CEPHEID RADIAL VELOCITIES

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ABSTRACT. Some results of the programme of the measurements of the Cepheid radial velocities by using a correlational spectrometer are presented. The spectral binarity of the classical Cepheids MW Cyg and VZ Cyg is discovered. The orbital elements of the Population II binary Cepheid TX Del and of the classical binary cepheid DL Cas in an open cluster are determined more precisely. Preliminary orbital elements of MW Cyg are determined. By using the Baade–Wesselink method, the preliminary values of the radii of TX Del and DL Cas are determined.

Key words: Stars: Cepheids, radial velocities.

Since 1989 one of the programs being actively fulfilled with Tokovinin's (1987) correlational spectrometer is devoted to measurements of Cepheid radial velocities. The instrument is of CORAVEL type, it gives the possibility to measure radial velocities of stars in the F5 – M5 spectral type range down to 13th – 14th visual magnitude. For a 10^m star in the middle of this spectral type range we get the internal accuracy of approximately 0.3 km/s, with typical exposure times around 8 minutes, at 1 m telescopes. Cepheids are in the early type part of the spectral type range, but are readily measured. Radial velocities of Cepheids measured during the first 3 years of the programme were included in our catalogue (Gorynya et al. 1992a), based on 1546 measurements of 83 variables. Now we have added several more hundred Cepheid radial velocity measurements, so having acquired the world–richest series of high accuracy radial velocity observations of Cepheids. Our program has been so far naturally restricted to stars to the north of -25^o declination; though we find interest among colleagues in Chile and in South Africa, financial problems have not yet permitted us to observe there. By now we have observed in Russia, Bulgaria, Uzbekistan, and the Ukraine. The greatest volume of data for Cepheids has been gathered by us at the Simeiz Observatory.

We discovered two new spectroscopic binary Cepheids, MW Cyg (Gorynya et al. 1992b) and VZ Cyg (Samus et al. 1993). Fig. 1 shows the pulsational radial velocity curve of VZ Cyg. The change of γ-velocity by ≈ 7 km/s is evident. We tried to determine orbital elements for MW Cyg. By now there are two possible solutions, with periods of 191^d and 199^d and quite different eccentricities. This summer we have added many new observations and hope to be able to solve this problem.

We also rediscovered independently the spectroscopic binarity of TX Del, first found by Harris and Welch (1989), and improved its orbital elements. TX Del is a very interesting star. It has a pulsational period 6.166^d and an orbital period 133.15^d, very short for a binary Cepheid and thus restricting seriously the possible dimensions of the pulsating star. Fortunately TX Del is usually considered Population II Cepheid (so it must be smaller than classical Cepheids of the same pulsational period). However, the star has high metal abundance (Harris 1981), and in our observations it always shows rather high line contrast, not typical for Population II F-type stars.

This problem can be checked using one of modern modifications of the well-known Baade–Wesselink technique. We have analyzed possibilities of the existing versions if this

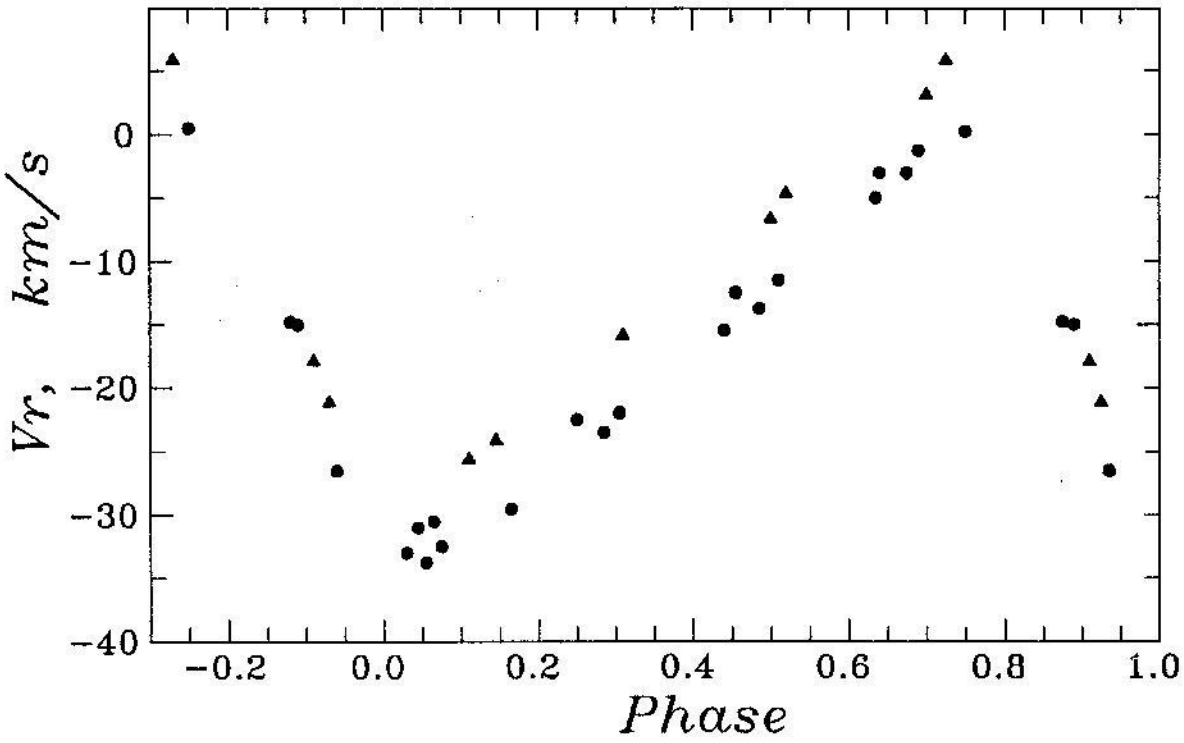

Figure 1: Radial velocity curve of VZ Cyg *vs* pulsational phase. Dots – the observations of 1992, triangles – the observations of 1993.

technique and found most promising to proceed on the base of the method described by Balona (1977). This method does not require selection of pairs of phases with equal effective temperatures, but rather takes use of the whole light and velocity curves. Our practise shows, however, that is might be better to exclude the ascending branch of the light curve with manifestations of shock waves and other phenomena difficult to account for. We also used software enabling us to check visually the quality of representation of observed light curves with model ones for adopted sizes of the star. Our version of Balona's technique was checked on several well-observed stars, like TT Aql, and gave very good results. Then we turned to complicated cases, like TX Del and a binary classical Cepheid DL Cas in the open cluster NGC 129 (we have also improved orbital elements for this star). For TX Del most reliable radius estimates are in the range 35–50 $R_\odot$, and for DL Cas – in the range 50–70 $R_\odot$.

Certainly, to get reliable results with any version of the Baade–Wesselink technique it is very important to have good photometry, preferably in red or infrared, and to be able to connect the systems of phases valid during intervals covered with photometry and with radial velocity measurements. Here we take full advantage of the excellent data base on Cepheid photometry created and kindly made available to us by L.N. Berdnikov.

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