DETECTING STRUCTURAL TRANSFORMATIONS AND FLARES ACTIVITY IN BINARY STARS WITH A COOL COMPANION

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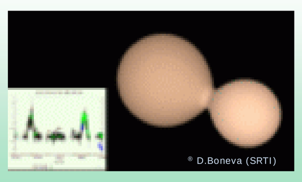

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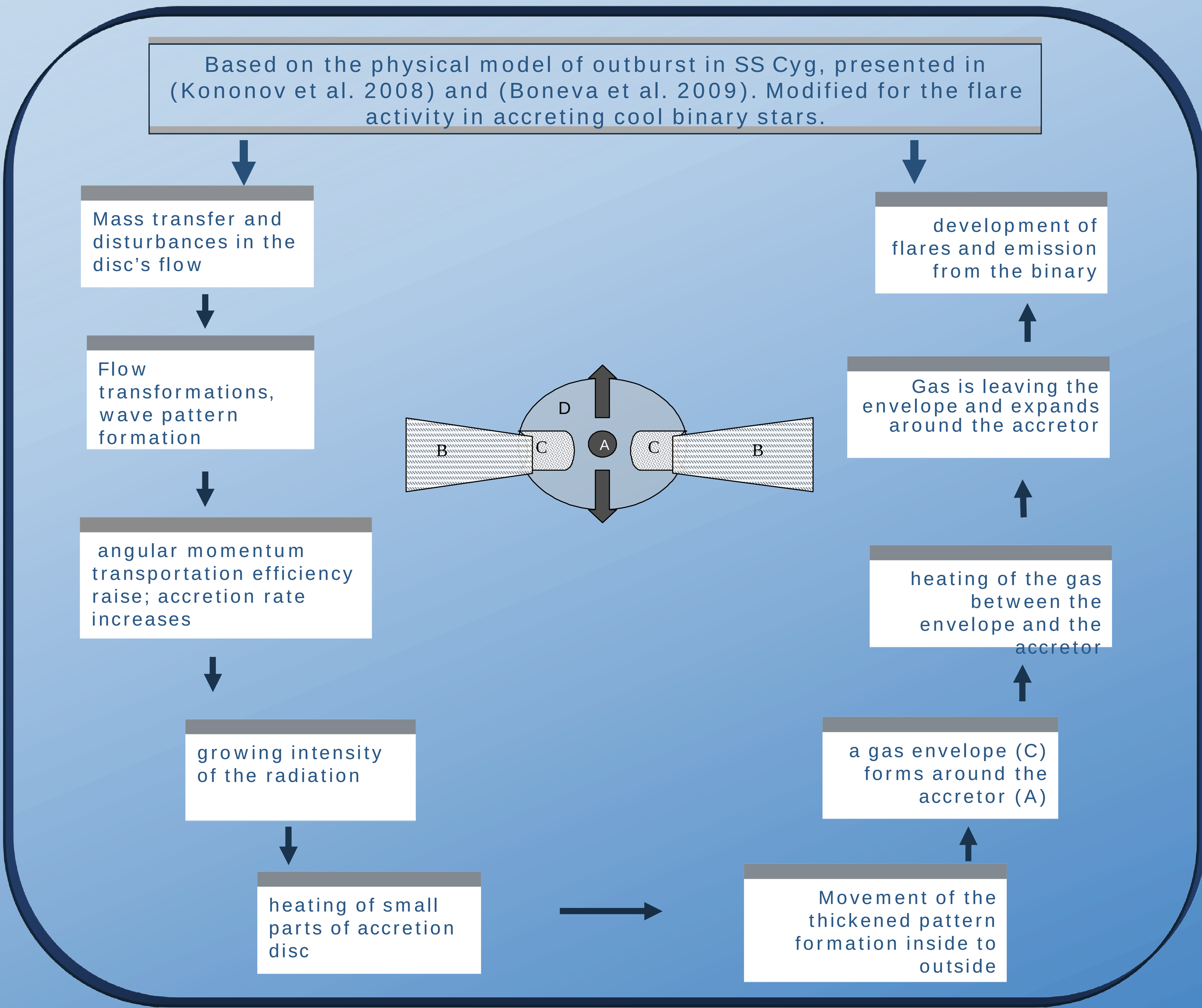
INTRODUCTION AND THE PROBLEM BACKGROUND

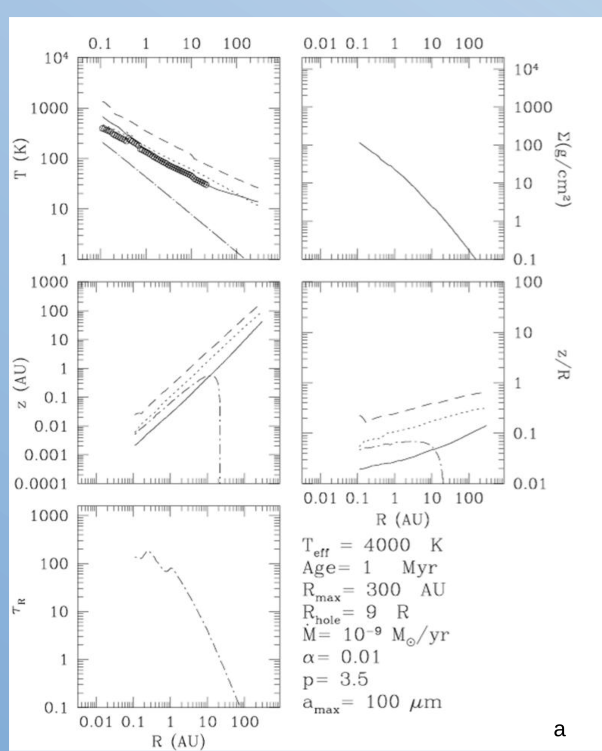
We investigate the flow's structure properties due to the mass transfer in binaries with a cool star. We study a possibility of activating flickerings and flares, in this kind of stars, in the result of dynamically unstable physical processes during the mass transfer between the components. A non-stable accretion disc configuration is then considerable. The relationship "flares – structure transformation" is established. We present a development of pattern formations throughout the binaries' connecting stream by the flow's fluctuations. We employ numerical computations and suggest a modeling of the flow's structure transformations. The observational data of two binaries are included into the calculations to analyse the quasi-periodic variability in the luminosity.

Variations in brightness that could be appeared in a stochastic way on timescales of a few minutes with amplitude of a few 0.1 magnitudes are studied. We should distinguish the events "flickering" and "flares", since they are with different amplitudes. Then the "flickering" with a small amplitude, continuous variations and the term "flaring" for larger scale events. Recently, it is widely accepted that the high-frequency or small-scale fluctuations could arise as a result of instability in the accreting flow and a gas-dynamics source exists for each of these processes. The idea was proposed by Osaki (1989), who has investigated the superoutbursts of the SU UMa systems and suggested that tidal instabilities give rise to them. Patterson (1981) also found the association of flickerings with the inner disc's part. Hameury and Lasota (2014) found that the light anomalous is reproduced by assuming the time profile of the mass transfer rate from the secondary.



RESULTS

Discs structure models around the cool component. Based on the models of D'Alessio et al. (2004) and Merin B. et al. (2004)



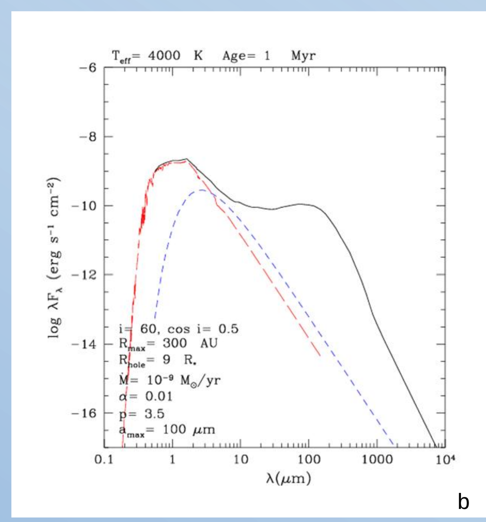


Figure 1.

Disc model for cool objects with different values of Teff (Temperature) and Rhole (Inner radius of the disc).

The plots show (Figs. 1a, 1b) changes in values of temperature, surface density, heights, ratios of heights over radius and the Rosseland mean opacity with variations of disc radius.

Spectral Energy Distribution for two different values of Teff (Temperature) and Rhole (Inner radius of the disc). In the plots we can see (Figs. 1b, 2b):

* The model flux in ergs/cm^2/s^1 against wavelength in micron in thin black line.
* The model flux for the central star in dashed red line. It illustrates the emission from the star.

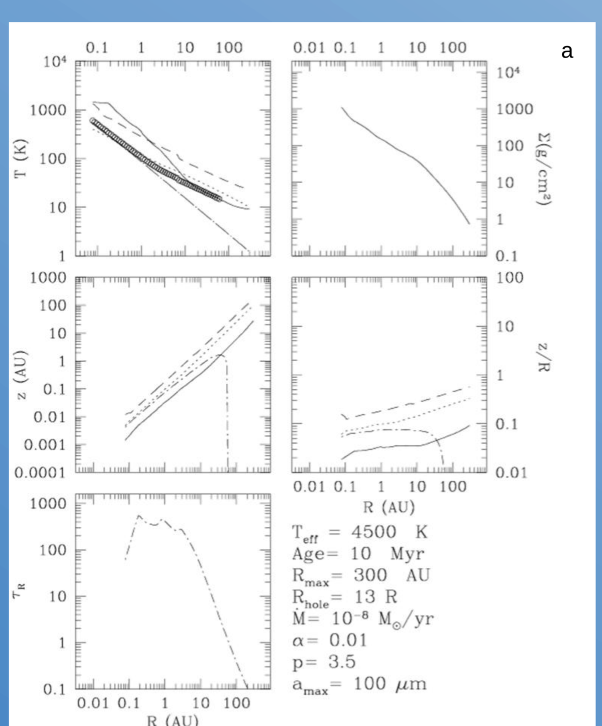
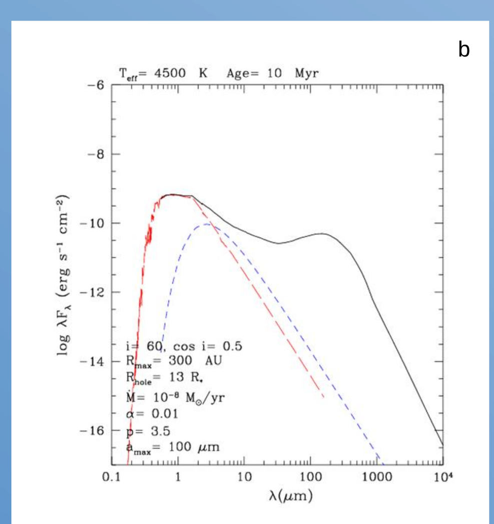
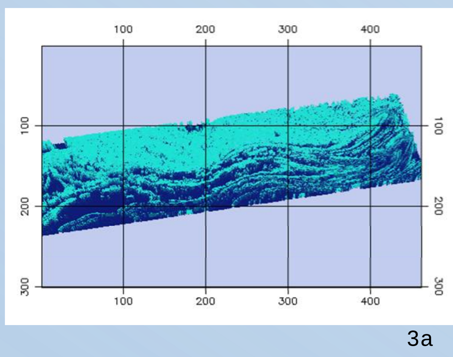


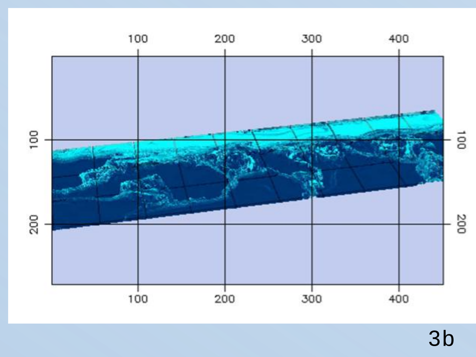
Figure 2



Flow structure in quiescence



Flow structure in active states



Results of gas-dynamical calculations. Figures show the flow conditions in the state of quiescence, where the flow is laminar and calm (Fig. 3a) and during the increasing rate of mass transfer in a binary and the corresponding activity of flares are observed (Fig. 3b). The box-frames visualize a covered range of about a size that is equivalent to the calculation area.

A development of small-scale vortical formations could be an effective mechanism able to sufficiently increase the accretion rate on a time scale typical to the duration of flare-ups.

A comparison with CVs flow structure in active states

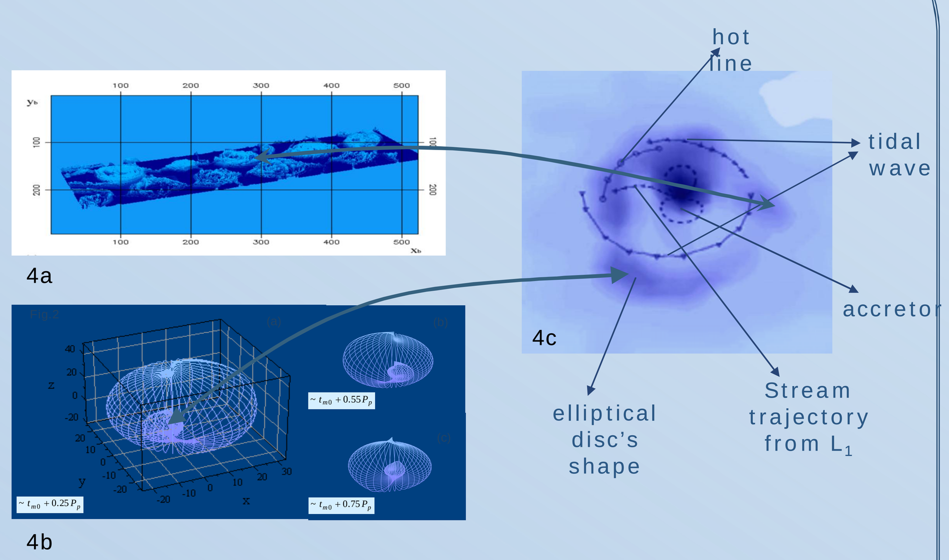
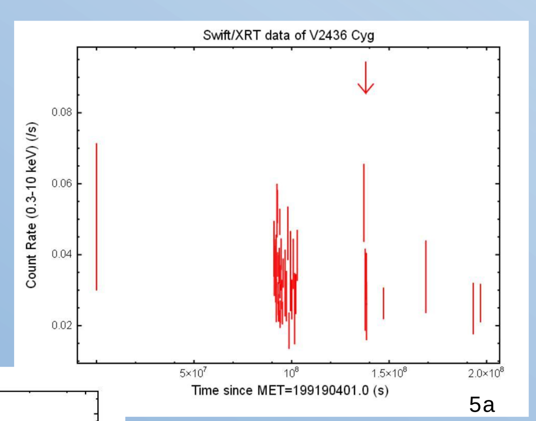
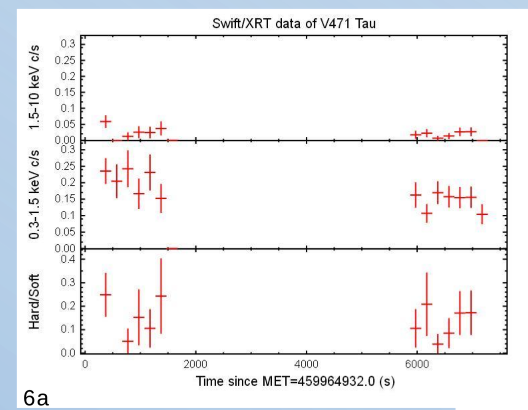


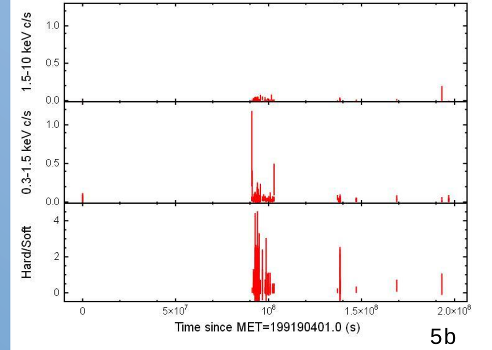
Figure 4b

The flow structure during the outburst in CV. A result from the Doppler tomogram with superposed flow elements inferred from the numerical simulations (Fig.4c). This includes: Vortical-like wave patterns may propagate throughout the disc, along the outer sides (Fig4a.). Consecutive phases of rotation of the thickened zone formation (the light blue spot, inside of the calculation area), as a result of disturbances in the stability state, caused by mass transfer in a binary system (Fig.4b).

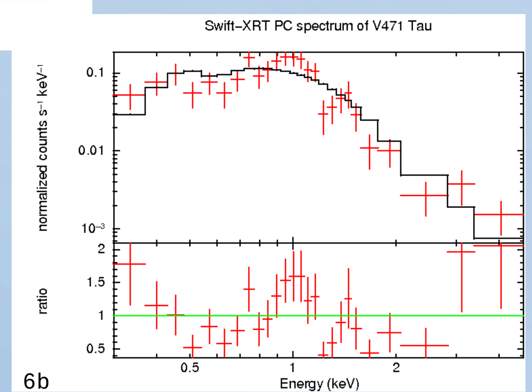
Observations of flares in cool binaries and their energy spectrum







Indications of activity states at the light curves of V2438 Cyg (Fig. 5a, 5b) and V471 Tau (Fig. 6a), and the corresponding energy spectrum (Fig. 6b). The objects are binary systems with a cool star of spectral type K (*SIMBAD objects*). Swift-XRT light curves (Swift-XRT generator) detect flare-ups with small magnitude's variations. The count rates in the energy spectrum are active for the most part at low ranges. The observed Flux of V471 Tau at (0.3^{-10} keV) is 3.6 (+0.4, -0.4) × 10^{-12} erg cm^{-2} s^{-1}.



Concluding points

- The results reveal flow structure transformation properties and their relation to the observational events as the quasi-periodic variability in the luminosity.
- It is shown the flow dynamics during the development even the weak flare's activity in the selected cool binaries.
- According to the light curves profiles, the presence of flares is detected at the above 2 binaries.
- Each of the events, which we have identified as flares, have a characteristic stellar flare profile.

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