THE PECULIAR SYMBIOTIC OBJECT V1329 CYGNI: SINGLE-STAR VERSUS BINARY MODELS

Jiri Grygar
Institute of Physics, Czechoslovak Academy of Sciences, Rez
Drahomir Chochol
Astronomical Institute, Slovak Academy of Sciences, Tatranska Lomnica, Czechoslovakia

1. Recapitulation of photometric and spectroscopic observations.

The variable emission-line object V1329 Cyg (= HBV 475) was discoverred by Kohoutek (1969). Crampton and Grygar (1969) identified more than 100 emission lines in the blue portion of the spectrum, while Andrillat (1969) found evidence for the late-type (M) spectrum in the near infrared. This justified the classification of the object among the symbiotic stars. The classification was subsequently confirmed by all authors who studied the spectroscopic evolution of the object.

Its optical variability was first noted by Kohoutek and Bossen (1970). Stienon et al. (1974) analysed the archive photographic data in the years 1891–1966 and established several modes of variability. From the absence of the object on some patrol plates they inferred that the object is probably an eclipsing binary with a period of 959 days. The duration of primary eclipse is about 60 days. In the years 1960–64 the object increased its photographic brightness from $15\overset{m}{.}1$ to $14\overset{m}{.}2$. Then started a sharp increase of the rate 0.02 mag/day up to $11\overset{m}{.}9$. Maximum brightness of $11\overset{m}{.}5$ was reached in the middle of the year 1966 (Arkhipova and Mandel 1973 and 1975). Since then the object slowly faded, but the original photometric period of about 960 days is preserved.

Radio emission of the object was discovered by Altenhoff and Wendker (1973) and Terzian and Dickey (1973).

2. Postdiscovery studies

A detailed description of the evolution of the postdiscovery spectrum was subsequently published by Crampton et al. (1970), Mammano and Righini (1973), Baratta et al. (1974), Stienon et al. (1974), Andrillat and Houziaux (1976) and Tamura (1977). The last author noted the appearance of the emission lines of [FeVII] and the strengthening of the HeII λ 4686 line in the years 1974-76. This tendency of the appearance of the emis-

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sion lines of higher and higher excitation was found by the others, too (for a summary see Grygar et al. 1979).

The complex structure of some emission line profiles strongly suggests that an ejection process started during the main outburst in the year 1966. However, the [OIII] lines were either weak or absent until July 13, 1969 and Tamura (1981a) did not find P Cygni profile in the HeI λ6678 line in the years 1976 and 1977. Grygar et al. (1979) noted that the line profile of [OIII] resembles profiles typical of the nebular stage of novae. Thus, separate blobs of matter were apparently ejected along the equatorial as well as polar directions with respect to the parent star. The ejection were in the range from 50 to 350 km s^{-1} (Crampton et al. 1970; Tamura 1981a).

3. Binary hypothesis

Following the suggestion by Stienon et al. (1974) we investigated the possibility that the object is an eclipsing binary. Using the pre-outburst photometry we have searched for possible periodicities in the data by various mathematical techniques (Grygar et al. 1977). From the analysis we may infer that in the time interval from 20 to 1000 days there is only one plausible period of about 950 days. The phase of the pre-outburst light curve is perfectly preserved in the post-outburst photoelectriv measurements (Grygar et al. 1979).

The radial velocity data for emission lines of HI, HeI, HeII, FeI, FeII, OI, [OIII] and [NeIII] in the years 1970-76 yielded the elements of spectroscopic binary circular orbit with a period of 950.1 days and semiamplitude of 61 km s^{-1}. Again, the derived phase of the primary minimum is in excellent agreement with the photometric data (Hric et al. 1978). The spectroscopic orbit was confirmed by Iijima et al. (1981) who from more numerous data covering the time interval of 3814 days found an eccentric orbit (e=0.17) with the same period and semiamplitude of 63 km s^{-1}.

Nice agreement of the pre-outburst and post-outburst photometry as well as its match with spectroscopic orbit lead us to the formulation of the binary hypothesis on the nature of the object V1329 Cyg, in spite of some problems arising:

(i) The mass function f(M) = 23 $M_\odot$ is pretty large. This infers the minimum mass of the late-type component M_2 = 25 $M_\odot$; the value that is too high for the estimated bolometric magnitude M_{bol}= -5 implying M_2 = 10 $M_\odot$ (Iijima et al. 1981).

(ii) The late-type component does not fill its Roche lobe by a wide margin. Thus all mass transfer may occur through the stellar wind only. Tamura (1981b) doubts whether the amount of matter transferred by the wind is sufficient enough to preserve the activity of the star.

(iii) The nature of the hot component is unclear. It should be a compact object (no secondary minima were detected) and its Roche lobe is small by 1–5 (!) orders of magnitude to accomodate the matter seen in emission (Tamura 1981b; Iijima and Mammano 1981). Thus, it is objected that the radial velocities as derived from the peaks of emission lines do not represent an orbital motion.

Still, we feel that all these objections could be overcome. Our binary model seems to be theoretically supported by evolutionary considerations published by Tutukov and Yungelson (1976), Bath (1977) and Paczynski and Rudak (1980).

4. Alternatives

Iijima and Mammano (1981) discussed the possibility that V1329 Cyg is a nova-like object with recurrent outbursts at intervals of about 950 days, were the compact component is a white dwarf with rapid mass accretion ($2\ 10^{-5} M_\odot yr^{-1}$), following the theoretical calculations of the hydrogen flashes by Nomoto et al.(1979).

Tamura (1981a, b) advocates a single-star model where a central star has a variable effective temperature in the range $1.2–1.8\ 10^5\ ^\circ K$ and the expanding zones of [FeVII] and HeII extend to $7\ 10^{14-16}$ cm from the star. He is supporting the interacting stellar winds model by Kwok et al.(1978).

5. Discussion

In spite of all observational as well as theoretical efforts no clear picture of the object V1329 Cyg seems to emerge. The only sure fact is that there was an outburst in the year 1966 followed by an ejection of matter. The interpretation of the rest of the data depends critically on the assumption about the binary or single-star nature of the object.

The relation to other symbiotic objects may give us a better clue. Iijima et al. (1981) noted the similarity of its optical spectrum to the spectrum of the optical counterpart of the X-ray binary GX 1+4. Morphologically, the stars V1016 Cyg, RT Ser, RR Tel, HM Sge and AS 295B are also similar.

We may be fortunate in getting more decisive results in the near future. Following the suggestion by Iijima and Mammano (1981), another period of activity of V1329 Cyg is expected since the end of the year 1981 and the next outburst should occur in November 1982. Thus, we advise the observers present at the Colloquium to run to their powerful instruments immediately after returning home in order to get the latest data in the end of the quiescent stage of this marvellous object.

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