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Review paper

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

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SUMMARY: An essential progress in astrophysics and CB evolution theory started about 1970 thanks to the development of computer models enabling 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. Owing to this, the accuracy and efficiency of the observations analysis has been significantly improved and consequently the studying of CB evolution has become 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 of 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 synthetic generation of CB observables one also develops the methods for solving the inverse problem. They are based on the minimization of the sum of squares of residuals $\Sigma(O-C)^2$ between the real observations and the simulated ones generated in a CB model. 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.

The analyzing of the eclipse-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 wealth 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.

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

1. INTRODUCTION

It is customary to emphasize the fundamental importance of analysing the photometric and spectroscopic observations of CB systems for the purpose of estimating the masses, the radii and the temperatures of the components, as well as a number of other essential parameters. Conditionally, the procedure of the observation analysis can be divided into several phases. The first thing to be done is to conceive and realise a computer model used in the synthesizing of light curves and line-of-sight velocities which can simulate the real observations. In the second step one develops a method of solving the inverse problem yielding an optimal fit to the observations and an optimal estimate of the parameters of a CB system. After more than fifty years of application, the spherical and rectifiable models are quickly ceding place to physical ones based on the Roche equipotentials whereby one considers the eccentric orbits, nonsynchronous rotations of the components and other generalisations. These programmes for synthetic generation of CB observables, began their development about 1970. The principles on which these models are based, given by Wilson and Devinney (1971), constitute a new beginning and break with the spherical and ellipsoidal models, whose application is really rare today. The intention is in generalising the models which for various modes would be adapted to the observation analysis of particular types of CB-systems. But the diversity of the systems, the presence of activity on the components and the gas dynamics in the system lead to the developing of specialised models which with some amendments can further be generalised.

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, formations 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.

2. THE MODELS OF ACTIVE CB SYSTEMS

With regard to the current importance of interpreting the asymmetric, deformed, light curves, the present author has developed computer models enabling a successful interpretation of photometric observations: of the active CB with spots on the components (Djurašević, 1992a), of the CB with an accretion disk being at the evolutional phase of an intensive matter exchange between the components (type W Ser) (Djurašević, 1992b) and of the cataclysmic variable, as well as of active CB with accretion onto a white dwarf (Djurašević, 1995; 1996). After some amendments these models can be also applied for calculating synthetic spectral line profiles and radial velocity curves of CB systems.

The modelling of the CB systems is based on the principles originated in the Wilson and Devinney (1971) model (WD) for the synthesis of a light curve. The shapes of the components correspond to the equipotentials in the Roche model so that the critical Roche lobes can be filled up to an arbitrary degree. The dimensions of the stars in the model are described by the filling coefficients for the critical lobes of the primary and secondary $S_{1,2}$. For a given mass ratio of the components and the nonsynchronicity parameters, the shape and the size of stars in a CB are unequivocally determined by the filling coefficients of the critical lobes.

In a spherical coordinate system the surfaces of the components are divided into a large number of elementary cells whose intensity and angular radiation distribution are determined by the star temperature, limb-darkening, gravity-darkening and by the effect of reflection in the system.

2.1. The Roche model of an active CB with spots on the components.

In the first place, we present the model developed for the synthesis of asymmetric, deformed, light curves of active CB with spots on their components. The active regions are approximated by circular spots (Fig. 1), characterised by the temperature contrast of the spot with respect to the surrounding photosphere ($A_s = T_s/T_*$), by the angular size of the spot (θ), by the longitude (λ) and by the latitude (φ) of the spot centre. The presence of spots (dark or hot) enables to explain the asymmetry and depressions on the light curves of active CB.

The CB model, presented in details in Djurašević (1992a), is rich enough to be able to simulate the basic properties of observed light curves in the case of both 'classical' CB (Roche geometry without spots) and active systems with spots on their components like RS CVn, W UMa, etc. The model can be also used for the purpose of interpretation of systems with hot spots which are due to a matter exchange

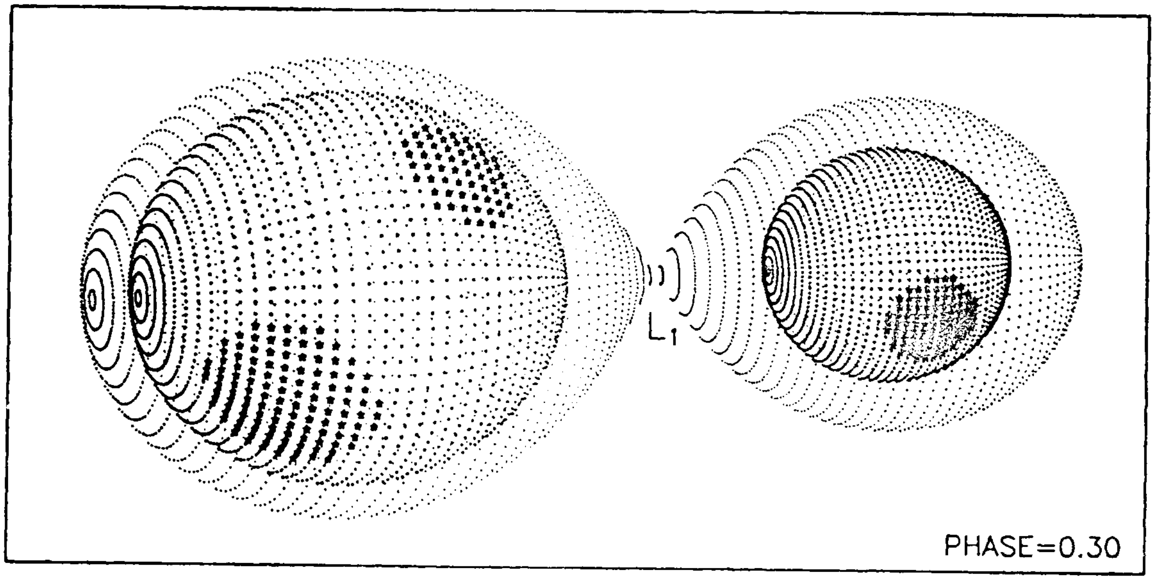

Fig. 1. The Roche model of an active CB with spots on the components.

between the components, i.e., to processes connected with gas dynamics in the system. If both system components fill in the critical Roche lobes, they have a physical contact near the Lagrangian neutral point L_1 which can also cause an exchange of thermal energy between the components with different temperatures. A confirmation may be found in the W UMa-type systems containing main-sequence stars. Their characteristic is that the temperatures of the stars are approximately equal regardless of the mass difference. The explanation of the phenomenon is in the overcontact configuration followed by a thermal-energy exchange from the hotter primary towards the secondary. The light curves possess the characteristic asymmetry due to the presence of an enlarged-temperature region on the cooler secondary to which this transfer is directed.

These models, for the parameters given a priori, generate synthetic light curves with which real observations can be fitted. Optimal parameters for which the model yields the best fit to the observations one finds by solving the inverse problem. In this way one can estimate the orbital and physical parameters of a CB system, as well as those of active regions on the components.

2.2. The Roche model for the active CB with accretion disk.

Recently the interest of astronomers in close binaries which are in the phase of an intensive matter exchange between their components, has been significantly increased. When in the course of its evolution, one of the CB components reaches the phase of filling its critical oval, the star becomes unstable and begins to loose the mass. This phenomenon often results in the formation of a gaseous disk around the component which captures with its gravitation field the matter flowing from the neighbouring star. The existence of the disk is made possible due to the gas stream from the component losing its mass. The disk lies in the orbital plane and on its lateral side, in the zone where the gas stream falls on the disk, there is an intensive hot-spot radiation. A hot spot causes deformations on a CB light curve which becomes asymmetric. On the light curves of some CB a characteristic hump appears, which is due to the intensive hot-spot radiation.

In the case of the active CB with an accretion disk a model for light- curve synthesis has been realised (Djurašević, 1992b) where the attention is given to systems like W Ser not sufficiently examined yet with regard to the fact that in them the accretion disk is formed around an ordinary star. The model (Fig. 2) can successfully describe the essential characteristics of the observed light curves due to existence of an accretion disk and a hot spot, as well as those originated in the temperature distribution along the disk radius. The system components are considered in the framework of the nonsynchronous Roche model and the accretion disk of a constant thickness lies in the orbital plane around the star capturing the matter of the neighbouring component.

The primary surrounded by the disk is situated relatively well within the Roche oval, and its rotation can be significantly nonsynchronous. Near the Lagrange equilibrium point L_1 flowing from the secondary (which fills the Roche limit) the gas stream 'nourishes' the disk. The lateral sides of the disk are approximated by a cylindrical surface. In the zone where the stream touches the lateral side of the disk a hot-spot is formed. In the model, the hot-spot is described by the angular size of the spot, longitude of the spot centre and by the temperature contrast of a spot with respect to the unperturbed temperature on the disk edge.

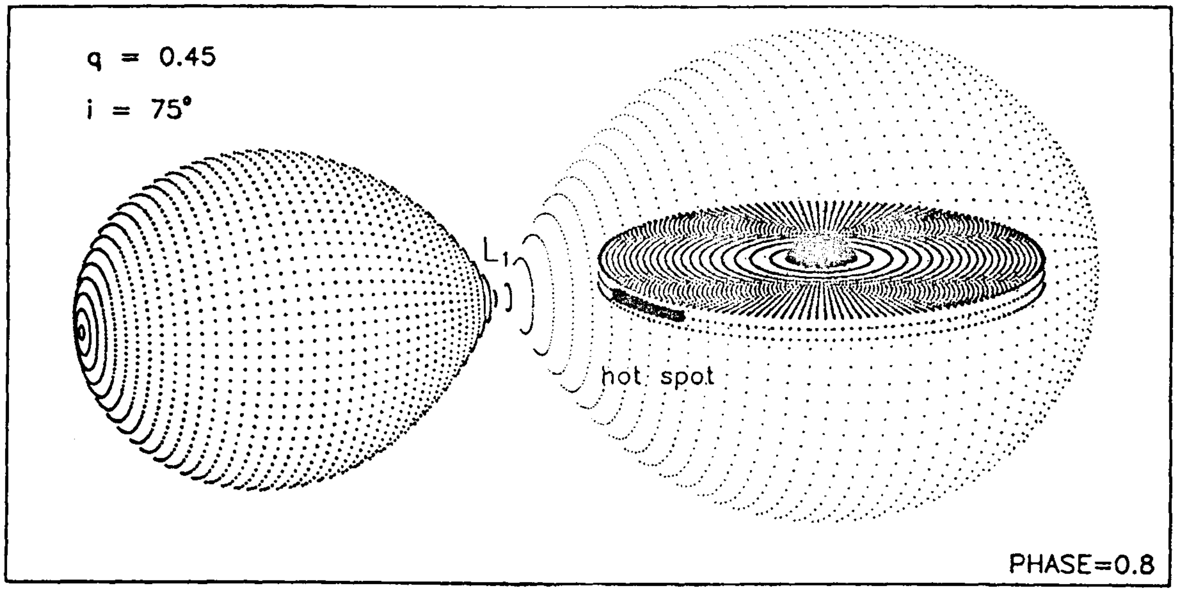

Fig. 2. The Roche model for the active CB with accretion disk.

The model involves a Planck-type radiation for the elementary cells into which the areas of the components and of the accretion disk are divided. In all details, the model and the synthesis procedure concerning a light-curve are explained in Djurašević (1992b).

The proposed model of a CB containing an accretion disk is rich enough to describe the fundamental observed phenomena on the light curves of these systems, which are due to an intensive matter exchange between the component. Some idealizations introduced here are necessary if one wants to realise a sufficiently fast computer programme for the light-curve synthesis based on this model. This requirement is just the imperative appearing in the applications of the model for the purpose of interpretations of the observed light curves by solving the corresponding inverse problem.

2.3. The Roche model for cataclysmic variables.

In the modern theory of accretion in CB it is important to determine from observations the physical characteristics of the system and accretion disk for the cataclysmic variables such as the novae and novae-like stars. The luminosity of majority of these stars in the quiescent phase (between outbursts) is due to the accretion disk located around the white dwarf and the hot-spot on the disk edge.

The canonical model of a cataclysmic variable is a Roche lobe-filling cool main sequence star, which loses matter into the Roche lobe of the white dwarf. The transferred material has too much angular momentum to fall onto the surface of the white dwarf. Because of the tiny dimensions of the primary, this material flies along its trajectory inside the white dwarf's Roche volume forming a ring around the central object. As viscous forces are at work, the matter gradually loses its angular momentum, and this ring spreads out to form a disk, which lies in the orbital plane of the system, extending down to the white dwarf. On the disk lateral side, in the zone where the gas stream falls on the disk, there is an intensive hot-spot radiation. The position, size, and temperature of a hot-spot are dependent of the gas-stream parameters, of the forces in the system and of the disk size. On account of a relatively low accretion-disk luminosity in the quiescent phase the hot-spot in these systems contributes significantly, sometimes dominantly, to the total system's luminosity. For this reason the light curves are significantly deformed and they become asymmetric with a characteristic form caused by the eclipse geometry, as well as by the radial and azimuthal temperature distributions in the disk.

When the matter is approaching the white dwarf it has to get rid of excess gravitational energy, half of which, according to the Virial Theorem, is converted into the kinetic energy of the disk material, while the other half is transformed into the radiative energy, causing the disk to shine as a luminous object. At the interface between the innermost disk area and the white dwarf (in the nonsynchronous rotation) the motion of disk material will have to be broken down to the velocity of the white dwarf, in the process of which an additional radiative energy will be liberated and the boundary layer will be formed.

For the purpose of analysing light curves of this active CB with an accretion disk around the white dwarf, being at the evolutionary phase of an intensive matter exchange between the components, a model for light-curve synthesis has been realised by modifying the model (Djurašević, 1992b), developed for the systems like W Ser. Since the basic elements of this model have been already presented, here only some specific properties will be given.

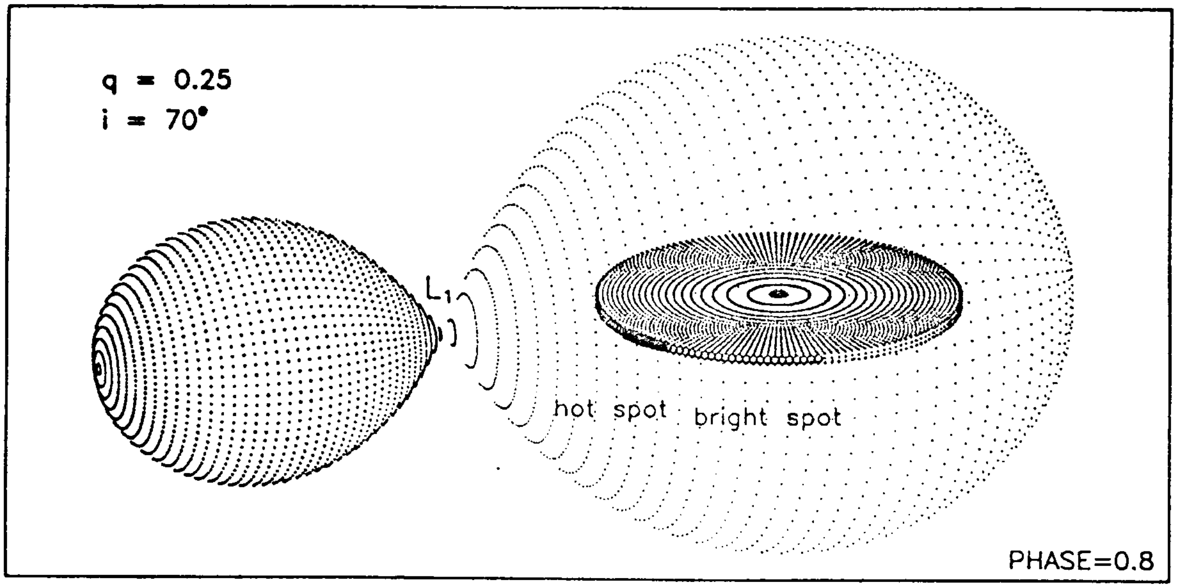

Fig. 3. The Roche model for cataclysmic variables.

In order to achieve a successful fit of real observations for these CB systems with synthetic light curves generated by the model, one should consider the problem of the hot-spot-region structure, as well as the one concerning the temperature distribution along the accretion-disc radius.

The hot-spot region has a complex structure, being represented by means of two components in the model. At the point where the most dense part of the gas stream touches the disk edge there is the central part of the spot with a significant temperature contrast and of a relatively small size. About this region the rarefied gas stream and the heating through coming from the central region form another spot, larger in size, but with somewhat lower temperature (Fig. 3). In the model these spots are described through their angular dimensions, centre longitude and the temperature contrast of a spot with respect to the unperturbed temperature on the disk edge. Due to the intensive gas-stream infall the disk surface in the central part of the hot-spot can be deformed resulting in a certain local radiation concentration which deviates from the global azimuthal distribution. In the model this effect is described by an angle Θ_{rad} between the lines perpendicular to the elementary cells and the corresponding azimuth. In the extended spot, about the central part of the hot-spot, this effect is negligible. The model does not take into account the gas-stream radiation, nor the possible stream penetration and the hot-spot influence towards the disk interior.

Without a model of the light distribution in the disk, it is not possible to perform a correct analysis of the eclipse curves for deriving the geometric properties of the system.

The viscosity of the disk material determines how much energy is liberated at any point in the disk, i.e., the temperature distribution along the disk radius. With the assumption that the whole disk is stationary, i.e., mass transfer rate $\dot{M}$ is constant throughout the disk, the effective temperature distribution $T_{eff}(r)$ can be described by a simple analytical formula (Verbunt, 1982):

$$T^4_{eff}(r) = \frac{3GM_{wd}\dot{M}}{8\pi\sigma r^3}\left(1 - \sqrt{\frac{R_{wd}}{r}}\right), \qquad (1)$$

where G and σ are Newton's and Stefan's constants, respectively, and R_{wd} is the inner radius of the disk. The assumption is that the disk with its internal side has a contact with the surface of the white dwarf.

The term in the parentheses accounts for the transfer of angular momentum between the disk and the white dwarf and imposes a certain, though in practice probably unimportant, uncertainty on the value of the effective temperature.

In our model the temperature on the edge of the disk $T_d(r = R_d)$ appears as a parameter. Expressed through this quantity, the temperature distribution in steady-state models for optically thick black body disks, based on (1), has the form:

$$T_{eff}(r) = \frac{T_d}{C_{fr}}\left(\frac{R_d}{r}\right)^{3/4}\left(1 - \sqrt{\frac{R_{wd}}{r}}\right)^{1/4}, \qquad (2)$$

where

$$C_{fr} = \left(1 - \sqrt{\frac{R_{wd}}{R_d}}\right)^{1/4}.$$

A model with the temperature distribution along the accretion-disk radius defined in this way can be used in the case of dwarf novae in the outburst phase. In the quiescence phase the radial temperature profile is much flatter than that of a steady-state, optically thick, accretion disk. This deviation from a steady state configuration may be a low-vis-

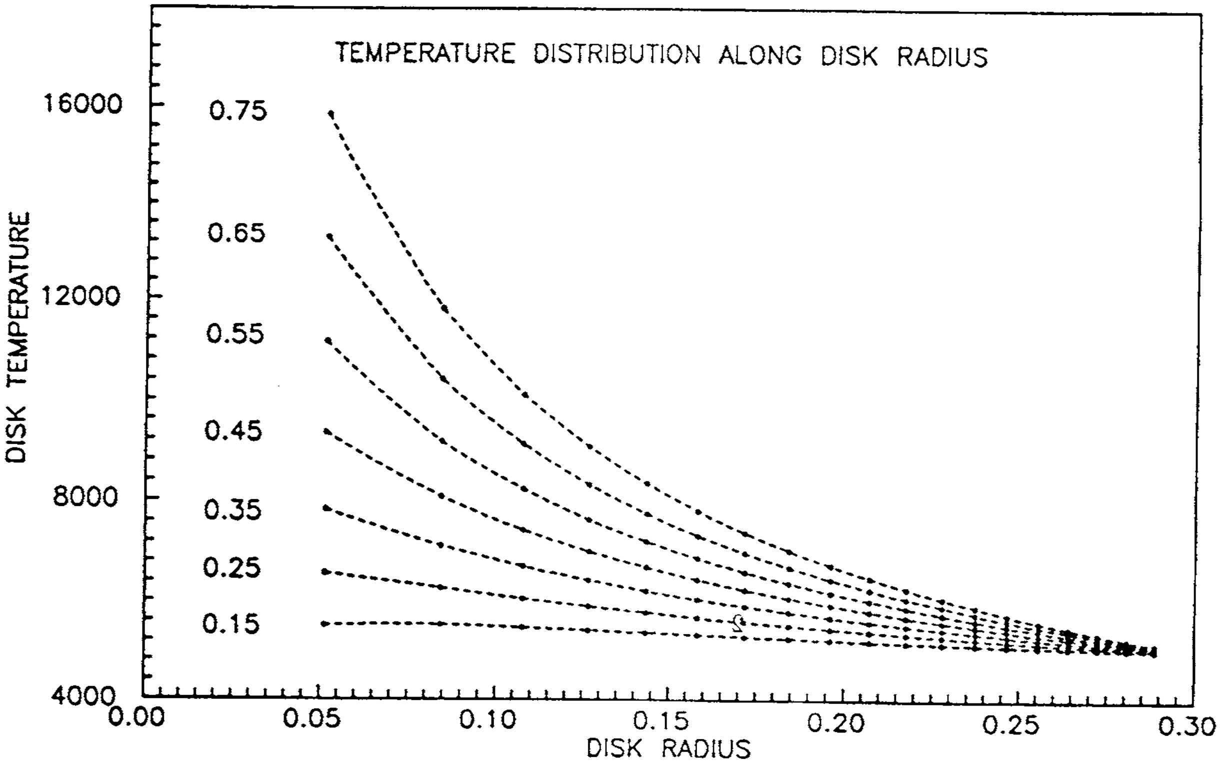

Fig. 4. Radial disk-temperature profiles for various a_T values.

cosity manifestation in the quiescent state. In order to offer an approximate description of this temperature distribution along the disk radius the former of the exponents in (2) is assumed as a free parameter of a_T, so that its form is:

$$T_{eff}(r) = \frac{T_d}{C_{fr}} \left(\frac{R_d}{r} \right)^{a_T} \left(1 - \sqrt{\frac{R_{wd}}{r}} \right)^{1/4}, \qquad (3)$$

This parameter has a dominant role in the radial-disk-temperature-profile determining. For relatively small a_T values, about 0.15, the temperature is nearly constant, whereas with a_T increasing the temperature gradient becomes steeper, to achieve the steady-state configuration for the case $a_T = 0.75$. The latter term with the exponent value of 1/4 describes the temperature distribution in the white-dwarf immediate surroundings so that its influence on the global picture is insignificant. Fig. 4 gives a few temperature profiles yielded by (3) for various values of the parameter a_T.

In order to include this temperature distribution in the CB-light-curve-synthesis model, the disk is divided into concentric isothermal annuli (of constant area), whose temperature is determined by relation (3). Each of the isothermal annuli is characterised by its mean radius dividing the annulus area into two equal parts. Such a choice enables an efficient realisation of the light-curve-synthesis programme. The area of the elementary cells is constant and with the temperature changing along the disk radius, the corresponding radiation fluxes are calculated for each annulus separately. The model involves a Planck-type radiation for the elementary cells into which the areas of the components and of the accretion disk are divided. The details of the synthesis procedure concerning a light curve have been given elsewhere (Djuraševič, 1992b), where the model was considered for the W Ser-type systems.

Such a model concept enables light-curve synthesizing for the parameters given *a priori* where the obtained light curve can describe all the essential elements of the observed ones for the case of dwarf novae. By varying the free model parameters it is possible to achieve a good fit to real observations and consequently to estimate the system parameters. The independent method of light-curve analysis for dwarf novae based in this way is useful for the purpose of verifying the results yielded by other methods. The idealisations involved in the model are basically acceptable so that its application to the light-curve analysing for cataclysmic variables followed by a corresponding method of solving the inverse problem is justified.

3. THE INVERSE PROBLEM AND PARAMETER ESTIMATION

The interpretation of photometric observations is based on the choice of optimal model parameters yielding the best agreement between an observed light curve and the corresponding synthetic one. Some of these parameters can be determined *a priori* in an independent way, while the others are found by solving the inverse problem. In this way methods of solving the inverse problem and models for synthetic generation of CB observables are simultaneously developed. Some of the earlier direct models were fitted by trial and error, whereas now we have applications of several good algorithms for solving this problem iteratively. Most of the ideas and methods for parameter adjustment are from the mathematical literature. Solutions are done 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 of them strive to minimize the sum of squares of residuals $\Sigma(O-C)^2$ between the real observations and the simulated ones generated by the CB model. The optimal parameters, for which the model yields the best fit, correspond to the minimum $\Sigma(O-C)^2$. The parameters of an adequate, physically based, model enable a realistic estimate of the orbital and physical characteristics of the observed system. Here are mentioned some of the optimisation methods offering for the inverse problem to be solved more or less successfully.

The Iterative Minimization (e.g., Horak, 1970) looks for a least-squares minimum simply through a cyclical adjustment of one parameter at a time, and thus avoids a possible divergence due to correlations among the parameters. Since it cycles through the entire parameter set a very large number of times, it is slow.

The Controlled Random Search (Price, 1976; Barone et al., 1988) belongs to very slow methods because the search is carried out over the entire parameter space in order to avoid local minima and guarantee the convergence to the global one $\Sigma(O-C)^2$.

The Steepest Descent computes and follows the local negative gradient of $\Sigma(O-C)^2$, which is a vector whose components are the partial derivatives of $\Sigma(O-C)^2$ with respect to the various parameters. In its practical applications this method also shows slowness in the iterative-process convergence which makes it unsuitable to the observational analysis in the framework of the considered models.

The Method of Differential Corrections (DC) has found a relatively ample application in the framework of the WD model. In the case of models with a higher number of free parameters this method without a solid initial approximation cannot guarantee the convergence of the iterative process in the $\Sigma(O-C)^2$ minimisation. Through different variants of the programme organising one can adapt this method to the requirements of complicated models. Among the possibilities one is to divide the set of the parameters in which the optimisation is done into subsets solved alternatively or sequentially (Wilson and Biermann, 1976). In this way one solves some of the problems connected with the iterative-process convergence for a higher number of parameters. At the same time such a procedure can diminish the mutual correlation of the influence of some parameters on synthetic model curves. During recent years this method has been combined with other approaches to the optimisation problem, such as Simplex Algorithm (Plewa, 1988). This leads to a higher robustness and reliability of the method. In the framework of the present author's models the DC method has shown some weak points. Hence the solution has been looked for in the nonlinear methods of optimisation.

In order to enable a successful application of the realised CB models in the analysing of the observed light curves an efficient algorithm is proposed unifying the best properties of the gradient method and of the differential-corrections into a single one. This method (Djurašević, 1992c) is realised by modifying the Marquardt (1963) algorithm. The inverse problem, based on a nonlinear least-square method is solved in an iterative cycle of corrections of the model elements. The Marquardt algorithm essentially strikes a compromise between the corrections provided by DC and those of Steepest Descent. It does not compute the two kinds of corrections separately, but incorporates a parameter, λ, which will lead to the DC results if set to zero and to the Steepest Descent results if set to very large values. At each iteration, λ is set according to rules designed to avoid the possible divergence of DC for small λ and the possible slow convergence of Steepest Descent at large λ. In all details, the method is explained in Djurašević (1992c).

The present author performs a special adaption of the programmes solving the inverse problem to a particular model for the purpose of obtaining an optimal solution which requires a minimum of computer time. This is very important because of the exceptional scope of calculating operations necessary in solving problems of this kind. Sometimes also in the framework of the same model, depending on the analysed observational material, one can save much of the computer time by modifying the programme organisation. Due to its efficiency and to the reliability in the convergence of the iterative process the Marquardt algorithm acquires a steadily increasing application in solving the problems of observation analysing of CBs systems.

Another possibility for estimating the parameters of a CB based on analyses of observations in the framework of given models is offered by the Simplex-algorithm application. This algorithm was applied by Kallrath and Linnel (1987) in the framework of WD model, pointing to the efficiency and reliability of the method. In the case of the present models the application of this algorithm in Torczon's (1991) variant has shown some advantages, but also essential disadvantages due to the slowness of the algorithm. The advantage is in the fact that it does not require the light-curve partial derivatives in the model parameters to be calculated. The algorithm calculates $\Sigma(O-C)^2$ in the parameter space for the vertices of the geometric figure called simplex. The simplex will be a triangle on a two-dimensional surface, a tetrahedron in a three-dimensional volume, etc. In general the simplex has one more vertex than the dimension of the parameter space in which it lies. The dimensions of the parameter space, within which the minimum $\Sigma(O-C)^2$ is looked for, are determined by the number of free model parameters. By means of the operations of contraction, expansion and reflexion the simplex moves through the parameter space guaranteeing the minimisation of $\Sigma(O-C)^2$. Finally it should contract down to a very small size surrounding the least-squares minimum. The model parameters corresponding to this minimum yield an optimal inverse-problem solution for the analysis of observations. By applying this algorithm one can carry out the organising of the observational-analysis programme relatively easy. Minimal corrections are needed in order to adapt the algorithm to the requirements of the particular models of CBs. However, this algorithm constructed to solve the inverse problem requires a long computer time being a serious disadvantage. The Marquardt one is by far more efficient. In the case of complicated models, like this, requiring a very long time for the synthetic generation of CB observables, the speed of carrying out the programme is very important. For other kinds of similar astrophysical problems, where the observations can be fitted with more simple models, because of the robustness and simplicity of application the Simplex algorithm is recommended.

4. CONCLUSION

The models proposed and the inverse-problem method enable one to estimate the basic orbital and physical parameters for a large number of active CBs. Therefore, they provide an important direction for the future research. By including the network of automatic telescopes used, above all, in photoelectric observations, the necessity of developing the computer models of CBs and methods for their analysing is increasing. This is a very dynamic research field, giving its contribution to the development of new observing programmes. In addition to photometry and line-of-sight velocities the radiation polarisation and the analysis of the photospheric-spectral-line profiles also become of interest. An adequately based procedure of spectral-line-profiles synthesis can allow the analysing of the effects affecting the spectral-line profiles due to the gas dynamics in the system and to the active-regions presence (dark or hot spots, accretion disk, etc). For the purpose of analysing these observations specialised models of CB systems are developing so that in this field a further progress is expected. Once a programme for synthesizing light curves of CB systems is formed, it can be generalised by means of certain improvements and modifications to become usable in a number of other problems. In these generalisations one has to endeavour to describe the considered problem with a number of free model parameters as low as possible in order to enable the solving of the inverse problem. The speed of the programme realisation is very essential. Only a sufficiently rapid programme, for generation of simulated observations, makes it possible for the inverse-problem solving to take a reasonable computer time.

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МОДЕЛИ АКТИВНИХ ТЕСНИХ ДВОЈНИХ СИСТЕМА (ТДС) И МЕТОДЕ ЗА ИНТЕРПРЕТАЦИЈУ ФОТОМЕТРИЈСКИХ ПОСМАТРАЊА

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Прегледни чланак

Битан напредак у астрофизици и теорији еволуције ТДС је отпочео око 1970, развојем компјутерских модела, који омогућавају синтезу кривих сјаја и кривих радијалних брзина. Ови физички засновани модели, базирани на Roche еквипотенцијалима, замењују традиционалне геометријске моделе. То доводи до битног напретка у тачности и ефикасности анализе посматрања, што омогућава боље сагледавање еволуције ТДС. Може се рећи да је напредак у шватању физичких процеса у ТДС, нераздвојно везан са развојем физичких модела за синтезу кривих сјаја и кривих радијалних брзина. Морфологија ТДС је проткана физичким моделима, специјализованим за анализу посматрања одређених типова ових система у разним фазама еволуционог развоја. Ако за одређени тип ТДС имамо адекватан, физички заснован модел, оптимизацијом његових параметара можемо постићи добро фитовање посматрања. Тако се могу реално проценити орбитални и физички параметри ТДС. Интерпретација посматрања се своди на два кључна проблема: прво треба развити адекватан модел за синтезу кривих сјаја или радијалних брзина (директан задатак), а затим, применом одговарајућег метода оптимизације проценити параметре, при којима изабрани модел најбоље фитује посматрања (обрнути задатак). Ови проблеми представљају изузетно активно поље рада. Тако се паралелно са развојем модела за синтетичко генерисање посматраних величина код ТДС, развијају и методе за решавање обрнутог задатка. Оне базирају на минимизацији суме квадрата одступања $\Sigma(O-C)^2$ између реалних посматрања и симулираних, која генерише модел. Данас се овај проблем решава применом методе диференцијалних корекција, градијентном методом, Simplex алгоритмом, понекад итеративном минимизацијом, методом контролисане претраге и Marquardt-овим алгоритмом.

Анализа посматрања еклипсних ТДС нуди готово јединствену могућност за процену орбиталних и физичких параметара система. Тако се добијају драгоцене информације о физичким особинама звезда на различитим стадијумима еволуције у ТДС. Богатство еволуционог сценарија у ТДС, доводи до развоја модела намењених интерпретацији посматрања одређених морфолошких типова система или специфичних врста активности у систему.

У овом прегледу је акценат стављен на моделима и методи интерпретације посматрања активних ТДС на којима је код нас рађено последњих година. За шири преглед активности у овој области у свету, препоручујемо изузетно лепо написан Wilson-ов (1994) позвани прегледни чланак.