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НОВЫЕ КВАЗИ-ИЗОТЕРМИЧЕСКИЕ МОДЕЛИ ГАЛАКТИК

New Quasi-Isothermal Models of Galaxies

Abstract. В данной работе предлагается новое семейство ротационно-симметричных моделей распределения масс в гравитирующих звездных системах. Рассматривается квази-изотермический потенциал, и для него строится модель по схеме, предложенной Г.Г. Кузминым. Для такого потенциала существует третий квадратичный по скоростям интеграл движения, объясняющий наблюдаемую трёхосность распределения скоростей.

Constructing analytical model of mass distribution in stellar systems is necessary for solving many problems of Galactic Dynamics. In this paper model with Stäckel's type potential is proposed. For this potential there is quadratic by the velocity integral of motion. The expression of density, equidensities and graphs of density ran in equatorial plane is given.

In the equatorial plane the potential for the considered family has the following form:

$$\Phi = \Phi_0 \ln\left(1 + \frac{\beta}{w(R)}\right), \tag{1}$$

where R is the cylindrical radius, Φ_0 is the central potential, $\beta \in [0, +\infty)$ is the structural parameter, and function $w(R)$ is defined as

$$w^2(R) = 1 + \kappa^2 R^2, \qquad \kappa^2 = O(\beta^2).$$

Such a potential was proposed by G.G. Kuzmin, Ü.-I.K. Veltmann and P.L. Tenjes P(Publ. Tartu Observ., 1986, **232**, 380).

Theory of constructing models with Stäckel's type potentials was developed by G.G. Kuzmin (AZh, 1956, **27**, 245). At first it is necessary to find such function $\phi(\xi)$ that potential in elliptic coordinates $\xi_1 \in [1, \infty)$, $\xi_2 \in [-1, 1]$ has the form:

$$\Phi = \frac{\phi(\xi_1) - \phi(\xi_2)}{\xi_1^2 - \xi_2^2}. \tag{2}$$

Cylindrical coordinates R,z are connected with ξ_1, ξ_2 by relations

$$R = z_0\sqrt{\left(\xi_1^2 - 1\right)\left(1 - \xi_2^2\right)}, \qquad z = z_0\xi_1\xi_2 \tag{3}$$

For quasi-isothermal potential it is easy to see that

$$\phi(\xi) = \xi^2\Phi_0 \ln\left(1 + \frac{\beta}{\sqrt{1 + \kappa^2 z_0^2(\xi^2 - 1)}}\right). \tag{4}$$

Then, the expression for spatral density is given by the formula proposed by G.G.Kuzmin (Publ. Tartu Observ., 1952, **332**, 385). After some calculation we obtain that

$$4\pi G\rho(\xi_1,\xi_2)=\Phi_0\left(\frac{-2\dfrac{\Phi}{\Phi_0}(2-\xi_1^2-\xi_2^2)+\mu(\xi_1)+\mu(\xi_2)}{(\xi_1^2-\xi_2^2)^2}+2\frac{\big(\nu(\xi_1)-\nu(\xi_2)\big)(2-\xi_1^2-\xi_2^2)}{(\xi_1^2-\xi_2^2)^3}\right), \quad (5)$$

where $\Phi=\Phi(\xi_1,\xi_2)$ and

$$\mu(\xi)=(\xi^2-1)\left(2\ln\left(1+\frac{\beta}{\sqrt{1+\kappa^2 z_0^2(\xi^2-1)}}\right)-\right.$$

$$-\frac{5\xi^2\beta\kappa^2 z_0^2(1-\kappa^2 z_0^2)-2\xi^4\beta\kappa^4 z_0^4}{\big(1+\kappa^2 z_0^2(\xi^2-1)\big)^{5/2}\left(1+\dfrac{\beta}{\sqrt{1+\kappa^2 z_0^2(\xi^2-1)}}\right)}-$$

$$\left.-\frac{\xi^4\beta^2\kappa^4 z_0^4}{\big(1+\kappa^2 z_0^2(\xi^2-1)\big)^{3}\left(1+\dfrac{\beta}{\sqrt{1+\kappa^2 z_0^2(\xi^2-1)}}\right)^2}\right),$$

$$\nu(\xi)=\frac{\xi^4\beta\kappa^2 z_0^2}{\big(1+\kappa^2 z_0^2(\xi^2-1)\big)^{3/2}\left(1+\dfrac{\beta}{\sqrt{1+\kappa^2 z_0^2(\xi^2-1)}}\right)}\,. \quad (6)$$

This family of models depends on two structural parameters: z_0 and β. The first parameter influences the flatness ($z_0=0$ for spherical system), β governs the radial structure of the system.

Equidensities for $z_0=1.5$, $\beta=1$ are shown in Fig. 1. For some values of β (for example, $\beta=0$) equidensities are found to be almost ellipsoidal.

Density run in the equatorial plane is shown for some values of the parameters in Fig. 2.

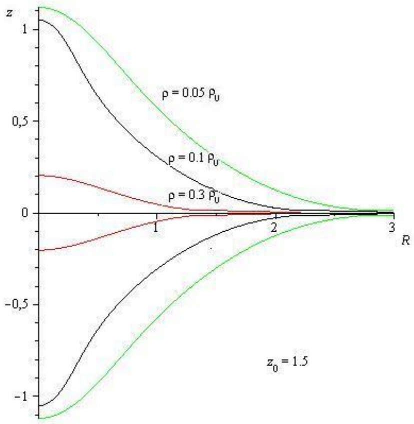

Figure 1: Equidensities for $z_0 = 1.5$, $\beta = 1$.

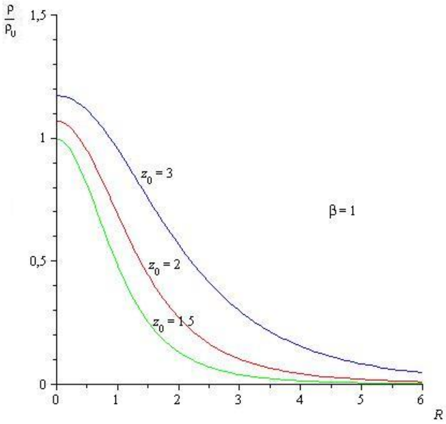

Figure 2: Density run in the equatorial plane for $\beta = 1$ and various values of z_0.

Further we plan to calculate the projected density and to compare it with observational data for actual galaxies.

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