MHD EFFECTS IN DEVELOPMENT OF THE ACCRETION FLOW

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Keywords: *accretion, advection, MHD model*

Abstract:*: Accretion is quantitatively and qualitatively more efficient in the presence of a magnetic field, since appeared more quickly and develop more diverse type instabilities.*

In series of papers we have developed MHD model of non-stationary accretion disc. Studying the structure of the accretion flow in magnetic flux by constructing phenomenological models to interpret the observations, allows to obtain information about the physical processes in the object.

Numerical modeling of the disks in the CBS and AGNs for investigation the influence of the magnetic field of accretion process will allow the construction of an adequate addition to the developing model for magnetized advective disk and so we will have a instrument for complete analysis of the development of the system disk – corona.

МХД ЕФЕКТИ В РАЗВИТИЕТО НА АКРЕЦИОННИЯТ ПОТОК

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Ключови думи : *акреция , адвекция , МХД модел*

Резюме: *Акрецията е количествено и качествено по- ефективна в присъствието на магнитно поле , появяват се по-бързо и се развиват по-разнообразни типове нестабилност.*

В поредица от статии ние сме разработили МХД модел на нестационарен акреционен диск. Проучването на структурирането на акреционното течение в магнитен поток , чрез изграждане на феноменологични модели за интерпретация на наблюденията , позволява да се получи информация за физическите процеси в обекта.

Числено моделиране на дисковете в CBS и AGNs за изследване на влиянието на магнитното поле на процеса на акреция ще позволи изграждането на адекватно допълнение към разработвания модел за магнетизирания адвективен диск и така ще имаме инструмент за пълен анализ на развитието на системата диск - корона .

Introduction

In a series of articles we built a model of non-stationary accretion disk, which evolving in the terms of the magnetic field. In the accretion disk in the process of evolution to create the conditions for the emergence of other major components - corona and jets [6], which are genetically related to him. Each of these mega- structures has its own energetics, which is part of the total, but in some objects can be autonomous for the subsystem. This is important because the equation of balance of energy in research object, whose expression in this case is the heat balance (HB), looks different in both cases.

When modelling the system disk - corona with total energetics, the corona is directly affected by disk's balance and the HB is represented by an equation or a system of two closely related equations, which cannot be seen individually.

When modelling the system disk - corona with individual energetics, this means that HB in the corona is influenced indirectly by the distributions of leading parameters on limit of the disk from disk's balance and then each component has its own heat balance, which can be considered individually.

Magnetic field effects over flow

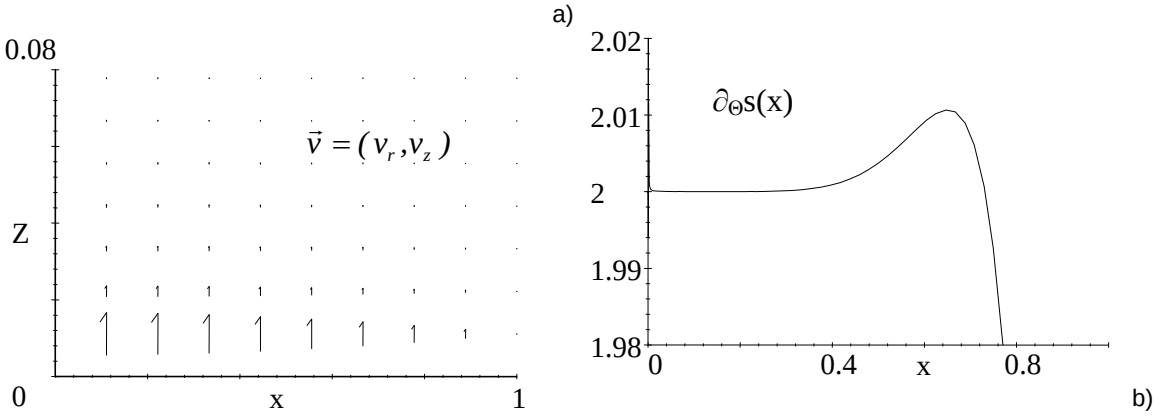
- For rotating stars with magnetic field electrodynamics force plays the role of the flow collimator [9], concentrated the flow in the equatorial plane.
- The case of spherical accretion is realized only if the magnetic star is not rotating.
- Efficiency of the accretion varies from 10% for spherical to 30% for the disc accretion, by mass at rest of the material. The interaction of the disc with the magnetic field increases the efficiency to 50%.
- The interaction of the field with the plasma creates conditions for the occurrence of corona.

Advective hypothesis – advective term

- We developed new model for MHD of accretion disk based on our specific advective hypothesis.
- Most authors of advection [1-3, 6, 8] in its proceedings suggest some deformation of the flow - in the form of rotation of the velocity vector or orbital advection [5].
- In contrast to these models we provide advection in the form of full advective term, naturally produced in the equations describing the dynamics of the flow.

(1)
$$\frac{\partial(\rho v_i)}{\partial t}+\frac{\partial}{\partial x_j}(\rho v_i v_j)=\rho\left(\frac{\partial v_i}{\partial t}+v_j\frac{\partial v_i}{\partial x_j}\right)=\rho\frac{Dv_i}{Dt}$$

- In this type of advective term shows that no individual variation of some components of the velocity, but total shift of middle stream, with speed v_i in some direction.
- In our considerations advection is not the dominant mechanism and therefore has no atypical deformations of the stream. The general interpretation is that the decision as a whole is transferred to smaller radii.
- For the dipole field normal to the disc plane, the term $B_r B_\varphi$ in equation of motion leads to radial advection [4] - that determines the direction of shift of middle stream uniquely.
- Based on feedback of the instabilities with physical characteristics of the stream we introduced modification in major perimeters, which retains the non-linearity of the investigated processes.
- Obtained as a result in the local model, math expression of the direct relationship of the instabilities with energetics disc, gives fullness to development of our concept.
- Based on the results of self-structuring in the hot advective disk [7] and their interpretation (fig.1, 2), we conclude that he developed a magnetic corona.



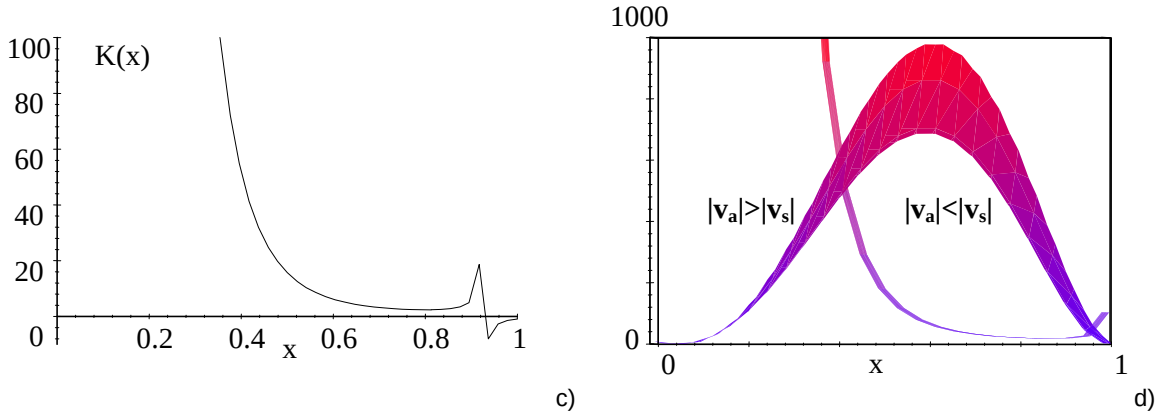


Figure 1: a) The velocity vector field is unidirectional; b) gradient of the entropy in the inner disk's regions is negative; c) the local warming there, surpasses the equilibrium value 1; d) and the condition of stratification is impaired in the same areas.

- The model allows us to: observe the evolution of the disc; investigate the emergence of instability in it; study the generation of its corona.
- The model is complete but open to future numerical modeling.

Observations

The presence of corona in observations registers from periodic replacement of hard and soft x-rays in the spectrum of the source.

The source Cyg X-1 is a close binary system, there thermal radiation from the standard disk with a maximum temperature of 10^5-10^7K, but therein are registered T_e~ 10^9K in the inner regions – corona.

Microlenses are suitable for the study of the compact region in the nuclei of galaxies. Passage of the microlens helps detailed investigated of the rotation of the disks and mapping those areas with high effective temperatures and non-thermal radiation. Quasars there are hot virial discs with $T>10^{7\sim9}$K and corona with $T>5.10^{11\sim12}$K.

Questions

How the corona was born in the absence of vertical convection?

Is it possible vertical convection can be substituted only by the Parker and Rayleigh-Taylor instabilities or there is something else?

How much Compton scattering in the innermost regions of the disk supports the process of formation of the corona?

Future

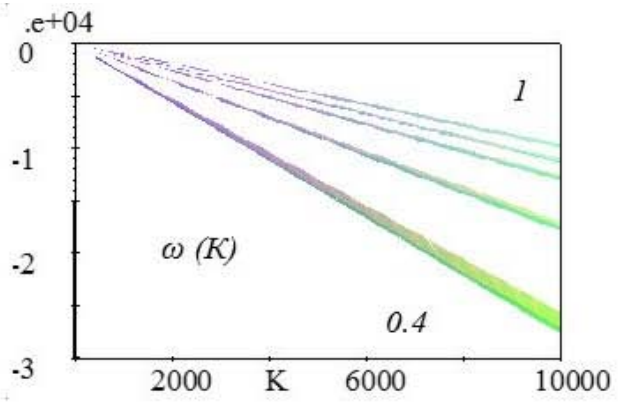
- To answer these questions in the future we can be applied developed model to a large number of sources, divided into groups with similar physical parameters and characteristics.
- Furthermore, the model opens up opportunities for the construction of naturally addition in the vertical direction, model which is suitable for describing the disk corona.
- By suitably selected initial condition of the surface of the disc we can be sewed decision even in the case when with the corona they not sharing energetics.

Conclusion

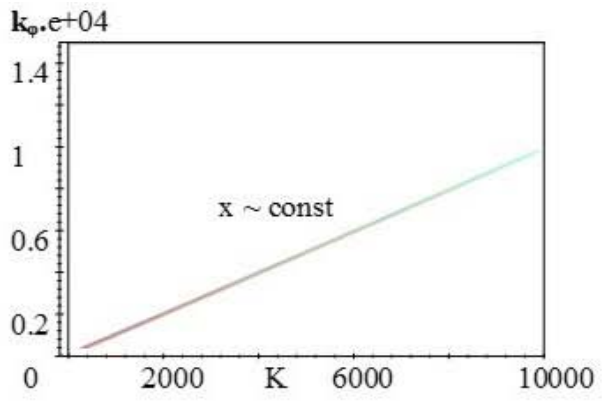
In conclusion we should note that the discussed method has the following important advantage: equations remain nonlinear; but has not yet been fully studied whether it is applicable in the new conditions:

Do we have significant changes in the approach; because restriction $v^2/c^2 \sim 4.10^{-2} << 1$ shall not act Newtonian approximation in the conditions of corona is not applicable.

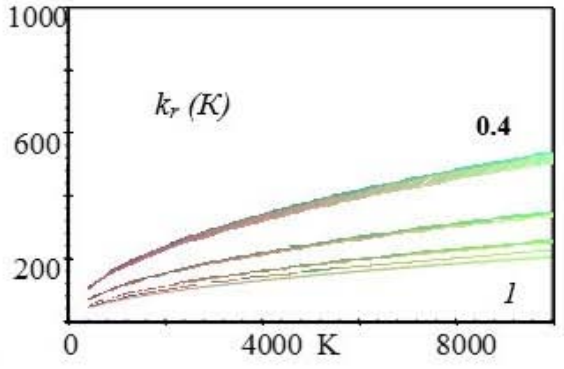
At the same time the density falling sharply and we can no more ignored quantum effects in radiative process.



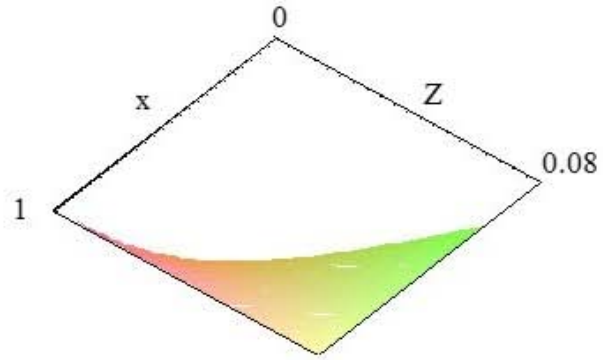
Profiles $\omega(K)$ for $x=1;0.9;\ 0.8;\ 0.6;\ 0.4$.



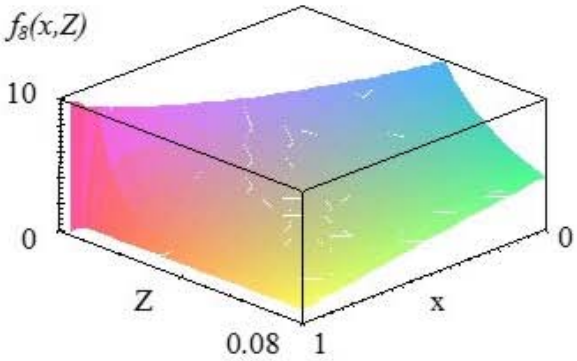
Profiles $k_\varphi(K)$ for x=const.



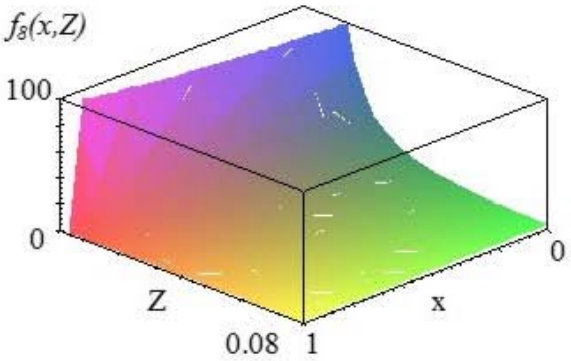
Profiles $k_r(K)$ for x=1;0.9; 0.8; 0.6; 0.4.



Distribution $\boldsymbol{\omega}(x,Z)$ for the moment $t \sim 1P$.



Distribution $k_\varphi(x,Z)$ for the moment t ~ 1P.



Distribution $k_\varphi(x,Z)$ for the moment t ~ 1P.

fig.2

Figure 2: The independent confirmation – profiles of wave numbers shows an increase in the number of MRI, but the distributions of the coefficients shows decreases their presence in the disk.

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