INFLUENCE OF THE MAGNETIC FIELD OF THE COMPACT OBJECT ON THE ACCRETION DISK – RESULTS

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***Abstract**:*

In this paper we will show our results. We consider the development of accretion flow and its interaction with the field of the star. We discuss the appear and the behavior of the instabilities.

Introduction

In the first part is construct non-stationary, non-axisymmetric, one-temperature MHD model of Keplerian accretion disk with advection in the normal dipole magnetic field of the central object. We used cylindrical co-ordinates (r, φ, z**;** t). Present is the mass continuity, magnetic flux conservation, equation of motion, angular momentum conservation, hydrostatic balance, the three components of magnetic induction, heat balance and using approximations. System is prepared for computer treating. Here we will see and comment obtaining analytic solution. The results show open view only along r, because we assume periodical dependencies for variables φ and t with coefficients depended from r .

Results and interpretation

System is non-linear and we solved with iterations. Second step is appropriate approximation for the system:

(1) $f_1(x) = \frac{4+c_2}{6x^6} + \frac{1+c_1+c_3}{x^{15/2}}\left[1-(x-x_g)\right] + \frac{2-c_2}{6}$

(2) $f_2(x) = (c_2+4)(x-1)+1$

$$f_3(x) = \frac{c_6}{7}x^7 + \frac{x^3}{3}\left(c_7 - \frac{(3+c_2)}{2}c_5\right) - \frac{(3+c_2)}{6x^3} -$$

(3) $$-\frac{1}{2}c_5(1+c_1+c_3)x^{3/2}(x-x_g-1)+$$

$$+\frac{1+c_1+c_3}{2x^{9/2}}(x-x_g-1)+1-\frac{c_6}{7}-\frac{c_7}{3}+\frac{(3+c_2)(1+c_5)}{6}$$

(4) $$f_4(x) = (1-c_{13}-c_{14})x^2 + \frac{c_{13}}{x^6} + c_{14}(x-x_g)$$

(5) $$f_5(x) = \frac{1+c_4}{x} - c_4$$

(6)

$$f_6(x) = -\frac{c_{10}x^2}{2c_9} - (x-1) - \frac{c_8}{2c_9x^{7/2}} - \left(\frac{3c_8}{2c_9} - \frac{1}{c_9}\right)\frac{1}{x^{9/2}} + \frac{1+c_1}{2c_9x^5} + \frac{2\alpha c_{11}}{c_9x^{11/2}} +$$

$$+\frac{9\alpha c_{11}}{4c_9x^{13/2}} + \frac{\alpha c_{12}}{c_9x^{17/2}} + \left[\left(\frac{3c_8}{2c_9} - \frac{1}{c_9}\right)\frac{1}{x^{9/2}} - \frac{9\alpha c_{11}}{4c_9x^{13/2}} - \frac{\alpha c_{12}}{c_9x^{17/2}}\right](x-x_g) +$$

$$+\left[\frac{c_8}{2c_9x^{7/2}} - \frac{2\alpha c_{11}}{3c_9x^{9/2}} - \frac{1+c_1}{2c_9x^5} - \frac{2\alpha c_{11}}{c_9x^{11/2}}\right]\frac{1}{(x-x_g)} + \frac{2\alpha c_{11}}{3c_9x^{9/2}}\frac{1}{(x-x_g)^2} + \frac{2c_9 - c_{10}}{2c_9}$$

(7)

$$f_7(x) = -\frac{c_2+4}{c_1x} + \frac{c_{16}+c_{12}}{c_1x^5} + \left[-\left(\frac{c_3}{2c_4} + c_3\right)\frac{1}{c_1x^{3/2}} + \frac{c_{17}}{c_1x^{9/2}}\right]\frac{1}{x-x_g} -$$

$$-\frac{c_3}{c_4c_1x^{1/2}}\frac{1}{(x-x_g)^2} + 1 - \frac{c_{17}}{c_1} + \frac{c_3}{c_1} + \frac{c_2+4}{c_1} - \frac{c_{16}+c_{12}}{c_1} + \frac{3c_3}{2c_4c_1}$$

(8)

$$f_8(x) = \frac{c_{15}x^2}{2c_4c_{11}} + \frac{c_4+1}{c_4c_{11}}x - \frac{1}{c_4x} - \frac{c_{16}+c_{12}}{3c_4c_{11}x^3} - \frac{1+c_1+c_3}{c_4c_{11}x^{1/2}}(x-x_g-1) +$$

$$+1 - \frac{c_{15}}{2c_4c_{11}} - \frac{c_4+1}{c_4c_{11}} + \frac{1}{c_4} + \frac{c_{16}+c_{12}}{3c_4c_{11}}$$

Where $f_1(x)$, $f_2(x)$, $f_3(x)$, $f_4(x)$, $f_5(x)$, $f_6(x)$, $f_7(x)$, $f_8(x)$ is corresponding of parameters ρ, v_r, v_s, H, B_r, B_φ, ω, k_φ, and c_i is constants.

Then if we compare $f_5(x)$ with $f_6(x)$ (fig.1) :

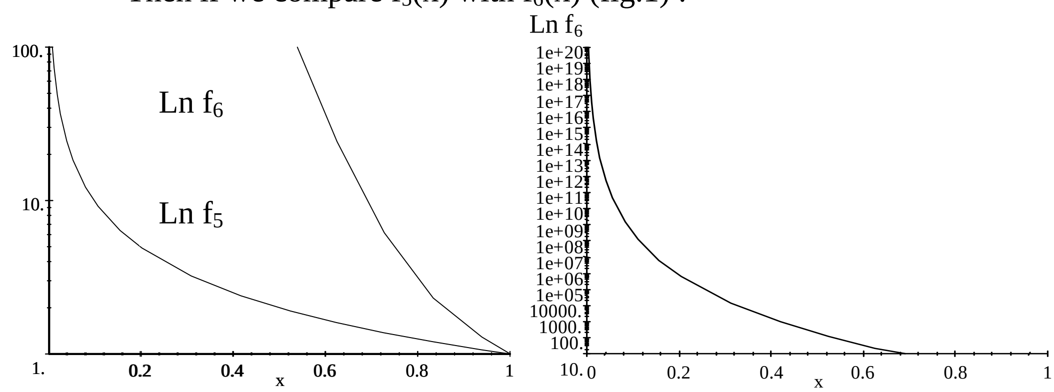

Fig.1

We can see that $f_6(x)$ increase very faster from $f_5(x)$. That is precondition $B_\varphi > B_r$ for all disk and magnetosphere. And because Br intensification MHD turbulence and Bφ repress it [6], we have (Q_{mag} / Q^+) <1 for all disk. This indicate that disk attain to central object and does not destroy in magnetosphere.

We can see also, that $f_2(x)$ decrease (fig.2):

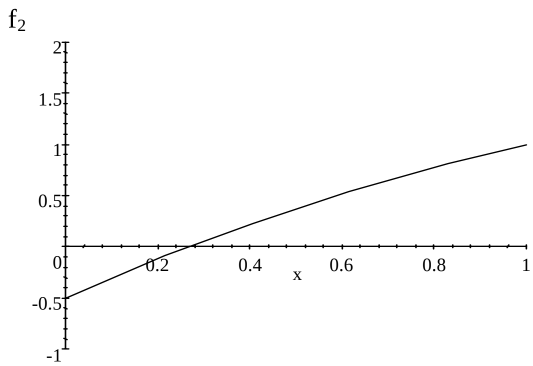

Fig.2

That is connect with delayed of the flow from magnetic field, which is a reason the plasma going off through equatorial window and may accreting.

Conclusions

In this paper we obtain dimensionless parameters of magnetic disk and coefficients of periodical dependencies from φ and t , k_φ and ω, corresponding from dimensionless variable for distance x. We showed, that magnetic dissipation is not surpass viscosity dissipation. This permit on the flow to stay thin , to run to most inner region and to accreting over object without the disk to destroy.

We see that v_r and v_s go down inward to the centre as a result from powerful field. Dipole field transfer basic part of angular moment inward to star, what accelerate the rotation and intensify the field. v_s decrease faster from v_r, that denote supersonic accretion and sonic waves along r, too.

v_a for difference from v_r and v_s grow up very fast. We know that:

1. for $v_s >> v_a$: v_s fast and v_a slow alfenic magneto-sonic waves is appear in fluid;
2. $v_s << v_a$: v_s slow sonic and v_a fast magneto-sonic waves [7],

for us in outer edge $v_{s0} >> v_{a0}$. Jump in v_a from rotation $\pm$ v_a generate fast sonic, slow alfenic and slow magnetic shock waves – magnetic turbulence.

ω, k_φ grow up very fast, too. That means in inner region MRI is most effective and exalting with time, or with other words the disk proceed to new steady state with forming of structure. This transition is irreversible.

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