Structures and instabilities in accretion discs in the close binary stars systems

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Структури и неустойчивости в акреционни дискове в тесни двойни звездни системи

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(Анотация на дисертация за образователна и научна степен "Доктор")

The theory of the accretion discs takes a central place in the modern astrophysics. The more than a half part of the stars are dynamically bounded with the companion. Binary stars are natural place, where there are conditions of matter accretion through the components. Way of mass transfer and the type of accretion flow could determine the evolution of the binary star components. The accretion material under the influence of mass transfer could have enough angular momentum to form an accretion disc.

Examinations in this survey are concerned on the studying of possible angular momentum transport mechanisms in accretion discs, which is of importance of their existence. This process is still not completely studied. The most effective mechanisms are considered to be: turbulence, wave effects and vortices, which arising and development are the base examinations in the work.

The aim of this thesis is the exploration of the dynamics of accretion material flow in the close binary star systems through the application of theoretical and observational methods by which to confirm and to give physical explanation of the emergence of instability in the flow, turbulence activity, wave processes and forming structures.

It is studied the morphology of the flow in the region of tidal interaction of the stream, coming from the donor star through the inner Lagrange point into the accretor star, with the area of the disc and circum-disc halo. Numerical gas-dynamical methods are applied for the decision of the problem. The results show the existence of shock waves: "hot line" and one-arm's or two-arm's spiral shock wave. The presence of the instability development gives rise to vortex structures, which are local formations on the disc and enforce the transport of angular momentum.

Studying of the accretion disc structure in the binary stars by numerical methods gives a proof that the gravitational effect of the second component may cause the development of spiral shock waves.

It is applied the methods of bifurcation analysis to investigate the transitions through the states of stability and instability, which are an expression of spatial-temporal structure's formation. It is carried out an equation of the "reaction - diffusion" type, which connect the process of angular momentum transportation and the established structure in the disc.

The structures in the accretion discs couldn't be observed directly. In this reason we receive information from the results of indirectly observed methods.

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We apply in our research the technique of the Doppler tomography. By using of observational data it is analyzed the spectrum of cataclysmic variable binary star SS Cygnus in active state. It is constructed Doppler tomograms for the $H\alpha, H\beta and H\gamma$ lines, which give the true picture of the structures of the accretion flow elements. The existence of the "hot line" and spiral shock waves is clearly seen in these images. In such way, the observational analysis confirms the results of the theoretical investigations in this thesis.

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