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ORBITAL PERIOD OF THE ECLIPSING VARIABLE V1147 CYGNI

V1147 Cyg = HBV 426 was discovered by Wachmann (1966) who estimated the period as $238^{\rm d}.02/n$. In the GCVS IV (Kholopov et al., 1985) another possible period $2^{\rm d}.24460$: is listed. We have measured the star on 144 photographic plates of the Odessa Sky Patrol by using the comparison stars published by Wachmann (1966).

For the period search we have used 6 moments of most prominent weakenings: HJD 2434119.525, 34952.358 (Wachmann, 1966), 36462.3483 ($12^{\rm m}.25$), 39741.3395 ($12^{\rm m}.47$), 41150.3982 ($12^{\rm m}.36$), 41544.3847 ($12^{\rm m}.27$) (this paper).

We have used the fast algorithm and computer code described by Andronov (1991, 1994). The test function used is the r.m.s. deviation of $\phi + 0.5$ from 0.5, where ϕ is the phase of decreased brightness. The phase curves were plotted for 32 most prominent minima at the periodogram. This visual control allowed us to choose the value of the possible period corresponding to the 4-th (by periodogram value) minimum. The linear ephemeris for the moments of minima is

$$\begin{array}{rcl} MinHJD = 2439741.340 & + & 1.097382 \times E \\ \pm\ 2 & & \pm\ \ \ 6 \end{array} \qquad (1)$$

Besides visual analysis, we have computed the "slow" periodograms corresponding to the methods of Lafler and Kinman (1965) and Deeming (1970) by using the computer code written by I.L. Andronov. The optimal value of the period was found to be $P=1^{\rm d}.097383$ for both methods. The accuracy estimate is better than 10^{-6} days, the value of the period shift for which the depth of the minimum at the periodogram decreases by ≈ 30 per cent. Naturally, smaller error estimate was obtained for the periodogram using all 144 observations instead of 6 moments of used in Eq. (1).

The light curve is shown in Figure 1. Outside eclipse the r.m.s. scatter, equal to $0^{\rm m}.066$, is typical of photographic measurements. Mean value is $11^{\rm m}.92$ is in excellent agreement with the value $11^{\rm m}.9$ listed in GCVS. The amplitudes of the first and second harmonics do not exceed 1.5σ and thus are not statistically significant. The duration of the eclipse is 0.076P.

The scatter of photographic data may mask the secondary minimum at phase 0.5, the depth of which does not exceed $0^{\rm m}.1$. As the depth of the primary minimum is $\approx 0^{\rm m}.46$, this may argue for a cooler secondary. Another possibility is that the real period is twice larger than the value mentioned above. In this case the minima may be of comparable depths arguing for similar surface brightnesses of both stars. From the present data we cannot determine magnitudes at both minima with an accuracy needed to find difference between them. Comparing Wachmann's (1966) estimate $238^{\rm d}.02/n$ with the period value computed in this work one may easily find that n=216.9. There is no contradiction, as Wachmann (1966) had used dim magnitudes instead of true minima, one of which was marked as unsure. Two sure minima were used to determine the period and are in excellent agreement with the given elements.

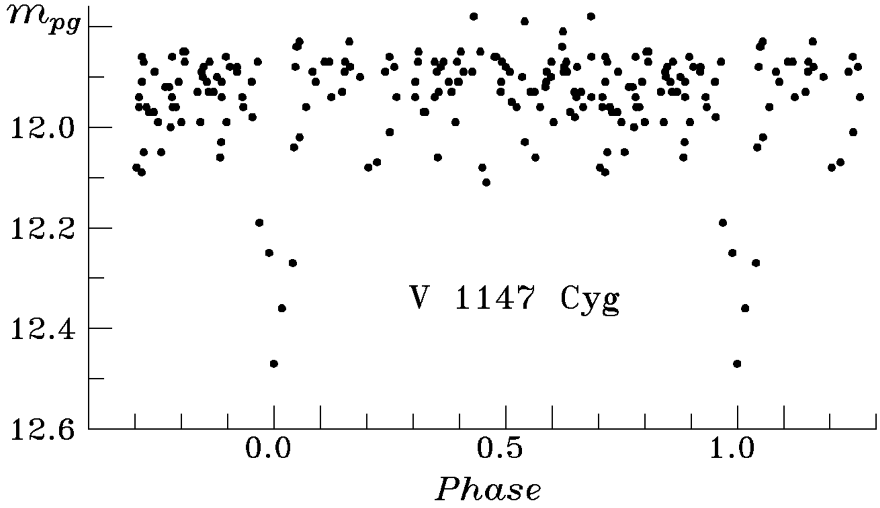

Figure 1. Photographic light curve of V1147 Cyg = HBV 426 computed according to the ephemeris $MinHJD = 2439741.340 + 1.097383 \times E$

Assuming the stars are of nearly spherical shape (from the EA classification), one may obtain the geometric inequality (e.g. Tsessevich, 1980) $(R_1 + R_2)/a \geq \sin(2\pi\phi) = 0.24$. Additionally assuming that both stars obey the main sequence mass-radius relation $R/R_\odot = R_*(M/M_\odot)$ with $R_* = 1.26$ (Allen, 1973), one may easily obtain another inequality

$$M_1 + M_2 \geq \frac{\sin^{3/2}\phi\,(GM_\odot)^{1/2}P}{2\pi(R_* R_\odot)^3/2} \qquad (2)$$

where ϕ is the phase of the first contact, i.e. half-duration of the minimum. Equality holds for the inclination angle i=90°. For our data, one may estimate $(M_1 + M_2) \geq 0.384 M_\odot$ for P=$1\overset{d}{.}097382$ and $(M_1 + M_2) \geq 0.77 M_\odot$ for the hypothesis of double period P=$2\overset{d}{.}194764$.

To distinguish between these two periods, CCD or photoelectric photometry in at least two filters is needed.

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