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Attractive forces in the Universe

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Abstract: A fluid-dynamic model of the motion of the cosmic objects is proposed in this paper. Within the limit of motion of the cosmic objects in the ideal medium, the expression of the attractive force is derived. In the case of planets ($\beta >> 1$, β -is the parameter depending upon the angular velocities, the dimension of the system and the velocity of the progressive motion of the system), the form of the attractive force coincides with the Newton law; in the case of the galaxies, $\beta \le 1$, the attractive force differs sufficiently from the Newton law.

The case $\beta >> 1$ corresponds to the planets and moons and we have in this limit the Kepler-Newton law of rotation curves. When the parameters $\beta \le 1$, we have the rotation curves of the galaxies.

The fluid-dynamic theory describes the rotation curves and attractive forces of both the galaxies and the planets systems without invoking dark matter hypothesis.

Key words: galaxies rotation curves; the Kepler law, the attractive force, dark matter .

Introduction

It is well known that in the Solar system, the attractive force is equal to: $F_a(R) = \dfrac{GMm}{R^2}$ where M is the central mass, m is a mass of a planet, G is the gravitation constant and R is the distance from the planet to the Sun (the Newton law).

The planets of the Solar system have a rotation curve which is well-described by the Kepler-Newton law: the orbital velocity, $V(R)$, is equal to $V(R) = \sqrt{\dfrac{MG}{R}}$.

The attempts to use the Kepler-Newton law for the description of the rotation curves of the galaxies, have led to failure. The galaxies rotation curves are varied and differ strongly on the Keplerian form. L.Volders was one of the first scientists who noticed this distinction. In 1959, he demonstrated [1] that the rotation curve of the spiral galaxy M33 differed strongly from the Kepler law. During the 1960s-1980s, V.Rubin and K.Ford, and O.Sofue , V.Rubin investigated the spiral galaxies [2,3]. They showed that there are three types of the rotation curves, and all of them differ from the Keplerian form. Their results have been confirmed over subsequent decades [4-13].

Previously, astronomers thought that disk galaxies had mass distribution similar to the observed shining distributions of stars and gas, therefore the orbital speed would decline with the increasing distances in the same way as do the planets of the Solar System or moons of Earth, Jupiter et al. But it is not the case. Moreover, the rotation curves of the spiral galaxies are often asymmetric.

The galaxies masses calculated from the observed rotation curves and law of gravity, and the mass profiles of galaxies, calculated from the luminosity profiles and the mass-to-light ratio in the stellar disks, do not match one another. The rotation curves imply that the mass continues to increase linearly with radius. Therefore, it has been postulated that a large amount of dark matter what extends galaxy into the galaxy's halo and permits to explain the observed rotation curves.

To calculate the speeds of the stars in the galaxies and the gas clouds speeds, the Doppler Effect is used. The measurement of the frequency (more exactly- the frequency shift relative to its position in free reference frame) is carried out on different spectrographs and optical interferometers. However, these methods allow to measure the spectrum velocities not of one star (there are a lot of

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stars in the galaxy), but some average integrated spectrum of emission, emitted by the large amount of indistinguishable emitters-stars.

The stars velocities are determined using the optical range of spectrum. The velocities of the gas clouds are measured also with the use of radio irradiation (usually with the help of frequency of the neutral hydrogen, it is the most widespread in the Universe, ($\lambda = 21$ cm), and of CO-molecules line in mm –range).

Unfortunately, the accuracy of such a method of calculation $V(R)$ is small due to the contribution to the frequency shift both the Doppler effect (due to the approximately progressive orbital motion) and the Sagnac effect [14], which is caused by the star rotation around its axis. Perhaps, namely the considerable influence of the Sagnac effect leads to the asymmetry of the rotation curves, which is often observed.

Therefore, the calculation of true rotation curve $V(R)$ for the galaxies on the basis of the observed data, averaged on a large amount of stars, is very difficult.

Several alternative hypotheses were proposed to explain the discrepancies of the observed rotation curves from the Kepler-Newton form.[15-17]. There are several other prepositions to avoid invoking dark matter.

We propose the new natural approach to this problem, without artificial introduction of doubtful fields and accelerations: the hydrodynamic description of the motion of all cosmic objects: galaxies, stars, planets, moons. This has led to fruitful results.

It is shown that the attractive forces are not the same for the planets in the star system and for the stars in the galaxy. In our description the forces are not continuous (as in the Newton law) but quantized, and the planets (and stars) have stable orbits (this is not so in the case of the Newton law).

Results and Discussion

The rotation curves

The galaxies consist of a huge community of stars, quasars, gas clouds, consisting of (according to modern knowledge) high temperature plasmas, the gaseous clouds of hydrogen, helium and some other light elements. Therefore, it is natural to use hydrodynamics to describe the motion of cosmic objects. Most of them rotates (with the angular velocity $\vec{\Omega}$) and simultaneously move progressively with some velocity V_0 . This is a motion along the screw line. Consider the rotation around z axis. The left and right screw lines are possible. It's convenient to use the cylindrical coordinates. The parametric equations for the motion along the screw lines:

$$\rho = a; \varphi = \pm\Omega t; z = V_0 t$$

We'll consider one of them with sign (+). Introduce the vector of velocity for an element of the cosmic matter: $\vec{U}(U_r, U_\varphi, U_z)$. We consider the propagation of the cosmic object through the ideal media, without collisions. It can be considered as incompressible liquid. In the case of rotation, the Euler equation has the form:

$$\frac{\partial \vec{U}}{\partial t} + (\vec{U}\cdot\nabla)\cdot\vec{U} + 2\cdot[\vec{\Omega}\times\vec{U}] = -\frac{1}{\rho_f} grad(p) \quad (1)$$

Suppose, that small vibrations of media take place when the cosmic object moves, and neglect the second term on the left side [18]. The Euler equation has the form:

$$\frac{\partial \vec{U}}{\partial t} + 2\cdot[\vec{\Omega}\times\vec{U}] = -\frac{1}{\rho_f}\nabla p' \quad (2)$$

Here the second term on the left side is the Coriolis force (with the sign (-)), $\nabla p'$ -is the gradient of the variable part of the pressure in a medium, included the centrifugal force $\frac{1}{2}\nabla[\vec{\Omega}\times\vec{r}]^2$ and other possible forces in the Universe.

In the dimensionless values, the solutions of the equation (2) for the components of the velocity of the equation (2) (with the equation of the discontinuity) are equal to:

$$U_r(r,t) = C\cdot\exp(i\omega t)\cdot J_1(r\cdot\beta)$$
$$U_\varphi(r,t) = iC\exp(i\omega t)\cdot\frac{2\Omega}{\omega}\cdot J_1(r\beta) \quad (3)$$
$$U_z(r,t) = iC\cdot\exp(i\omega t)\cdot\sqrt{\frac{4\Omega^2}{\omega^2}-1}\cdot J_0(r\beta)$$

Here $r = \frac{r_1}{R_0}$; $\beta = \frac{\omega R_0}{V_0}\sqrt{\frac{4\Omega^2}{\omega^2}-1}$; r_1 is a dimension coordinate, $R_0 -$ is some characteristic dimension of the cosmic object. As the velocity is positive value, then only positive parts of the Bessel functions have the physical sense.

The possible meanings of the frequency ω are restricted with the condition $\omega < 2\Omega$, because only in this case the equation for U_r has the finite solutions. As a result, we have the quantized function on r for all three components of velocity.

The obtained results for the velocity components allow conducting an analysis of the possible rotation curves of the cosmic objects. The orbital velocity is proportional to $U_\varphi(r,t)$ component: $U_\varphi \sim \frac{2\Omega}{\omega} \cdot J_1(r\beta)$. The Bessel function *J1(x),* has asymptotic form for *x>>1*:

$$J1(x) \rightarrow \sqrt{\frac{2}{\pi} \cdot \frac{1}{\sqrt{x}}} \cdot \cos(x - \frac{3\pi}{4}) \tag{4}$$

The positive part of it coincides with the Kepler-Newton law. In Fig.1, the rotation curves for the Solar system are given: symbols – the orbital velocities of nine planets of the Solar system; dotted line – the Kepler law and solid line – the Bessel function *J1(x)* with $r = \frac{r_1}{R_0} = 0 \div 1; \beta = 200; R_0 = 40 a.u.$. In the case of the planets $\beta >> 1$.

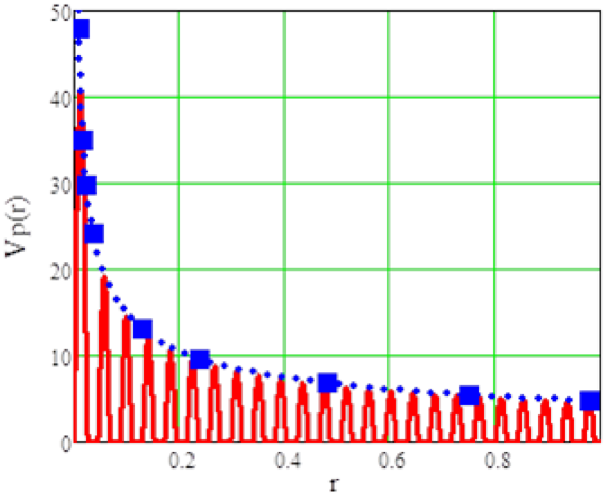

Figure1. The rotation curves for the Solar system are given: symbols – the orbital velocities of nine planets of the Solar system; dotted line – the Kepler-Newton law and solid line – the Bessel function with $\beta = 150$.

The form of the rotation curves depends on the parameter β. The case $\beta >> 1$ corresponds to the rotation curves of the planets and moons and coincides with the Kepler law. Hence, the Kepler approach is good for the planets. The other limited case, $\beta \le 1$ corresponds to the rotation curves of the stars and gas clouds in the galaxies.

In Fig. 2 the rotation curves are given in the case of a group of stars with the different parameters β. It agrees with the fact that the measured curves corresponds to the group of different stars with different rotation parameters β.

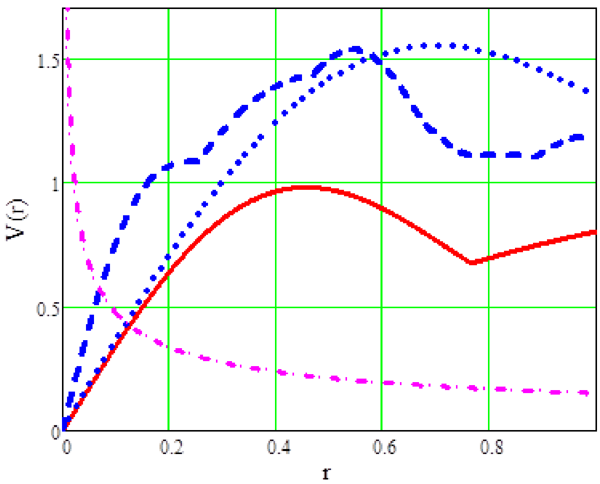

Figure 2. The rotation curves at the sum of the stars parameters: β =0.5; 1.5;5 (solid line); β =0.5; 1.1.5; 2; 3.7 (dotted line); β = 0.5; 1.5; 2; 3.7; 5; 5.2; 15 (dashed line); β = 50 - dot – and dash- line – the Kepler-Newton law.

The attractive force.

Let us derive the attractive force, which is peculiar both to the stars in the galaxies and the planets in the star systems. Consider the motion of the cosmic object on the circular orbit around the galaxy (or star) center and assume that the attractive force is balanced against the centripetal force of this object. If the medium is ideal, the velocity of an object is determined by the Euler equation and the orbital velocity is proportional to the positive part of the Bessel function:

$$U_\varphi(r,t) = iC\exp(i\omega t)\cdot\frac{2\Omega}{\omega}\cdot J_1(r\beta).$$

The attractive force is equal to: $F_a = \rho V\dfrac{U_\varphi^2}{r}$

where V is a volume of the object.

Note the positive part of the Bessel function $J_1(r\beta)$ as $G_1(r\beta)$. The attractive force is equal:

$$F_a(r) = \rho V\frac{C_1\Omega^2}{\omega^2}\cdot\frac{1}{r}\cdot[G_1(r\beta)]^2 \quad . \tag{5}$$

Here $C_1 = 4C^2R_0$, C^2 is in terms of the square of velocity, and $\frac{1}{r}\cdot[G_1(r\beta)]^2$ is dimensionless.

In the limit of big parameter β ($\beta >> 1$ for the planet) we obtain:

$$G_1(r\beta)\to\frac{2}{\pi}\cdot\frac{1}{r} \quad . \tag{6}$$

and we have the Newton law:

$F_a(r) = \dfrac{GMm}{r^2}$. Here the parameter GM corresponds to $\dfrac{2C_1\Omega^2}{\pi\cdot\omega^2}$.

In Fig.3 the dependences of the attractive force $F_a(r)$ on the distance from the center of the rotation axis are given for the cosmic objects, both the planets and stars.

It is seen that for the planet the attractive force coincides with the Newton law, at the edge of a system $F_a(r)\to 0$, whereas for the galaxies it is not the case: the attractive force is extended far from the edge of a system, it is not monotone. After zero point there are regions where forces are still strong enough. The form of $F_a(r)$ depends strongly on the parameter β .

The attractive force for the group of neighboring stars with different parameters β , can have more complicated form, for example, is present in Fig.3. The stars attractive forces are extended far into space, much further than the Newton force and it can capture from the space other cosmic objects. Perhaps, owing to this fact, the large rarefied regions of gas clouds, asteroids and small planets exist far from the lighting regions of the galaxies.

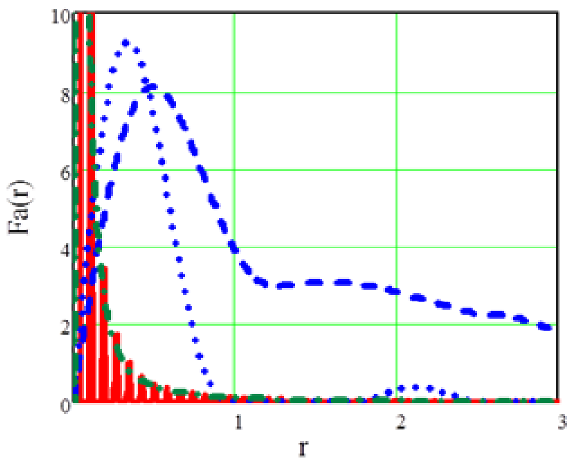

Figure 3. The dependences of the attractive force $F_a(r)$ on the distance from the rotation axis. The parameters: β = 80 (planets, solid line); and for galaxies : β = 4(dotted line); the sum of different parameters β : β = (0.1 + 0.3 + 1 + 2) (dashed line). The Newton law – dot-and-dash line. The maximum distance 3 R_0.

In Fig. 4, the dependences of the attractive force $F_a(r)$ on the distance from the rotation axis in the star system are given. It is supposed that when $r\le 0.4$, the small planets rotate, with $\beta = 80$, when $r > 0.4$, the giant planets rotate, with $\beta = 30$, (like Jupiter, Saturn). In such a case, the attractive force $F_a(r)$ deviates from the Newton law.

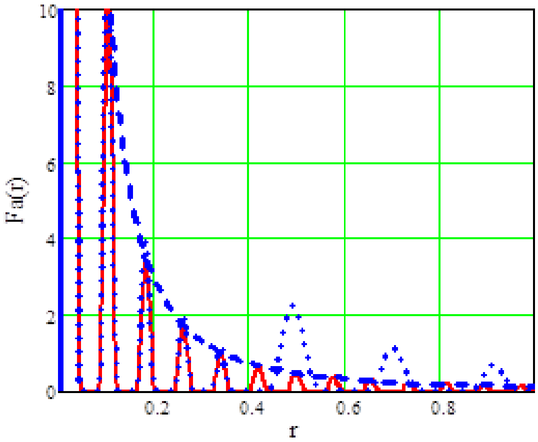

Figure 4. The dependence of the attractive force $F_a(r)$ on the distance from the rotation axis in the Solar system. The parameters: β =80 (solid line), small planets; and for the sum of small planets, β = 80 , $r \le 0.4$ and giant planets β = 30 (dotted line).
The Newton law – dashed line. The maximum distanc

Perhaps, the strange motion of the space crafts "Pioneer" is due to these additional forces as well as the deviations of the planets motion which have led to search of the hypothetic tenth planet in the Kuiper belt.

Conclusion

The hydrodynamic model of the motion of the cosmic objects explains the rotation curves of both the galaxies and planet systems. The positive part of the Bessel functions describes the law of the motion. The Kepler-Newton law, which describes well the rotation curves of the planets and moons, is one of the limited cases ($\beta >> 1$) of the general expression for the rotation curves. In the other limit case $\beta \le 1$, the obtained expression describes the rotation curves of the stars in the galaxies.

The measured rotation curves correspond to a large group of stars with different parameters of rotation. The proposed hydrodynamic model shows that the observed rotation curves can be explained without invoking dark matter.

The expression for the attractive force which is applicable both for the stars in the galaxies and the planets in the stars systems, was derived. It was obtained for the case of ideal medium and the motion of the cosmic object on the circular orbit around the center of rotation. In the case of $\beta >> 1$, which takes place for planets, this expression coincides with the Newton law. When $\beta \le 1$, the attractive force differs considerably from the Newton law and spreads much longer than to the edge of the galaxy.

The strange motion of the space crafts "Pioneer" can be explained with the influence of the force of the planets-giants. (Fig. 4).

Our investigation has shown that dark matter and dark energy don't exist in the Universe.

The attractive force between the cosmic objects is caused by their motion.

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