PREDICTION OF THE COMPONENTS MASS RATIOS AND THE SPECTRAL CLASSES OF THE MAIN COMPONENT FOR W UMa–TYPE ECLIPSING VARIABLE STARS

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ABSTRACT. The new approach to estimation of components mass ratios for close binary systems is suggested. 225 unknown from spectroscopic observations magnitudes of mass ratios for W UMa-type contact binaries are restored by statistical method ZET. 204 magnitudes of the spectral classes of the main component for this type systems are defined by analogous way. The evolutionary types of some stars are specified as a matter of record. ZET-method efficiency for predict these characteristics of W UMa-type contact systems is shown.

Key words: Stars: Binaries, Contact, Component mass ratios, ZET method.

In this paper the mass-ratios of the less massive to more massive component $q = M_2/M_1$ and the spectra of the more massive component Sp_1 for W UMa-type close binary systems are computed by statistical method, namely, ZET algorithm (Zagoruiko et all. 1985). The statistical approach necessity is stimulated by imposibility to obtain the sufficiently reliable values of q for W UMa-type systems by the used at present the method of synthesis of the theoretical light curves because of observed light curves assimmetry and their variance from night to night and from season to season.

ZET algorithm is intended to predict uncertain elements in empiric tables "object-property" and to verify the table or part of it. In tables "object-property" with dimension $M * N$ lines (objects) have numbers $1, 2, .., i, ..M$ and columns (properties) - $1, 2, .., j, ..N$. Uncertain element $a_{i,j}$ in ZET algoritm is predicted on the basis of local linearity principle, i.e. under assuming linear dependence between lines and/or columns, most similar with line i and/or column j.

The approximate values from these columns a_{ij} (lines a_{ij}) are computed on the basis of the linear regression equation:

$$a_{ij}^k = b_{jk} a_{ik} + c_{jk},$$

where b_{jk} and c_{jk} - the linear regression coefficients, calculated on the basis of the certain elements of j and k columns.

The obtained values are averaged with the weights Q , proportional to linearity degree and mutual filling of the columns:

$$a_{ij}^{col} = \frac{\sum_{k=1}^{p} a_{ij}^k Q_{kj}}{\sum_{k=1}^{p} Q_{kj}},$$

$$Q_{kj} = |r_{kj}|^{\alpha} L_{kj},$$

where r_{kj} - the coefficient of the linear correlation, L_{kj} - the number of unempty pairs of elements for k and j columns, p - the number of columns, which have no gaps in i line. The minimum of the average prediction error for all certain elements of column with the filled gap is the criterion for choice of parameter . The prediction by lines is carried out by the analogous way. The final value is that one for which the prediction error of certain elements j column (i line) is least.

Four characteristics of stars from Svechnikov, Kuznetsova (1990), most informative for predicting the mass-ratios and spectra were used to restore uncertain magnitudes q and Sp_1: the absolute bolometric magnitude M_{1b} of the more massive component, the mass of this component M_1, the value of orbital majior semiaxis A and the value of orbital inclination . The table with 6 parameters such as $q, Sp_1, M_{1b}, M_1, A, i$ for 295 KW-type stars according to Svechnikov's classification (Svechnikov et all. (1980)) were compiled. The certain values of q and the corresponding informative characteristics (altogether 70 values) were taken from Svechnikov (1986), Webbink (1991) and a number of original articles. The spectroscopic observation data from Svechnicov and Kuznetsova (1990) and the data from mentioned literature sources were taken as a certain value of Sp_1 (altogether 91 values). Gaps were plased instead of the rest of q and Sp_1 values.

All the certain elements of the first and second columns were verified. The average errors of verification

were 11.8 % and 3 % respectively. This result shows application expediency of ZET method for restoration of uncertain mass ratios and spectra for W UMa-type systems.

Actually, when predicting 225 uncertain values q on the basis of this table 218 magnitudes were restored with the error about 5 % and 7 magnitudes - with the error about 10 %.

The spectra of the main component were predicted by analogous way. When predicting 204 uncertain values Sp_1 198 magnitudes were defined with the error about 5 % and three each magnitudes - with the error about 10 % and 15 % accordingly.

The obtained values of Sp_1 are similar to spectra approximately estimated by Svechnicov and Kuznetsova (1990) for majority systems. But the obtained values of Sp_1 differ from spectra estimated by Svechnikov and Kuznetsova more than at one spectral class for approximately 1/5 systems. The spectra of some of these stars are earlier than F5. So such systems as V 520 Cas, OP Cen, AY CrA, V 940 Cyg, DG Lup, V 878 Oph, V 938 Oph, V 940 Oph, AY Pup, V 842 Sco, AH Vir, perhaps, belong to contact systems of early spectra of primaries (according to Svechnikov's classification).

The obtained results allow us to conclude that prediction of mass ratios q and spectra Sp_1 for KW-type systems by ZET method are possible.

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