}{.}0001$, and $P_3 = 0\overset{d}{.}80513\pm0\overset{d}{.}00005$. The last one was noted by WQ. These three periods are aliases interconnected with a window feature of 1 c/day (Fig. 1d). The periodicities belong to V1674 Cyg – the power spectrum of the check star does not show any details.

Figure 1b shows the amplitude spectrum of the residual set after prewhitening the initial set for $P_1 = 4\overset{d}{.}272$. The probability level of $10^{-5}$ has also been calculated. The peaks of the residual spectrum are highly reliable: $P_4 = 5\overset{d}{.}267\pm0\overset{d}{.}002$; $P_5 = 6\overset{d}{.}676\pm0\overset{d}{.}002$; $P_6 = 1\overset{d}{.}2300\pm0\overset{d}{.}0001$; $P_7 = 0\overset{d}{.}83839\pm0\overset{d}{.}00005$, the highest peak being 3.6 mmag.

Repetition of the prewhitening procedure for the larger amplitude wave with $P_4$ leads to a residual set with a flat amplitude spectrum (Fig. 1c). This test shows that the periods $P_4$ – $P_7$ are interdependent, and reflect only one wave in the light curve. So, our analysis

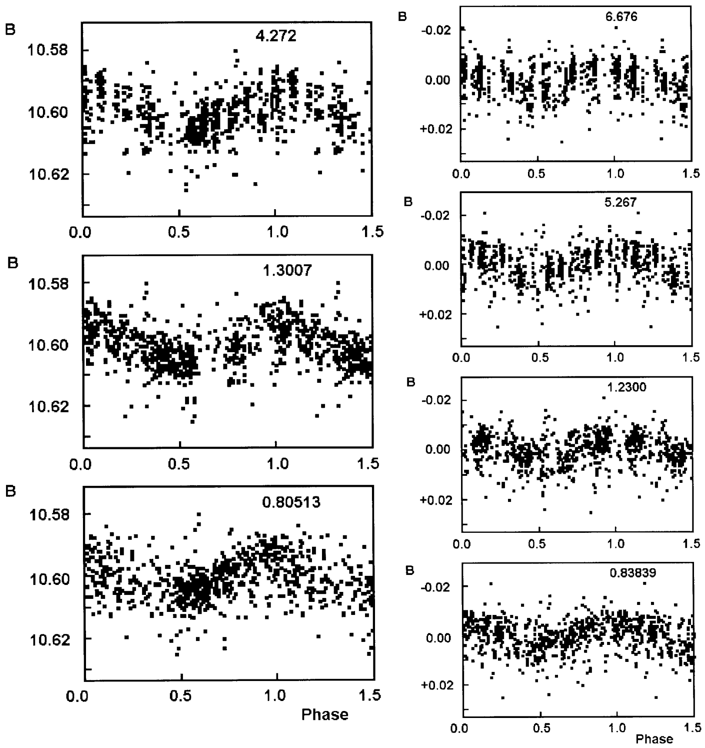


**Figure 2.** Left: the light curves of the three predominant periods $P_1$–$P_3$ (the secondary wave with $P_4$ is eliminated). Right: the light curves of secondary periods (the primary wave with $P_1$ eliminated).

detects only two independent waves in V1674 Cyg, with the full amplitudes of 10.8 and 7.2 mmag. Periods $P_1 = 4\overset{d}{.}272$ and $P_4 = 5\overset{d}{.}267$ may be preferable only because of their higher peak amplitudes, but their aliases and double values are also possible.

The flat spectrum of the residual set and the absence of low-frequency noise in our data suggest that the trends in our observations are small relative to those found by WQ in B band. We find marginal evidence of a trend with the amplitude of $0\overset{m}{.}012$ in the second season of our observations in JD 2450360–50399. We have also analysed the influence of possible season-to-season trends on our results and found it to be insignificant. Analysing HIPPARCOS photometry of $\eta$ Cyg (NSV 12586, Sp. K0III), a comparison star used by WQ, we reject the assumption that this star may be the source of any trends or periodicities.

The principal results in the individual photometric bands are given in Table 1 (the number of observations, the total range of variability, the mean magnitude, the dispersion, and the full amplitudes of harmonic component are given).

V1674 Cyg is a double star. Our CCD astrometry and photometry for the faint companion gives: $\rho = 5\overset{''}{.}9$; $\theta = 170°$; $B = 14\overset{m}{.}0 \pm 0.2$; $V = 13\overset{m}{.}0 \pm 0.1$; $R = 12\overset{m}{.}0 \pm 0.1$ (JD 2451199.15). For the bright component: $B = 10\overset{m}{.}65$; $V = 10\overset{m}{.}07$; $R = 9\overset{m}{.}57$. (The summary brightnesses are presented in the Table). The colours agree with the primary's F8III spectrum (Bregman et al., 1973).

In spite of the periodic nature of the light curve, we cannot yet find a unique type for V1674 Cyg. One can suggest that the bright component is a pulsating variable [the ratio $P_1/P_4 = 0.81$ is close to that between the 2nd and the 1st overtones of mixed mode pulsators like CO Aur or GSC 4018.1807 (Antipin, 1997)]. The star may be also a spotted,

Table 1

| Band | N (obs.) | Total range (mag) | Mean (mag) | Dispersion (mmag) | Ampl. $P_1$ (mmag) | Ampl. $P_4$ (mmag) |
|---|---|---|---|---|---|---|
| U | 75 | 10.71 – 10.79 | 10.741 | 17.2 | — | — |
| B | 596 | 10.58 – 10.64 | 10.601 | 8.9 | 12.2 | 7.0 |
| V | 598 | 9.98 – 10.03 | 10.001 | 8.4 | 12.8 | 8.2 |
| R | 589 | 9.43 – 9.49 | 9.456 | 8.9 | 11.2 | 7.0 |

or an ellipsoidal variable. Spectroscopic study may help to choose a real type for V1674 Cyg. Besides, the variability may also be due to the faint companion. Then its amplitude may be about $0\overset{m}{.}19$ V, with EW type.

Taking into account recent results of the OGLE project (see, e.g., Udalski et al., 1994), we can conclude that the low-amplitude periodic variable stars with the periods of few days are not unique, but widely spread. They are found in so-called 'miscellaneous' group. So the classification of OGLE variables will face us with the same problem as that of V1674 Cyg. GCVS has many types for poorly studied irregular variables (i.e. I, IA, IB, L, LB, S:), but unfortunately it does not have any type for poorly studied regular, or periodic, or multiperiodic ones. Without the special type definition, V1674 Cyg should stay in the GCVS as an unique variable with the symbol (*) in the column "Type".

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