Publ. Astron. Obs. Belgrade No. 54 (1996), 93 – 94 *Invited review*

ACTIVE CLOSE BINARIES (CB) MODELS AND METHODS FOR INTERPRETATION OF THE PHOTOMETRIC OBSERVATIONS

G. DJURAŠEVIĆ
Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia
E-mail gdjurasevic@aob.aob.bg.ac.yu

An essential progress in astrophysics and CB evolution theory started about 1970 due to the development of computer models enabling the synthesizing of the light curves and those of line-of-sight velocity. These models, based physically on the Roche equipotentials, appear as substitutions for the traditional geometrical models. Due to this, the accuracy and efficiency of the observations analysis has been significantly improved and consequently the studying of CB evolution became easier. It may be said that the progress in the understanding of the physical processes in CBs is closely connected with the development of the physical model for synthesizing of light curves and those of line-of-sight velocities. The morphology of CB systems is full of physical models specialized for analyzing some types of these systems over various phases of their evolution. If we have for a given CB type an adequate, physically based model, by optimization of its parameters one can achieve a good fit to the observations. In this way one can obtain a realistic estimate of the orbital and physical parameters for a CB. The interpretation of the observations is reduced to two crucial problems: one should first develop an adequate model for synthesizing a light curve or that of line-of-sight velocity (direct problem) and then by applying a corresponding optimization model to estimate the parameters for which the chosen model yields the best fit to the observations (inverse problem). These problems offer an exceptionally active field of interest. In this way together with the development of the models for CB-observations generating one also develops the methods for solving the inverse problem. Some of the earlier direct models have been fitted by trial and error, whereas today one applies several good algorithms for solving this problem iteratively. Most of the ideas and methods for parameter adjustment are from the mathematical literature. The solutions are obtained today by applying the method of Differential Corrections (DC), by Steepest Descent, by the Simplex Algorithm, occasionally by Iterative Minimization, by Controlled Random Search and by the Marquardt (1963) algorithm. All seek to minimize the sum of squares of residuals $\Sigma(O-C)^2$ between the real observations and the simulated ones originated in a CB model.

The analyzing of the eclipcing-CB observations offers an almost unique possibility for estimating the orbital and physical system parameters. In this way one obtains

valuable information on the physical properties of stars at different evolutionary stages of CBs. The development of computer models and of the methods of observation analysis based on the parameter optimization is a very dynamical research also stimulating new observational programmes. In addition to photometry and line-of-sight velocities the light polarization and analyzing of the photospheric-spectral-line profiles also become of interest. For analyzing these observations special models have been developed. The richness in evolutionary scenarios for CBs leads to the developing of the models used in the interpretation of observations of different morphological-type systems or of special kind of activities in the system.

The observed light curves in CB systems are often asymmetric and deformed. In some cases this appears as an indication for the presence of active regions on stars in CBs of RS CVn and W UMa types. The evolution followed by a mass exchange between the CB components results in exotic phenomena, such as the gas stream in the system, formation of hot spots and of an accretion disc around the star capturing the mass of its neighbour.

The analyzing of light curves based on these models and the methods of solving the inverse problem enable a realistic estimate for the physical and orbital parameters of active CBs. The knowledge of the component parameters in RS CVn and W UMa CB types, as well as of the active regions which deform their light curves, contributes to a better understanding of physical processes on stars. The possibility of estimating the parameters of the components and of the accretion disc with a hot-spot region is of special interest in CBs with an intensive matter exchange between the components (type W Ser and cataclysmic variable). The knowledge of these parameters contributes to a better understanding of stellar evolution in the conditions of mass transfer between the components.

In this review emphasized are the models and methods for interpreting the observations of active CBs which have recently been the subject – matter in this country. As a more comprehensive review comprising the activities concerning this subject all world-wide, the present author recommends Wilson's (1994) excellently written, invited paper.