

COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS

Number 1525

Konkoly Observatory
Budapest
1978 December 29

THE EVIDENCE FOR THE BINARY NATURE OF THE SYMBIOTIC OBJECT
V 1329 CYGNI (= HBV 475)

Stienon et al. (1974) suggested that the object V 1329 Cyg is an eclipsing binary with the ephemeris:

$$(1) \text{ JD}_{\text{hel}}(\text{pri.min.}) = 2432480 + 959^{\text{d}} \times E, \\ \pm 10 \quad \pm 2$$

where the primary minimum lasts about 0.1 of the orbital period. These parameters were derived from the photographic magnitudes of the object obtained from the Harvard plate collection in the years 1891 - 1966. The same period is seen also in the photoelectric data obtained by Arhipova (1977) in the years 1973 - 1976, after the major outburst in the year 1964.

Grygar et al. (1977) searched for periodicities in the Harvard data and found several values around 578^{d} , 729^{d} and 953^{d} , which are, however, mathematically interrelated.

We have reanalyzed the Harvard data prior to the year 1963 by formally using the code for the determination of the orbital elements of spectroscopic binaries written by Dr. J. Horn (1978). In this way we have found the following parameters of the pre-outburst light curve:

$$(2) \text{ JD}_{\text{hel}}(\text{pri.min.}) = 2424869.9 + 950.07^{\text{d}} \times E, \\ \pm 27.4 \quad \pm 4.37$$

where the photographic amplitude of the "mean" light curve was 0.63^{m} and the mean magnitude of the object was 15.1^{m} .

More evidence about the binary nature of the object can be found from spectroscopy. We have obtained 14 spectrograms of the object V 1329 Cyg between May 30, 1970 and November 28, 1976 at the observatories Victoria - D.A.O. (V; 1.2 m telescope), Ondřejov (O; 2 m telescope), Asiago (A; 1.2 m telescope with the image intensifier) in various spectral regions covering the interval 370 - 867 nm.

All plates were measured by one of us (L.H.) on the Abbé comparators of the Ondřejov and Skalnaté Pleso Observatories. Radial velocities were determined by using the code written by Dr. P. Harmanec (1978), who also provided us with the codes for period searching. The average values of the radial velocities of the emission lines of H I, He I, He II, Fe I, Fe II, O I, [O III] and [Ne III] are given in Table I. No significant differences between the radial velocities as determined for various ions were detected.

Table I
Radial velocities of the emission lines in
V 1329 Cyg

| Plate No. | Dispersion $\times 10^{-7}$ | Date d,m,y | JD _{hel} 2400000.0+ | Phase | RV _{obs} kms ⁻¹ | O-C kms ⁻¹ | No. of lines | Weight |
|-----------|-----------------------------|------------|------------------------------|-------|-------------------------------------|-----------------------|--------------|--------|
| V 5790 | 6.40 | 30.05.70 | 40736.9249 | .696 | 23.0 \pm 3.3 | 4.8 | 3 | 14 |
| V 5916 | 6.39 | 07.07.70 | 40774.8651 | .736 | 6.4 \pm 10.8 | -15.0 | 4 | 12 |
| A 745 | 73.1 | 13.08.71 | 41176.5453 | .159 | -115.0 \pm 17.8 | -24.4 | 8 | 5 |
| O 1274 | 17.0 | 06.10.72 | 41597.4061 | .602 | -6.4 \pm 5.2 | -3.4 | 8 | 13 |
| A 1411 | 83.9 | 18.11.72 | 41640.3377 | .647 | 29.7 \pm 12.3 | 20.4 | 7 | 4 |
| A 1809 | 127 | 29.11.72 | 41651.3050 | .658 | 41.8 \pm 9.6 | -53.6 | 5 | 3 |
| A 1690 | 379 | 06.11.73 | 41993.2815 | .018 | -53.0 \pm 23.7 | -6.7 | 5 | 1 |
| A 2192 | 127 | 01.12.73 | 42018.4369 | .045 | -56.7 \pm 17.4 | -0.4 | 6 | 3 |
| A 2404 | 125 | 13.09.74 | 42303.5104 | .345 | -84.7 \pm 38.0 | 5.1 | 7 | 3 |
| A 2405 | 125 | 13.09.74 | 42303.5729 | .345 | -69.7 \pm 13.3 | 20.1 | 7 | 3 |
| A 2414 | 127 | 18.09.74 | 42309.3811 | .351 | -87.9 \pm 62.1 | 0.6 | 2 | 1 |
| A 2415 | 127 | 18.09.74 | 42309.4498 | .351 | -72.3 \pm 7.9 | 16.1 | 4 | 3 |
| A 2070 | 76.8 | 21.11.75 | 42738.3612 | .803 | 57.0 \pm 11.4 | 38.6 | 13 | 6 |
| A 2723 | 127 | 28.11.76 | 43111.3377 | .195 | -91.9 \pm 9.9 | 4.8 | 3 | 2 |

Phases were calculated on the basis of the ephemeris:

$$(3) \quad \text{JD}_{\text{hel}} (\text{pri.min.}) = 2442926.0 + 950^{\text{d}}_{.07} \times E, \\ \pm 20.0 \quad \pm 4.37$$

which was derived from the solution of the spectroscopic elements using Dr. Horn's code. It is encouraging to note that by comparing T_0 (pri.min.) from the ephemeris (2) and (3) we arrive to the period of $950^{\text{d}}_{.32}$, in excellent agreement with the assumed value. The spectroscopic elements and their r.m.s. errors were determined as follows:

$$(4) \quad \begin{aligned} e &= 0 \text{ (assumed)} & K_1 &= (61.0 \pm 5.4) \text{ km s}^{-1} \\ P &= 950^{\text{d}}_{.07} \text{ (assumed from (2))} & f(M) &= 22.3 M_{\odot} \\ \gamma &= (-39.3 \pm 4.7) \text{ km s}^{-1} & a_1 \sin i &= 1140 R_{\odot} \end{aligned}$$

From the set of elements (4) we have calculated the O-C values

in Table I.

By combining the present photometric and spectroscopic evidence we can estimate the radius of the eclipsing component (i.e. of the late-type star) being close to $350 R_{\odot}$. Assuming that the inclination is close to 90° (as inferred from the probable presence of rather long photometric eclipses) we may determine some plausible combinations of the masses of the components that correspond to the calculated mass function:

| $M_1 (M_{\odot} = 1)$ (emission-line component) | $M_2 (M_{\odot} = 1)$ (late-type component) |
|--|--|
| 0.4 | 23 |
| 0.9 | 24 |
| 1.5 | 25 |

If the hot component is a degenerate star with $M_1 \approx 1 M_{\odot}$, then the late-type star is a red giant ($M_2 \approx 24 M_{\odot}$) of the approximate luminosity class II. The system then strongly resembles a model recently proposed by Paczynski and Rudak (1978) for the type II symbiotic stars.

The observing material used in this note was obtained by J.G. and D.C. during their stays at the Asiago and D.A.O. Observatories. Part of the Asiago plates were kindly given to our disposal by Dr. A. Mammano. We are also indebted to Drs. P. Harmanec and J. Horn for the permission of using their computing codes and for consultations.

| | |
|------------|---|
| L. HRIC | J. GRYGAR |
| D. CHOCHOL | Astronomical Institute, Czechoslovak Academy of Sciences, CS-059 60 Tatranská Lomnica, Czechoslovakia |

References:

- Arhipova, V.P., 1977: *Peremennyje Zvezdy* 20, 345
Grygar, J., Hric, L., Chochol, D., 1977: IAU Colloq.No. 42
(eds. R.Kippenhahn, J.Rahe, W.Strohmeier), Bamberg, 383
Harmanec, P., 1978: private communication
Horn, J., 1978: private communication
Paczynski, B., Rudak, B., 1978: N.Copernicus Astron.Center Preprint, Warsaw, October
Stienon, F.M., Chartrand, M.R., Shao, C.Y., 1974: *Astron.J.* 79, 47