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Memorie della

Concluding remarks

J.-P. Lasota[1,2]

[1] Institut d'Astrophysique de Paris, UMR 7095 CNRS, UPMC Univ Paris 06, 98bis Bd Arago, 75014 Paris, France. e-mail: lasota@iap.fr
[2] Astronomical Observatory, Jagiellonian University, ul. Orla 171, 30-244 Kraków, Poland

Abstract. Concluding remarks on the status of the Disc Instability Model.

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1. Introduction

My concluding remarks at the conference were devoted to the present status of the Disc Instability Model (DIM). The model is now 30 years old but my impression (confirmed by the present workshop) is that only a minority of astronomers working on CVs and related objects know what the model is about and what are its predictions. The best justification for this pessimistic statement are the persistent attempts to fit quiescent dwarf-nova spectra with stationary disc models and the often expressed bewilderment that such a procedure does not work (mercifully no references will be given). Recently, the general believe that SU UMa's superhumps are due to an eccentric deformation of the disc and the (less general) conviction that superoutbursts have something to do with this eccentricity have been challenged in an impressive series of articles by Smak (2009a,b,c,d, 2011) who at the same time proposed a new interpretation of the superhumps and argued in favour of the enhanced mass-transfer origin of superoutbursts. These papers have been almost universally ignored. Smak's argument and reasoning are serious and require a reaction. Positive or negative but one cannot continue writing papers on superhumps as if nothing has happened. That is why in my concluding remarks talk I advertised Smak's papers in an attempt to generate interest in this remarkable work.

Here, I will concentrate on other aspects of the DIM. Of course my concluding remarks are not a lecture on this model but I will shortly address some points I think are important to remind.

Send offprint requests to: J.-P. Lasota

2. What the DIM says and what it does not

The DIM has been mentioned several times at our conference. Sometimes observations were presented that were supposed not to follow the DIM, some other times observations presented were argued to clearly contradict this model. In my concluding remarks I tried to clarify what the DIM says, what are its predictions and how firm they are.

But first, let us see what the DIM should say, or rather what it should explain and reproduce. Fig. 1 shows several outbursts of SS

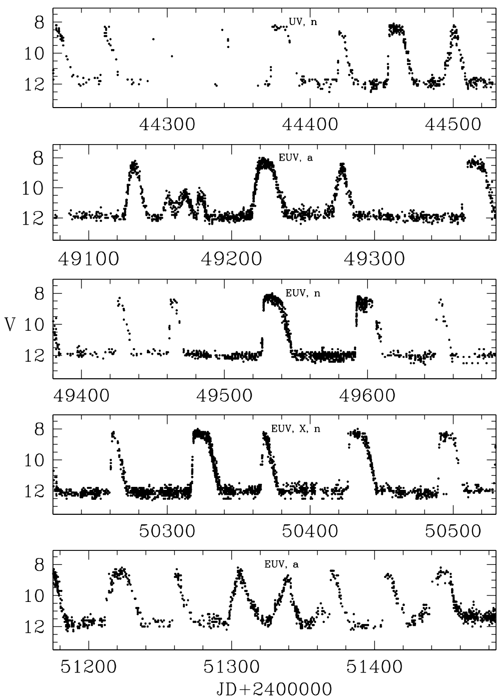

Fig. 1. Snapshots of the visual light curve of SS Cyg. The five panels show parts of the light curve including the outbursts for which observations in the UV, EUV, or X-ray range exist. Outbursts called normal (anomalous) are marked with n (a). The data have been taken from the AFOEV. (Schreiber et al. 2003)

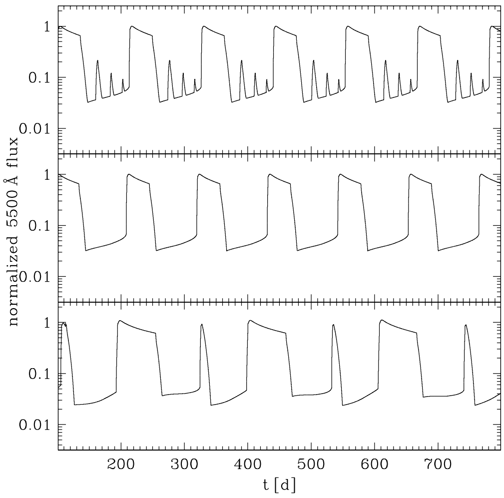

Fig. 2. Calculated long term light curves. From top to bottom: without truncation, with truncation, and finally with truncation and assuming that the mass transfer rate varies slightly and smoothly.(Schreiber et al. 2003)

Cyg. Let us assume that the parallax distance of 166 pc is wrong and the SS Cyg is a dwarf nova. It look so much like one and is the brightest and best observed of all. The figure shows clearly that the outburst cycle is quite complicated with at least three types of normal outbursts (long, short and symmetric – sometimes with a flat top, sometimes without – known as anomalous), one occurrence of lower amplitude "cycling" activity and a sequence of anomalous outbursts with no quiescent phase between them.

The standard DIM, with the assumed constant mass-transfer rate and the disc extending down to the white-dwarf surface cannot reproduce the observed outburst cycle of SS Cyg. Fig. 2 shows the results of using the DIM to reproduce SS the Cyg lightcurve (Schreiber et al. 2003). Only inner truncation and mass-transfer modulation gives something resembling the short and long outbursts. No anomalous outbursts appear but one could be tempted to identify the small "reflare" outbursts in the upper panel with those observed in the real system. Since, however, they are obliterated by irradiation by the hot white dwarf the physics of such an identification is rather doubtful. This is a constant problem with the DIM: by modifying parameters or adding free functions one can reproduce a large class of outbursts but in most cases such procedure is not very satisfactory because of lack of physical interpretation. Therefore even in the simplest case of normal outbursts (no superoutbursts) one has to add ingredients such as disc truncation and mass-transfer modulations if one wishes to reproduce the observed behaviour of dwarf novae. One should also notice that in the model light-curve the quiescent flux increases with time while it is observed to be constant in the real object. Part of this increase can be masked by adding the light of the secondary and primary stars but in general this discrepancy be-

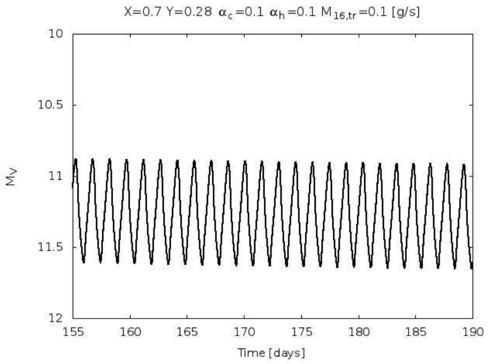

Fig. 3. Disc outburst for α constant in time, i.e. the same in quiescence and outburst (Curtesy of Iwona Kotko).

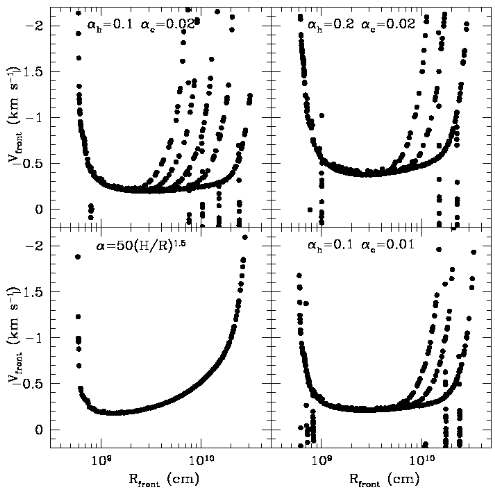

Fig. 4. Speed of successive cooling fronts in four models with various α-prescriptions. Cooling quickly converge to an asymptotic speed (in a given model) as they propagate inward (Menou et al. 1999).

tween the model and observations persists and is an unsolved problem. As is quiescence in general[1].

3. The α problem

A well known problem of the DIM is the ad hoc change of the viscosity parameter α necessary to allow production of something that would look like a dwarf nova outburst. Figure 3 shows a light-curve with α assumed to be constant. Clearly this is not what we are looking for. Interestingly the required α "jump" might depend on the disc's chemical composition (see Kotko - these volume). Since the MRI calculations reputed to simulate Keplerian discs turbulent "viscosity" produce values of α too low by an order of magnitude and no jump of this parameter during temperature rapid changes, the question about the influence (if any) of the chemical composition on the viscosity parameter must be left unasked.

4. Fronts

A lot has been written about heating and cooling fronts in the DIM. As I mentioned in contribution in this volume, contrary to a widespread belief cooling front do not govern the decay from maximum but rather extinguish the ambers left after the outburst and only in the final stage of the eruption they extinguish the outburst itself. As seen in Fig. 4, in the case of a two-valued α-prescription, after a rapid initial deceleration, cooling fronts reach constant velocity that is slightly lower than the viscous velocity in the hot disc. Only when cooling fronts approach the inner disc edge they accelerate and overcome the viscous decay. In the case of α varying with the disc's aspect ratio, the deceleration is less rapid and front might not reach a constant value. The rapid deceleration of the cooling fronts at their outset are a strong prediction of the DIM. The detection of this characteristic would provide a strong evidence that the DIM operates in accretion discs (Menou et al. 1999).

5. Finale

I have presented a rather pessimistic view of the research on outbursts in binary systems. I think that not enough people are interested in

[1] My comment (Lasota 2001): "The Achilles heel of the DIM is quiescence" has gained some notoriety and is often quoted

this subject as well as in the CVs and related objects in general. In addition, too many researchers working in the subject take too many things for granted.

It was therefore a great idea to organize the "Golden Age" conference in such a magnificent setting and have people meet, listen to talks and discuss. Let us hope that it contributed to the progress in the field. For that we are all grateful to Franco and Lola. Molte grazie!

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