The Principle of the Decenter of Mass:
Solution to the Problem of Galactic Rotation Curves and Unmask of Hidden Mass

Leonid O. Shabaev

Moscow, Russia

(Dated: September 4, 2021)

It was found that the principle of the center of mass is fundamentally unsuitable for describing the mechanics of baryonic matter in galactic disks. A new principle was developed – the principle of the decenter of mass, based on the division of any volumetric bodies into many sectors and cells, each of which has its own center of mass and the corresponding values of mass and gravitational force. The resulting principle makes it possible to decentralize all the available mass from the barycenter in a natural way and obtain different and more accurate values of gravitational force, mass and orbital velocity that are different from the previous ones. In view of the semantic difference between the “nominal” and “perceived” values of the parameters of mass and gravitational force, which the new principle gives, new additional concepts and the corresponding classification were introduced for the values of these parameters for the convenience of their determination. In total, 4 types of different distribution of the conventional substance are presented. For the fourth type, a distribution was fitted that made it possible to obtain a non-ideal plateau-like rotation curve – one of those that is usually obtained from data. The nominal (total) mass of such a plateau-like model turned out to be \( \sim 7.84 \) times greater than the value estimated from the upper value of the Kepler curve. This principle gives a clear hint at the incorrectness of the existing assumption of the existence of dark matter, which can become another weighty counterweight to the current cosmological concept of \( \Lambda \)CDM and all other alternatives that exist for it.

PACS numbers: 04.25.Nx, 04.80.Cc, 95.35.+d, 98.62.Dm, 98.35.Df

I. INTRODUCTION

The rotation curve of the galactic disk is a function that describes its kinematic properties. It is represented by a graph of the dependence of the orbital velocities of stars and gas, obtained from the displacement of the radio line of neutral hydrogen, on the radius of the orbit. According to Kepler – Newton [1], as the radius from the common center of mass (hereinafter CM) increases, the velocity decreases along the hyperbola (also keplerian profile or keplerian). It seemed that such a model of velocities could be applied to describe the motion of the baryon component in galactic disks, but, as real observations show, stars and gas revolve around a common CM much faster than it should be. And this is where a fundamental problem arises.

The problem of galactic rotation curves is a strong discrepancy between the Newtonian dynamics and real observations of the rotation of the baryon component in the galactic disks. The modern cosmological concept of \( \Lambda \)CDM claims that these discrepancies indicate the presence of some other invisible form of matter, which creates additional mass, the value of which increases, approaching closer to the periphery of the galactic disks and due to which the plateau-like velocity curve of galaxies cannot correspond to the Keplerian profile [2, 3].

The invisibility of such matter is explained by the fact that the particles of dark matter is that it is not involved in any electromagnetic interaction and therefore is inaccessible to direct observation [4]. However, every now and then, with the help of telescopes, only indirect observational hints of the existence of such a form of matter in the form of gravitational lensing of galaxies and their clusters are found [5–8].

The detection of a dark matter particle, as most experts on this issue suggest, could explain all the inconsistencies in the difference between classical orbits and observational data, and it would also explain the visible structure, radial velocities of galaxies in clusters and the formation of filaments [9, 10].

At the moment, research is being carried out around the world and more and more sophisticated detectors are being designed for experiments to detect particles of dark matter. However, none of the currently built detectors, such as, for example, CRESST, XENON1T and many others, have found not a single hint of trapping or even a sign of the gravitational effect of a dark matter particle on baryonic ones.

Currently, candidates for the role of dark matter are such hypothetical particles as WIMPs, the lightest supersymmetric particles (LSP), darkinos and other exotic particles. They all still remain undiscovered.

There is an alternative physical hypothesis – modified Newtonian dynamics (MoND) [11], which tries to explain the behavior of rotation curves, but this hypothesis is undergoing serious difficulties and does not have proper compatibility with physical principles [12–16].

There is also the problem of cusps in Navarro–Frenk–White profile [17], which is a serious contradiction of the model of cold dark matter in the central regions of galax-
ies, where its density values do not grow and tend to a constant value, and not to a singularity, as was obtained in theoretical calculations [18–23].

The author of this paper investigated the problem of galactic rotation curves exclusively from the point of view of classical mechanics and now proposes another way of solving the problem, taking as a basis the already existing principles of classical mechanics and, having modified one of them, supplemented the missing mathematical apparatus without the need to use any rotation curves of galaxies in the description additional hypothetical mass, acceleration parameters, or the introduction of a new metric.

II. MORE ABOUT THE PROBLEM OF THE ROTATION CURVES OF GALAXIES

With the onset of the 20th century and the emergence of new technologies that make it possible to engage in extragalactic astronomy, a number of serious fundamental problems have arisen related to the estimation of the mass of galaxies and the pronounced discrepancy between the radial velocities of the stellar population of their disks [24–27].

Indeed, after all, the speed of the circular motion of celestial bodies in orbits is calculated using a simple formula for the orbital speed of the planet’s satellite (it is also the first cosmic, circular):

\[ v_{\text{orb}} = \sqrt{\frac{GM}{R}}, \]  

(1)

where \( G \) is the gravitational constant, \( M \) is the mass of a body around which another body revolves (it is assumed that \( M \gg m \)), \( R \) is the radius of the orbit from the center of mass of a body with mass \( M \). In some cases, write \( R_0 + h \), where \( R_0 \) is the radius of the planet, \( h \) - height above the surface of the planet. It follows from the formula that the velocity decreases from the beginning of the center of a body with mass \( M \) up to radius \( R \).

There is also another form of recording the orbital velocity, expressed in terms of gravitational force:

\[ v_{\text{orb}} = \sqrt{\frac{F_{\text{grav}}R}{m}}. \]  

(2)

Formulas (1) and (2) are identically equal to each other.

And this happens at a time when in galactic (i.e. in relatively continuous in the distribution of matter) disk systems, orbital velocities with increasing radius, on the contrary, do not follow Keplerian laws: either they tend to some constant velocity optimal for a particular system (curves speeds tend to their plateau), continue to grow slowly, or fluctuate to varying degrees throughout their entire length [28–36].

The author of this paper noticed that formula (1), just like the classical formula of gravitational force, derived by Isaac Newton (see in the Appendix A), ideally works only for systems consisting of two mathematically point bodies. Almost in every problem encountered in classical mechanics, it is required to neglect the volume of a body for reasons of mathematical convenience. This is exactly what happens: the dimensions of bodies in such problems, for example, for finding the gravitating force, are considered negligible, that is, their masses are concentrated in their centers of mass (barycenters).

In astronomy, some masses of bodies, such as, for example, terrestrial planets and asteroids in the Solar System, are not particularly taken into account for convenience, since they play an insignificant role in gravitational disturbances of other planets and the Sun. However, it is known for certain that other more massive planets (such as Jupiter and Saturn, for example) quite noticeably bring their influence on the general center of mass of the solar system: the entire system revolves not around the geometric center of the progenitor star, but around the barycenter common to the entire system of bodies, which occurs both in the body of the Sun itself and outside it. The planets themselves, meanwhile, also experience gravitational disturbances among themselves due to their natural inherent gravitational influence on each other. Direct evidence of such an influence is, for example, the ebb and flow on the Earth with the constant interaction of its liquid component with the Moon, cracks in the ice of Enceladus with jets of water and ice escaping from them, etc.

III. FIRST APPROXIMATION:
STATEMENT OF THE PROBLEM OF FINDING
THE VALUES OF GRAVITATIONAL FORCE
AND ORBITAL VELOCITY FOR THREE
BODIES ACCORDING TO TWO PRINCIPLES
AND RESULTS

In the first approximation, the problem is considered on the example of a conditional planetary system with stationary orbits to avoid calculations of perturbations of the orbits of point objects in order to find out the approximate value of the instantaneous gravitational force and instantaneous orbital velocity, which should be in each position of their measurement.

Measurement positions are understood as such arrangements of objects in the system when the body under consideration remains fixed (for the convenience of counting), and the rest of the bodies with each new dimension, as they say, “frame by frame” revolve around the barycenter common for the entire system.

A. Problem statement based on the center of mass principle

Considering the problem for three bodies (Fig. 1 (a)), where a body of mass \( m_1 \) with orbital radius \( R_{m_1,M} \) re-
volves around a system of bodies with a total mass enclosed in their common center of mass \( M = M' + m_2 \) (following the center of mass principle), located in the center of the entire system with ideal circular orbits, we get a well-defined gravitational force \( F_{m_1, M} \) and, in accordance with the formula (1), velocity \( v_1 \), respectively:

\[
F_{m_1, M} = \frac{G m_1 M}{R_{m_1, M}^2} = \frac{G m_1 (M' + m_2)}{R_{m_1, M}^2},
\]

\[
v_1 = \sqrt{\frac{\left| F \right|_{m_1, M}^2}{m_1}} \iff v_1 = v_{m_1, M} = \sqrt{\frac{GM}{R_{m_1, M}}} = \sqrt{\frac{G(M' + m_2)}{R_{m_1, M}}},
\]

The masses of bodies, in accordance with the CM principle, are transferred to the common barycenter \( M \). As a consequence, the gravitational force will not change over time, which means that the instantaneous orbital velocity will also have a constant value.

**B. Problem statement based on the decenter of mass principle**

Consider the problem with three objects (Fig. 1 (b)), where there is the same body with mass \( m_1 \) and orbital radius \( R_{m_1, M} \), but rotating not just around the barycenter, but around two objects with the same total mass \( M = M' + m_2 \), which is transferred to the objects themselves. The value of the total mass is intentionally left the same as it was in the first problem, in order to show how, with a simple redistribution of the centers of mass from the barycenter, the values of the instantaneous gravitational force and the value of the orbital velocity of the body in question will change.

\[
F_{\text{gen}} = F_{m_1, m_2} + F_{m_1, M'} = \frac{G m_1 m_2 \cos \alpha}{R_{m_1, m_2}^2} + \frac{G m_1 M' \cos \beta}{R_{m_1, M'}^2},
\]

\[
v_{\text{gen}} = \sqrt{\frac{\left| F \right|_{m_1, m_2}^2}{m_1}} + \sqrt{\frac{\left| F \right|_{m_1, M'}^2}{m_1}} \iff v_{\text{gen}} = \sqrt{\frac{G m_2 \cos \alpha}{R_{m_1, m_2}}} + \sqrt{\frac{G M' \cos \beta}{R_{m_1, M'}^2}},
\]

where \( F_{\text{gen}} \) is the vector of the general instantaneous gravitational force, \( v_{\text{gen}} \) is the vector of the general instantaneous orbital velocity, \( \alpha \) is the angle between the force vector \( F_{m_1, m_2} \) and the axis of projection of forces (in the figure it is indicated as the “Main axis”), and \( \beta \) is the angle between the force vector \( F_{m_1, M'} \) and the Main the axis of projection of forces.

The masses of bodies, in accordance with the decenter of mass principle, are transferred from the common barycenter \( M \) to the immediate bodies of the system. As a result, the instantaneous gravitational force will begin to change over time, which means that the instantaneous orbital velocity will also change its value.
C. Noticeable difference in results between calculations according to two principles

The values of the instantaneous gravitational force, and hence the instantaneous velocity in the formulas (5) and (6) will become larger than in the formulas (3) and (4), i.e., \( F_{m,1,M} < F_{\text{gen}} \) and \( v_1 < v_{\text{gen}} \).

Let’s demonstrate how the two approaches work with a specific example. Suppose we have the following parameters for a given measurement:

1. Body with mass \( m_1 = 0.5 \) kg (object under consideration), with orbital radius around the barycenter \( R_{m_1,M} = 500 \) m (green*);
2. Mass body \( m_2 = 2 \) kg with orbital radius \( R_{m_2,M} = 250 \) m (blue*);
3. Body with mass \( M' = 10 \) kg with orbital radius \( R_{M',M} = 50 \) m (orange*);
4. Barycenter with mass \( M \), which is the conditional center of equilibrium of the system (red*). In the problem according to the principle of the CM is equal to \( M = m_2 + M' = 12 \) kg.

(* – colors correspond to curves in Fig. 2.)

Based on the results of measurements and calculations the values of instantaneous orbital velocities.

![Diagram](image)

FIG. 2. Measurement data of the values of the gravitational forces of the three-body system according to two principles.

It becomes obvious that for the considered object of mass \( m_1 \), the instantaneous orbital velocity must definitely be higher, since both the general instantaneous gravitational force between the considered body and all other bodies, as well as the instantaneous gravitational potential in which the considered object is located, by definition have changed their values. The general gravitational force \( F_{\text{gen}} \) exerted on a body with mass \( m_1 \), just like the instantaneous orbital velocity \( v_{\text{gen}} \), will take on its maximum values at the moment when a body of mass \( m_2 \) is located on the main axis between the other two bodies (position numbers 0, 32, 64 correspond to this arrangement).

D. Primary conclusion from the results obtained

So, if in a similar problem we considered systems with a larger number of bodies, distributing from the center of the system every time more and more values of the mass corresponding to these bodies within the radius \( R_{m_1,M} \) of the body in question, we would get that the orbital velocity \( v_1 \) and orbital moment that had the body, at its first and second considerations, will no longer be enough to maintain its circular orbit. As a result, such an object will physically begin to “fall” into the system. That is why such an object is simply obliged to have a higher speed than that which it has according to the CM principle.

Based on the graphs shown in Fig. 2, we can conclude that with the addition of a body with mass \( m_2 \) to the orbit of a certain number of bodies of the same mass, sufficient to consider the system continuous, the total gravitational force of the considered body \( F_{\text{gen}} \) will have a more or less constant value (but much higher than the previous one) at all measurement positions, as if the totality of all these objects were considered one, but more massive. In this case, the system could be considered to consist of only two objects and the center of mass could again be moved to the center of the disk, but here we will again make a serious mistake, since the problem will be considered again by the formulas (1) and (2), which again will lead us to serious inconsistencies in assessing the total gravitational force and mass of the system itself.

As a result of the formulation and solution of problems according to two principles, it turns out that the problem of the rotation curves of galaxies consists in finding the dependence of the velocity of the body’s orbit on the exact location (or at least close to the real one) over the entire studied system of its total true mass, enclosed in the barycenter of the system. This means that the principle already in fact acquires a somewhat “smeared” form in the system, which the author called for ease of use the “decenter of the mass” (hereinafter DCM). It is precisely the “decenter”, since the common barycenter still remains in such systems as the mathematical point of general equilibrium of the system, located on the same straight line with the object under consideration, that is, on the already mentioned “Main axis”, onto which the gravitational forces of all bodies are projected systems. The value of the entire mass of the system, based on the principle of the DCM and for objective physical reasons, simply must be distributed practically over the entire system under consideration, i.e. in the objects present in
it, thereby “allowing” the test particle to have a higher orbital velocity initially than it should be according to Kepler – Newton velocities. It is this imperfection in the current classical mechanics that became the key to continuing the search for a solution to the problem of plateau-like rotation curves of galaxies, which prompted the author to further develop the idea.

IV. SECOND APPROXIMATION: SUBDIVIDING SOLID BODIES OF VARIOUS SHAPES TO CALCULATE A MORE ACCURATE GRAVITATIONAL FORCE

A. Preparation and execution of the calculation

For a more accurate determination of the gravitational force for the disk models, the author carried out a preliminary draft research of the possibility of using the DCM principle on a primitive figure – a homogeneous cube, using the so-called “subdivision of bodies”.

The idea of the DCM principle, on the whole, began to consist precisely in the subdivision of any flat or volumetric body into ever smaller equal sectors (in this case, these are cells), in the centroids of which their own CMs are located. Each sector is assigned its own mean density, which will be correct for the considered body with mass \( m \) located at the zero point of the polar coordinate system.

5. The values of each resulting sector (cell) are calculated according to formula (7).

6. The values of the perceived gravitational forces \( ^sF_{\text{per} \ i} \) of all sectors (cells) are summed up into one value of the total gravitational force \( ^sF_{\text{per gen}} \), which will be correct for the considered body with mass \( m \) located at the zero point of the polar coordinate system.

7. The calculation of the total gravitational force is carried out according to formulas (8), or, depending on the location inside the system, according to formula (9).

Definition of gravitational forces of an individual sector and the summation of the values, respectively:

\[
^sF_{\text{per} \ i} = \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_i \Rightarrow ^sF_{\text{per} \ i} = Gm \left[ \frac{M_{\text{nom} \ i} \cos \alpha}{R^2} \right]_i = Gm \left[ \langle \rho_i \rangle \frac{S \cos \alpha}{R^2} \right]_i
\]

(7)

\[
^sF_{\text{per gen}} = \sum_{i=1}^{\mu} ^sF_{\text{per} \ i} = ^sF_{\text{per} \ 1} + \cdots + ^sF_{\text{per} \ \mu} = \sum_{i=1}^{\mu} \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_i = \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_1 + \cdots + \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_\mu,
\]

\[0^\circ \leq \alpha \leq 90^\circ\] (8)

In the case when the body under consideration is located inside the system (Fig. 3 (c)), formula (8) will take the following form:

\[
^sF_{\text{per gen}} = \sum_{i=1}^{\mu} \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_i - \sum_{j=1}^{\varepsilon} \left[ ^sF_{\text{nom} \ j} \cos \beta \right]_j = \left( \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_1 + \cdots + \left[ ^sF_{\text{nom} \ i} \cos \alpha \right]_\mu \right) - \left( \left[ ^sF_{\text{nom} \ j} \cos \beta \right]_1 + \cdots + \left[ ^sF_{\text{nom} \ j} \cos \beta \right]_\varepsilon \right),
\]

\[0^\circ \leq \{\alpha_i, \beta_j\} \leq 90^\circ\] (9)

where \( ^sF_{\text{nom} \ j} \) is the value of the gravitational force between the body under consideration and the cell \( j \) located beyond the abscissa, \( \cos \beta_j \) is the angle between the Main axis and the vector \( ^sF_{\text{nom} \ j} \). Angles \( \alpha_i \), just like the angles \( \alpha_i \), are necessarily built from the Main axis, but already in the direction opposite to the barycenter.
With a greater number of subdivisions of the body, the value of the gravitational force will tend to its true values. In reality, of course, if we were to calculate the gravitational force for a particular star in the galactic disk, then it would be necessary to calculate the force of influence for each object inhabiting the galactic disk, but since computers do not yet have such computing power, and the task itself is no longer a task, but madness, we will have to limit ourselves to some generalizations, dividing the conditional body into cells with averaged values of the density of the stellar population in each of these cells, if we are talking about the galactic disk or about an ordinary star cluster.

![Diagram](image)

(a) Zero degree of subdivision (without subdivision)

![Diagram](image)

(b) The first degree of subdivision

![Diagram](image)

(c) An example of the location of the body in question inside the system

FIG. 3. Examples of subdivisions.

**B. An example of a homogeneous cube**

Let’s compose, for example, the problem of finding the value of the perceived gravitational force between a cube and a material point. A cube with a side of $a = 5$ meters has a mass of $M = 1000$ kg, and a point object has a mass of $m = 5$ kg. The centers of the volumes of these objects are located on the Main axis, and the distance between these centers is $R = 10$ meters.

Substituting this input into the classical gravitational force formula we get the following quite expected result:

$$F_{\text{grav classic}} = \frac{GMm}{R^2} = 3.335 \times 10^{-9} \text{ N.}$$

In this task, there was absolutely no need to use data on the dimensions of the object itself. It is not required initially, according to its own idea, and some inaccuracies, such as a mass defect, are omitted in such calculations. But what will happen if we consider this force just taking into account the volume of the body and, along with it, the uniform distribution of mass? Then the problem with an increase in the degree of subdivision will acquire an increasingly complicated form as in the formula (8). For such a case, the principle of the decenter of mass was developed.

So, according to the DCM principle, dividing the cube according to the example from the Fig. 4, we get the following values of the gravitational force:

<table>
<thead>
<tr>
<th>$s$</th>
<th>$^sF_{\text{per gen}}$ (N)</th>
<th>$\Delta^sF_{\text{per gen}}$ (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$3.335 \times 10^{-9}$</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>$3.3477607 \times 10^{-9}$</td>
<td>$1.27607 \times 10^{-11}$</td>
</tr>
<tr>
<td>3</td>
<td>$3.3556589 \times 10^{-9}$</td>
<td>$2.0658952 \times 10^{-11}$</td>
</tr>
<tr>
<td>7</td>
<td>$3.3573683 \times 10^{-9}$</td>
<td>$2.2368309 \times 10^{-11}$</td>
</tr>
<tr>
<td>9</td>
<td>$3.3573691 \times 10^{-9}$</td>
<td>$2.23691 \times 10^{-11}$</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

$\approx 3.35737 \times 10^{-9}$ \quad $\approx 2.237 \times 10^{-11}$

**TABLE I.** With an increase in the degree of subdivision $s$ of the body, the value of the perceived gravitational force with a constant configuration of the cube will tend to the indicated value $\lim_{s \to \infty} ^sF_{\text{per gen}} \approx 3.35737 \times 10^{-9}$ N. At the same time, the difference between the values of the forces also grows up to a certain value $^sF_{\text{per gen}}$ and $^0F_{\text{per gen}}$: $\lim_{s \to \infty} \Delta^sF_{\text{per gen}} \approx 2.237 \times 10^{-11}$ N.

As seen from the table above, with an increase in the number of units, the overall value of the perceived gravitational force increases. In addition, with an increasing degree of subdivision, we gradually reach a certain limit of the value of the perceived gravitational force, and it is this that will be the true value of this force, i.e.:

$$\lim_{s \to \infty} ^sF_{\text{per gen}} = Gm\rho \sum_{i=1}^{\mu} \left[ \frac{dV}{R^2} \right]_i = F_{\text{gen true}}.$$
V. THIRD APPROXIMATION: SOLVING THE PROBLEM OF GALACTIC ROTATION CURVES

A. The considered theoretical model

The theoretical model for solving the problem will be an ideally round disk of zero thickness and a radius of 100 meters (see Fig. 5), consisting of perfectly round thin rings with a step of their radius of 12.5 meters. There are 8 such rings in this model. It is understood that these thin rings will serve as control radii \( R_{\text{ctrl}} \), on which, with each of the 8 considerations, the corresponding polar coordinate systems will be built up according to which the required parameters of the disk will be calculated. Spaces are located between the thin rings, which will be assigned the eigenvalues of the density \( \rho \) of the conventional substance. The barycenter of the body will be located in the geometric center of this ideal disk.

So, indicating the degree of subdivision by radial lines \( \mathfrak{r} \) (from lat. \textit{radialis} – radial) (see Fig. 6), we divide in addition to the already existing subdivision of the disk using control radii indicated by the letter \( c \) (from lat. \textit{circulus} – circle), having the same radius step of 12.5 meters, that is, directly for \( c \), the number of rings subdividing the circular disk model is indicated (there are 8 of them in this model).

B. Parameter classification

To make a complete reading of the physical formulas possible, it is necessary to determine and indicate important parameter differences of the gravitational forces \( F \) and the masses \( M \).

1. Gravitational force

\( \triangleright \) The value of the nominal grav. force of the sector (or cell) \( i \):

\[
\mathfrak{r}_i^c F_{\text{nom}} r_i.
\]

\( \triangleright \) The value of the perceived grav. force of the sector (or cell) \((\text{after the projection of the vector of the grav. force of the sector } i)\):

\[
\mathfrak{r}_i^c F_{\text{per}} r_i.
\]

\( \triangleright \) The value of the nominal grav. force of the entire effective radius \( r \):

\[
\mathfrak{r} F_{\text{nom gen}} r.
\]

\( \triangleright \) The value of the perceived grav. force of the entire effective radius \( r \) \((\text{after the projection of the vectors of the grav. forces of the sectors } i)\):

\[
\mathfrak{r} F_{\text{per gen}} r.
\]

\( \triangleright \) The value of the general nominal grav. force for the control radius \( \mathfrak{r} \):

\[
\mathfrak{r} F_{\text{nom gen}}.
\]

\( \triangleright \) The value of the perceived general grav. force for the control radius \( \mathfrak{r} \) \((\text{after the projection of the vectors of the grav. forces of the sectors } i)\):

\[
\mathfrak{r} F_{\text{per gen}}.
\]
FIG. 5. Scheme of a conditional theoretical model of a disk body, in which at the moment the gravitational force vector $\vec{F}_{\text{nom}}^{46}$ is projected onto the Main axis (where the lower right indices “4” and “6” mean, respectively, the ordinal number of the effective radius $r$ ($r_{\text{eff}}$) and the ordinal number sectors $i$, counting from the Main axis, and the upper left indices “4” and “8” mean, respectively, the degree of subdivision $c$ and $r$ of the disk) between the considered body $m$ located at the zero point of the polar coordinate system built on 6th control radius $R_{\text{ctrl}}$, and a sector with mass $\frac{48}{6} M_{\text{nom}}^{46}$. After projection, the nominal gravitational force vector $\frac{48}{6} F_{\text{nom}}^{46}$ is projected vector of the nominal gravitational force, i.e. $\frac{48}{6} F_{\text{nom}}^{46} \cos \alpha = \frac{48}{6} F_{\text{per}}^{46}$ - this is the perceived gravitational force.

FIG. 6. Examples of subdivisions by radial lines $r$ in polar coordinate system. It is clearly shown that new radial lines appear in the forms of the unit $r$, “dividing” the remaining “parts” of the coordinate plane in half.
2. **Mass**

- The value of the **nominal** mass of the sector (or cell) $i$:

$$\mathcal{N} M_{\text{nom} ri}.$$ 

- The value of the **perceived** mass of the sector (or cell) (after the projection of the vectors of the grav. forces of the sectors $i$):

$$\mathcal{N} M_{\text{per} ri}.$$ 

- The value of the **nominal** mass of the entire effective radius $r$:

$$\mathcal{N} M_{\text{gen nom} r}.$$ 

- The value of the **perceived** mass of the entire effective radius $r$ (after the projection of the vectors of the grav. forces of the sectors $i$):

$$\mathcal{N} M_{\text{gen per} r}.$$ 

- The value of the **general nominal** mass for the control radius $\mathcal{R}$:

$$\mathcal{N} M_{\text{gen nom}}.$$ 

- The value of the **perceived general** mass for the control radius $\mathcal{R}$ (after the projection of the vectors of the grav. forces of the sectors $i$):

$$\mathcal{N} M_{\text{gen per} \mathcal{R}}.$$ 

1. For sectors (or cells) with the index $j$ located beyond the abscissa of the polar coordinate system, all of the above is similar.

2. The importance of indexing with the letters $c$, $r$ and $\mathcal{R}$ in each of the parameters is due to the existing difference in their common values at different degrees of subdivision of the model of the same disk. At the same time, it is necessary to understand the context in which such parameters are calculated, if we talk about them separately outside the context. If the context is known and everything is considered within the framework of one type of unit, then such indexing can be completely neglected.

### C. Master model for further research

The SketchUp program was used to simulate the master models of the disks. 8 models of half-discs were built (see Fig. 7), assuming that they are symmetrical to their deliberately unfinished halves along the Main axis to avoid recalculations. The values of the mass of the sectors in the calculations were multiplied by 2. For each half-disk, its own polar coordinate systems were built, which were shifted closer to the center by a step of the radius with each subsequent consideration of the orbit.

The radius of the disk is 100 meters. Control radii are located at distances from 12.5 to 100 meters from the center of the “disk”. The radius step is 12.5 meters. The core of the disk is considered to be a “pinkish” semicircle with a radius of 12.5 meters. The mass of the object under consideration is $m = 0.0001$ kg. Disk subdivisions: $c = 4$, $r = 8$.

In the course of this approximation, the author simulated the gravitational effect of flat disks with four types of matter density distributions. In the first, the density of matter decreased by half of its previous value, and in the second – by a quarter, in the third – by $10^n$, where $n \in [-7; 0]$. The density distribution in the fourth model corresponded to such a distribution, which gives a plateau-like rotation curve, which is observed in galaxies (more about the 4th model in the Ch. VI “Plateau-like curve”) The initial density value for all models is taken as $1 \text{ kg} \times \text{m}^{-2}$. The purpose of this study was to find out at what optimal profile of gravitational force we get some similarity of the plateau, obtained in the graph of the orbital velocity profiles (see Ch. V F “Obtaining the orbital velocity”). Numerical values are described in table II, visualization of the tabular values is shown in Fig. 13 (a) in Appendix D.

<table>
<thead>
<tr>
<th>$\rho_n$ and their distribution of density values along the control radii, kg $\times \text{m}^{-2}$</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_1$</td>
<td>1</td>
<td>1</td>
<td>$10^0$</td>
</tr>
<tr>
<td>$\rho_2$</td>
<td>$1/2$</td>
<td>$1/4$</td>
<td>$10^{-1}$</td>
</tr>
<tr>
<td>$\rho_3$</td>
<td>$1/4$</td>
<td>$1/16$</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>$\rho_4$</td>
<td>$1/8$</td>
<td>$1/64$</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>$\rho_5$</td>
<td>$1/16$</td>
<td>$1/256$</td>
<td>$10^{-4}$</td>
</tr>
<tr>
<td>$\rho_6$</td>
<td>$1/32$</td>
<td>$1/1024$</td>
<td>$10^{-5}$</td>
</tr>
<tr>
<td>$\rho_7$</td>
<td>$1/64$</td>
<td>$1/4096$</td>
<td>$10^{-6}$</td>
</tr>
<tr>
<td>$\rho_8$</td>
<td>$1/128$</td>
<td>$1/16384$</td>
<td>$10^{-7}$</td>
</tr>
</tbody>
</table>

---

C. Master model for further research

The SketchUp program was used to simulate the master models of the disks. 8 models of half-discs were built (see Fig. 7), assuming that they are symmetrical to their deliberately unfinished halves along the Main axis to avoid recalculations. The values of the mass of the sectors in the calculations were multiplied by 2. For each half-disk, its own polar coordinate systems were built, which were shifted closer to the center by a step of the radius with each subsequent consideration of the orbit.

The radius of the disk is 100 meters. Control radii are located at distances from 12.5 to 100 meters from the center of the “disk”. The radius step is 12.5 meters. The core of the disk is considered to be a “pinkish” semicircle with a radius of 12.5 meters. The mass of the object under consideration is $m = 0.0001$ kg. Disk subdivisions: $c = 4$, $r = 8$.

In the course of this approximation, the author simulated the gravitational effect of flat disks with four types of matter density distributions. In the first, the density of matter decreased by half of its previous value, and in the second – by a quarter, in the third – by $10^n$, where $n \in [-7; 0]$. The density distribution in the fourth model corresponded to such a distribution, which gives a plateau-like rotation curve, which is observed in galaxies (more about the 4th model in the Ch. VI “Plateau-like curve”) The initial density value for all models is taken as $1 \text{ kg} \times \text{m}^{-2}$. The purpose of this study was to find out at what optimal profile of gravitational force we get some similarity of the plateau, obtained in the graph of the orbital velocity profiles (see Ch. V F “Obtaining the orbital velocity”). Numerical values are described in table II, visualization of the tabular values is shown in Fig. 13 (a) in Appendix D.

<table>
<thead>
<tr>
<th>TABLE II. A table of numerical values for three types of density distribution of a substance.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_1$</td>
<td>1</td>
<td>1</td>
<td>$10^0$</td>
</tr>
<tr>
<td>$\rho_2$</td>
<td>$1/2$</td>
<td>$1/4$</td>
<td>$10^{-1}$</td>
</tr>
<tr>
<td>$\rho_3$</td>
<td>$1/4$</td>
<td>$1/16$</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>$\rho_4$</td>
<td>$1/8$</td>
<td>$1/64$</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>$\rho_5$</td>
<td>$1/16$</td>
<td>$1/256$</td>
<td>$10^{-4}$</td>
</tr>
<tr>
<td>$\rho_6$</td>
<td>$1/32$</td>
<td>$1/1024$</td>
<td>$10^{-5}$</td>
</tr>
<tr>
<td>$\rho_7$</td>
<td>$1/64$</td>
<td>$1/4096$</td>
<td>$10^{-6}$</td>
</tr>
<tr>
<td>$\rho_8$</td>
<td>$1/128$</td>
<td>$1/16384$</td>
<td>$10^{-7}$</td>
</tr>
</tbody>
</table>
D. Distribution and summation of the values of the gravitational force before and after the projection of the vectors on the Main axis

The nominal gravitational force value for the \(i\) sector (exactly as for the \(j\) sectors lying beyond the abscissa axis) in the effective radius \(r\) is expressed as follows:

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{nom}_{ri} &= \left( \frac{\xi}{\Omega} \frac{M^\text{nom}}{R^2} \right)_{ri} = \frac{Gm}{\Omega} \left[ \left( \frac{\langle \rho_n \rangle S}{R^2} \right) \right]_{ri}.
\end{align*}
\]

The summation of the values nominal gravitational forces of all sectors \(i\) at the last and internal control radii \(\Omega\) is determined as follows:

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{nom gen}_{\Omega} &= \frac{\xi}{\Omega} \sum_{i=1}^{\mu} F^\text{nom}_{ri},
\end{align*}
\]

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{nom gen}_{\Omega} &= \left[ \sum_{i=1}^{\mu} F^\text{nom}_{ri} - \sum_{j=1}^{\varepsilon} F^\text{nom}_{rj} \right].
\end{align*}
\]

General value nominal gravitational force of the entire disk at the last and inner control radii \(\Omega\), respectively:

\[
\frac{\xi}{\Omega} F^\text{nom gen}_{\Omega} = \frac{\xi}{\Omega} \sum_{r=1}^{\theta} \sum_{i=1}^{\mu} F^\text{nom gen}_{ri},
\]

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{nom gen}_{\Omega} &= \frac{\xi}{\Omega} \sum_{r=1}^{\theta} \left( \sum_{i=1}^{\mu} F^\text{nom gen}_{ri} - \sum_{j=1}^{\varepsilon} F^\text{nom gen}_{rj} \right).
\end{align*}
\]

The value of the nominal gravitational force after projection for the \(i\) sector (as well as for the \(j\) sectors) in the effective radius \(r\) is transformed in the same way:

\[
\frac{\xi}{\Omega} F^\text{per}_{ri} = \frac{Gm}{\Omega} \left[ \left( \frac{\langle \rho_n \rangle S \cos \alpha}{R^2} \right) \right]_{ri}.
\]

The summation of the values nominal gravitational force after projection of all sectors \(i\) at the control last and internal radii \(\Omega\) is determined as follows:

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{per gen}_{\Omega} &= \frac{\xi}{\Omega} \sum_{i=1}^{\mu} F^\text{per}_{ri},
\end{align*}
\]

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{per gen}_{\Omega} &= \left[ \sum_{i=1}^{\mu} F^\text{per}_{ri} - \sum_{j=1}^{\varepsilon} F^\text{per}_{rj} \right].
\end{align*}
\]

General value of the projected nominal gravitational force of the entire disk at the control last and internal radii \(\Omega\), respectively:

\[
\frac{\xi}{\Omega} F^\text{per gen}_{\Omega} = \frac{\xi}{\Omega} \sum_{r=1}^{\theta} \sum_{i=1}^{\mu} F^\text{per gen}_{ri},
\]

\[
\begin{align*}
\frac{\xi}{\Omega} F^\text{per gen}_{\Omega} &= \frac{\xi}{\Omega} \sum_{r=1}^{\theta} \left( \sum_{i=1}^{\mu} F^\text{per gen}_{ri} - \sum_{j=1}^{\varepsilon} F^\text{per gen}_{rj} \right).
\end{align*}
\]

FIG. 7. This is a screenshot of a full-scale model for calculating gravitational forces. 9 half-disks are shown. The left half is the sample. This is followed by 8 other half-disks, with polar coordinates built on them. The intersections of the lines of radii and lines of the grid of polar coordinates formed cells. The crosshairs in these cells are some approximate sector centroids, which is why the model cannot be considered as ideal as possible, but this approximation was sufficient in this study to collect data and calculate all possible parameters on density distributions. The indicated numbers correspond to the numbers of the control radii \(\Omega\), by which all the necessary parameters of each of the cells were calculated.
According to the formulas described in this chapter from (10) to (12) and from (15) to (17), we obtain profiles of the sums of the distributed values of the gravitational forces of the sectors at the effective radii (see Fig. 11 in Appendix C 1). Applying the formulas (13), (14), (18) and (19), we obtain the final profiles of the sums of the distributed values of the gravitational forces of cells at each control radius from the origin of polar coordinates (see Fig. 13 (b) in Appendix D).

**Important note:** to calculate the real orbital speed, only the values of the perceived gravitational force $\sum \mathbf{F}_{\text{per gen}}$ from the last two formulas (18) and (19) are suitable. Schemes of addition of gravitational forces will look like in Fig. B in Appendix B.

### E. Distribution and summation of mass values before and after the projection of the vectors of gravitational forces on the Main axis

To find the values of the nominal (real) masses of the sectors (cells) and their values after the projection of the gravitational force vectors on one of the 8 control radii, we will use the gravitational force transformation $\sum \mathbf{F}_{\text{per ri}}$ of a separate sector (cell).

The **nominal mass** value for the $i$ sector (exactly as for the $j$ sectors lying beyond the abscissa axis) in the effective radius $r$ is expressed as follows:

$$
\sum \mathbf{F}_{\text{nom ri}} = Gm \left[ \sum \mathbf{F}_{\text{nom ri}} \right] \Rightarrow 
\sum \mathbf{M}_{\text{nom ri}} = \frac{1}{Gm} \left[ \sum \mathbf{F}_{\text{nom ri}} \right].
$$

The sum of the values **nominal masses** of all sectors $i$ at the control last and inner radii $\mathfrak{R}$ is determined as follows:

$$
\mathfrak{R} \sum \mathbf{M}_{\text{nom gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{i=1}^{\mu} \mathbf{M}_{\text{nom ri}},
$$

$$
\Rightarrow \mathfrak{R} \sum \mathbf{M}_{\text{nom gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{i=1}^{\mu} \sum_{j=1}^{\mu} \mathbf{M}_{\text{nom ri j}}.
$$

**General value of the perceived mass** of the entire disk at the control last and inner radii $\mathfrak{R}$, respectively:

$$
\mathfrak{R} \sum \mathbf{M}_{\text{per gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{r=1}^{\mu} \sum_{i=1}^{\mu} \mathbf{M}_{\text{per gen ri}},
$$

$$
\Rightarrow \mathfrak{R} \sum \mathbf{M}_{\text{per gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{r=1}^{\mu} \left( \sum_{i=1}^{\mu} \mathbf{M}_{\text{per gen ri}} - \sum_{j=1}^{\mu} \mathbf{M}_{\text{per gen ij}} \right).
$$

The value of the **perceived mass** for the sector $i$ (as well as for the sectors $j$) in the effective radius $r$ is transformed in the same way:

$$
\mathfrak{R} \sum \mathbf{M}_{\text{per ri}} = \frac{1}{Gm} \left[ \mathfrak{R} \sum \mathbf{F}_{\text{per ri}} \right] = \frac{1}{Gm} \left[ \mathfrak{R} \sum \mathbf{F}_{\text{per ri}} \right] = \frac{1}{Gm} \left[ \mathfrak{R} \sum \mathbf{M}_{\text{nom gen ri}} \right].
$$

The sum of the values of the **perceived mass** of all sectors $i$ at the last control and inner radii $\mathfrak{R}$ is determined as follows:

$$
\mathfrak{R} \sum \mathbf{M}_{\text{per gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{i=1}^{\mu} \mathbf{M}_{\text{per gen ri}} - \sum_{j=1}^{\mu} \mathbf{M}_{\text{per gen rj}}.
$$

**General value of the perceived mass** of the entire disk at the control last and inner radii $\mathfrak{R}$, respectively:

$$
\mathfrak{R} \sum \mathbf{M}_{\text{per gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{r=1}^{\mu} \sum_{i=1}^{\mu} \mathbf{M}_{\text{per gen ri}},
$$

$$
\Rightarrow \mathfrak{R} \sum \mathbf{M}_{\text{per gen ri}} = \frac{\theta}{\mathfrak{R}} \sum_{r=1}^{\mu} \left( \sum_{i=1}^{\mu} \mathbf{M}_{\text{per gen ri}} - \sum_{j=1}^{\mu} \mathbf{M}_{\text{per gen rj}} \right).
$$

According to the formulas described in this chapter from (20) to (22) and from (25) to (27), we obtain the following profiles of the sums of the distributed values of the sector masses at effective radii (see Fig. 12 in Appendix C 2). Applying the formulas (23), (24), (28) and (29), we obtain the final profiles of the sums of the distributed values of the sector masses at each radius from the origin of polar coordinates (see Fig. 13 (c) in Appendix D). The values are summed in exactly the same way as the gravitational force values are summed (see Fig. B in Appendix B).

**There are several important things to note here.** Using the formulas (23) and (24), the total nominal (true) value of the disk mass $\sum \mathbf{M}_{\text{nom gen}}$ will ideally have a constant value regardless of which control radius $\mathfrak{R}_{\text{ctrl}}$ we are looking at the system. The values of any perceived masses $\sum \mathbf{M}_{\text{per gen}}$ are partly useless and have nothing to do with reality, since they only reproduce the value of the nominal mass that we would find from the formulas of the perceived gravitational forces, which are only projections of their nominal values onto the Main axis. And at the same time, they are very necessary as parameters showing us an estimate of mass, which we would calculate from the values of the perceived gravitational force, if this was our initial known parameter.
F. Obtaining the orbital speed

The classical formula for orbital velocity is expressed directly in terms of the gravitational force equated to the centrifugal force:

$$\frac{GMm}{R^2} = \frac{mv^2}{R} \Rightarrow v_{\text{orb}} = \sqrt{\frac{F_{\text{grav}} R}{m}} \tag{30}$$

To calculate the correct (true) orbital velocity according to the DCM principle, it is necessary to use only the general values of the perceived gravitational forces according to the formulas (18) and (19). Then the formula (30) takes the following form:

$$\alpha v_{\text{orb}} = \sqrt{\frac{R_\text{per gen} \rho_{\text{ctrl}}}{\rho}} \tag{31}$$

where the distance from the barycenter to the control radius $\rho_{\text{ctrl}}$ tells us that the calculation of the orbital velocity is made exclusively from the gravitational force values obtained for the corresponding control radius.

If we used just the nominal mass, then the values of the orbital (circular) velocities would be unnaturally overestimated. Therefore, such formulas would not be correct.

### TABLE III. The values of orbital speed from the Fig. 13 (d) in Appendix D are indicated in the power of 10^{-5} and are rounded to hundredths of the order.

<table>
<thead>
<tr>
<th>Models Radii, $\rho_{\text{ctrl}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models</td>
</tr>
<tr>
<td>1 (Before)</td>
</tr>
<tr>
<td>1 (After)</td>
</tr>
<tr>
<td>2 (Before)</td>
</tr>
<tr>
<td>2 (After)</td>
</tr>
<tr>
<td>3 (Before)</td>
</tr>
<tr>
<td>3 (After)</td>
</tr>
</tbody>
</table>

### VI. PLATEAU-LIKE CURVE

This is a special, separate chapter, which demonstrates the case of the plateau-difference of the rotation curve. Based on the first model, the density values were adjusted in such a way that a plateau-like velocity curve was obtained (model 4 “plateau”). The density values of the fourth model correspond to the Table IV.

The density distribution according to the 1st and 4th models corresponds to the graphs of the force of gravity, mass, as well as the curves of orbital velocities shown in Fig 14 in the Appendix E.

**Important note:** The method of finding the rotation curve is such that if you build a model based on the true luminosity of the galactic profile, and not from the density of its stellar population at a particular control radius, the expected profiles of the rotation curves will ride up higher and higher closer to the periphery than it actually exists. Therefore, ideally, the method works only when we construct the profile of the curve, first of all, based on the density of the stellar population in one or another part of the space of the galactic disk, and, in the second place, it is necessary to proceed from the luminosity of separately taken on one or another section of the stellar disk according to the Hertzsprung-Russell diagram. This is justified by the fact that not all of a single section of the galactic disk shines in one of its mean luminosity values, since there is a substantial space without stars between the stars in such a section, which is an obvious fact.

In this case, the formula for the nominal and perceived grav. forces for a specific region of space in the galactic disk should be determined as follows:

$$\frac{\alpha R F_{\text{nom} ri}}{\rho} = G m \left[ \frac{\alpha \rho_{\text{nom}}}{R^2} \right]_{ri} = G m \left[ \frac{M_{\odot} N}{R^2} \right]_{ri} \tag{32}$$

and respectively

$$\frac{\alpha R F_{\text{per} ri}}{\rho} = G m \left[ \frac{\alpha \rho_{\text{per}}}{R^2} \right]_{ri} = G m \left[ \frac{M_{\odot} N \cos \alpha}{R^2} \right]_{ri} \tag{33}$$

where $M_{\odot}$ – the mass of stars in units of solar masses, $N$ – the number (quantity) of stellar objects.

**TABLE IV. A table of numerical values for two types of density distribution of a substance.**

<table>
<thead>
<tr>
<th>Models Radii, $\rho_{\text{ctrl}}$</th>
<th>$\rho_1$</th>
<th>$\rho_2$</th>
<th>$\rho_3$</th>
<th>$\rho_4$</th>
<th>$\rho_5$</th>
<th>$\rho_6$</th>
<th>$\rho_7$</th>
<th>$\rho_8$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Before)</td>
<td>1</td>
<td>1/2</td>
<td>1/4</td>
<td>1/8</td>
<td>1/16</td>
<td>1/32</td>
<td>1/64</td>
<td>1/128</td>
</tr>
<tr>
<td>1 (After)</td>
<td>2.31</td>
<td>2.09</td>
<td>1.66</td>
<td>1.39</td>
<td>1.22</td>
<td>1.10</td>
<td>1.01</td>
<td>0.95</td>
</tr>
<tr>
<td>2 (Before)</td>
<td>2.23</td>
<td>2.41</td>
<td>2.15</td>
<td>1.95</td>
<td>1.62</td>
<td>1.45</td>
<td>1.33</td>
<td>1.23</td>
</tr>
<tr>
<td>2 (After)</td>
<td>2.31</td>
<td>2.09</td>
<td>1.66</td>
<td>1.39</td>
<td>1.22</td>
<td>1.10</td>
<td>1.01</td>
<td>0.95</td>
</tr>
<tr>
<td>3 (Before)</td>
<td>2.96</td>
<td>2.27</td>
<td>1.73</td>
<td>1.41</td>
<td>1.23</td>
<td>1.11</td>
<td>1.02</td>
<td>0.97</td>
</tr>
<tr>
<td>3 (After)</td>
<td>2.31</td>
<td>2.09</td>
<td>1.66</td>
<td>1.39</td>
<td>1.22</td>
<td>1.10</td>
<td>1.01</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**TABLE V. The values of orbital speed from the Fig. 14 (d) in Appendix E) are indicated in the power of 10^{-5} and are rounded to hundredths of the order.**

<table>
<thead>
<tr>
<th>Models Radii, $\rho_{\text{ctrl}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models</td>
</tr>
<tr>
<td>1 (Before)</td>
</tr>
<tr>
<td>1 (After)</td>
</tr>
<tr>
<td>2 (Before)</td>
</tr>
<tr>
<td>2 (After)</td>
</tr>
<tr>
<td>3 (Before)</td>
</tr>
<tr>
<td>3 (After)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Models Radii, $\rho_{\text{ctrl}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models</td>
</tr>
<tr>
<td>1 (Before)</td>
</tr>
<tr>
<td>1 (After)</td>
</tr>
<tr>
<td>2 (Before)</td>
</tr>
<tr>
<td>2 (After)</td>
</tr>
<tr>
<td>3 (Before)</td>
</tr>
<tr>
<td>3 (After)</td>
</tr>
</tbody>
</table>
VII. DARK MASS EFFECT

As it was already clarified earlier in this article, the effect of dark mass (it is also dark matter) arises in those cases when we calculate the mass and gravitational force based on the obtained rotation velocity curves using the formula for finding the mass through the ordinary formula of the orbital velocity, or by the virial theorem, where the mean square velocity of the members of the system is used, which also gives us an incorrect result. The mass values obtained from these formulas are false from the point of view of the DCM principle.

It should be remembered that the estimated (expected) Keplers of galaxies are now lined up according to the masses estimated largely from the velocities in their central regions (Fig. 8), which is why the estimated masses are low. That is, it turns out that the current estimates of the masses of galaxies are not only false due to calculations by the classical method, but, in principle, are greatly underestimated than they actually are.

Let's construct for model 4 its own keplerian (see Fig. 9), as if we were doing the calculation using the current methods. Let the reference point of the keplerian be the velocity value in the first control radius $R_{1}^\text{ctrl}$.

Estimating the mass of all matter inside this radius using the classical formula for orbital velocity, we get the following result:

$$M = \frac{v_{\text{orb}}^2 R_{1}^\text{ctrl}}{G} = \frac{(2,0814 \times 10^{-05})^2 \times 12.5}{6.67 \times 10^{-11}} \approx 81.19 \text{ kg},$$

which is an extremely low mass for the stability of the entire system. The ratio of the clarified estimated real mass (see Fig. 14-(c) in Appendix E) to the last estimate for the fourth model is $n \approx 7.84$, which clearly hints to us...


FIG. 9. The resulting “false” keplerian (red), if instead of the conditional density of some disk model substance, it contained the stellar and gas-dust components and the influence of the dark halo (black). The latter is the difference between a plateau-like curve and a keplerian.

When estimating the mass of the fourth model using the virial theorem, which supposedly includes both the mass of baryonic and non-baryonic matter, we must calculate it using the following formula:

$$M_{\text{vir}} = \frac{\langle v_{\text{orb}}^2 \rangle R_{8}^\text{ctrl}}{G},$$

where $\langle v_{\text{orb}}^2 \rangle$ is the mean square orbital velocity of all bodies in the system; $R_{8}^\text{ctrl}$ is the last control radius of the model, $G$ is the gravitational constant. It turns out that the mass of the fourth model according to this theorem will correspond to the following value: $M_{\text{vir}} \approx 926.08 \text{ kg}$, which is already more than the previous estimated value in $n \approx 11.41$ times, which should be misleading by now. And this is the mass value only at the 8th control radius of the disk model! In fact, the calculation of the virial mass occurs as long as we observe the baryonic matter related to the system, which is located quite far from the center of the galactic system, which means that the virial mass, with an ideal plateau-likeness, almost directly depends on the control radius $(M_{\text{vir}} \propto R_{\text{ctrl}})$, which is why we get excessively overestimated estimates of the mass of the entire system. And this once again gives us doubts about the correctness of the choice of the method for estimating the mass of the galaxy and, at the
same time, doubt the existence of the darkest matter. Based on the above arguments, the author proposes to consider the dark mass nothing more than an inalienable effect of gravity, or even an error in the interpretation of such an effect, which arose due to the use of incorrect methods.

In other words, the average value of the nominal (true) mass of the “fourth model”, as it was already found out (see the green dashed line in Fig. 14 (c) in Appendix E, according to the DCM principle is
\[
\langle 4.8 M_{\text{nom gen 4th mod}} \rangle \approx 636.89 \text{ kg},
\]
which is the true value of the entire mass of the disk model with the indicated earlier subdivisions. It is clear that if we concentrated all the true nominal mass in the barycenter of the disk model, as if we were acting according to the CM principle, then the resulting Keplerian would already have an upper value much higher than that of the Keplerian shown in the Fig. 9 approximately 2.8 times, which would also be a serious error and simply inappropriate modeling of useless curves.

VIII. GENERAL CONCLUSION

In the presented article, it was graphically, schematically and analytically demonstrated that the problem of the rotation curve of galaxies may well be described according to the principle of the decenter of mass proposed by the author, which complements classical mechanics and does not go beyond its scope at all.

The new principle made it possible to obtain plateau-like and any other curves of the rotation profiles of galaxies according to the true distribution of mass over the entire volume of stationary disk models, thereby describing the mechanics of rotation of baryonic matter inside such disks without using contrived additional mass – dark matter, closing the question of the problem of rotation curves and about the controversial existence of the darkest matter itself, since the latter was primarily the need to describe the behavior of the rotation curves of galactic disks, the radial motion of galaxies in clusters, as well as their accelerated formation at different stages of evolution. Among other things, the proposed principle allows one to analytically evaluate the true (nominal) values of the mass of bodies and their gravitational forces. Also, the new principle automatically resolves the cusp problem, which conflicts with the ΛCDM model. The ΛCDM model itself receives one more weighty argument about its incorrectness.

The new principle clearly makes it clear that the orbital velocities in galaxies are not an indicator of the amount, as it turned out, of the underestimated baryonic mass and, together with it, dark mass, as was seriously considered before, but the mass of the perceived, that is, pseudo-true from the point of view of the new principle. Behind the perceived mass was hidden a special, more complex mechanics of baryonic matter in galactic disks, which gave the same effect of acceleration, which was demonstrated in this paper.

As it was once again found out, calculations according to the classical principle of the center of mass are ideal either for a system of two point bodies, or for two volume bodies located at sufficiently large distances, when the bodies, in fact, can be taken for point objects, because we do not observe discrepancies in calculating the gravitational force between them, just like estimating their own masses.

Most likely, conflicting galaxy clusters, large-scale structures, as well as significant gravitational lensing in galaxies and their clusters can be explained by the natural distribution of the real component with its nominal value over their entire volume, since, as was clarified and proved in this article, the current mass estimates are excessively unnaturally underestimated.
The forerunners to the solution of this problem were non-single attempts to construct their own original theory explaining the incomprehensibility at first glance distribution of velocities in the disks of galaxies. But all of them verifiably underwent logical and factual failures and gave way to more successful ideas until this one came: simple and quite understandable, but difficult, in the author’s opinion, to execute, due to the huge amount of calculations for the bearing data. In general, for 8 models of stationary disks, it was necessary to find out 3 parameters for each of 1770 sectors, which could not be done automatically in the SketchUp program used for the master model. Among other things, a big problem was the meeting with the initially confusing different data, for which the appropriate classification had to be drawn up.

The author’s aspiration to solve the problem of the rotation curves of galaxies was caused by his dissatisfaction with the modern cosmological scientific concept, which is erroneous and is currently based on an fiction that has not been solved for more than 90 years since its appearance. Responsibility for the absence of “empty” was assigned to the elusive hypothetical particles, which are the basic components in the current dominant cosmological ΛCDM concept, and therefore the author considered it inappropriate in this article to reconcile his invention with this model, since the cosmological concept require a serious revision.

To detect an elusive particle at the present time, they are trying to carry out experiments that are complex in idea and expensive in execution with more and more technologically advanced detectors, which supposedly should detect these very particles, but, according to the author, all these experiments, as before, will fail, because the modern scientific world is looking for a solution to the problem of dark matter in the wrong places of physics and in the wrong available methods. It is because of the current desperate situation on this score that the author raised the argument that this problem may not be about particles at all, but about something that cosmologists and theorists have overlooked.

The author noticed that almost every work about dark matter had logical inconsistencies, for example: stars in disks in computer simulations of galactic systems were considered as massless particles, as if they were dusty particles that did not play any gravitational role for each other, only sticking together between itself, and only the nuclei of the disk models of galaxies played a dominant role in them, which is why it was necessary to introduce the so-called dark matter for the models to work. But this cannot be so in reality! Stars have mass, which is simply obvious, and completely wrong, according to the author, was that stellar mass was neglected in computer simulations. It is possible that the masses of the particles were deliberately omitted in such simulations, due to the additional complexity of calculating the instantaneous gravitational forces for each of the particles. In addition, based on the judgment about the presence of dark matter, on the curves obtained, an increase in the influence of dark matter is observed closer to the periphery, while, according to some statements, dark matter is also present inside the galaxies themselves, which means that its density should also reach their maximum values in the very nuclei of galaxies, in accordance with the Navarro – Frenk – White profile, which would be directly reflected in the graphs of the orbital velocity curves and on the luminosity curves – this is the so-called cusp problem. It was then that the author had a suspicion that something was wrong in this whole story. So, the gradual direction of the author’s thought led him on the path of inventing another small addition to classical mechanics - the principle of the decenter of mass, which, according to the author, can become a full-fledged description of the dynamics in galactic systems.

The application of the DCM principle will allow not only to describe the models of rotation curves, but also to make it possible to carry out a correct reassessment of the mass for individual physical bodies: both the Earth and any other celestial object, using 3D modeling of a geoidal body with a higher degree of subdivision and the ability to introduce the same density values that are already known, or some other values according to theoretical calculations. It turns out that real estimates of the masses of planets and other objects in the Universe may turn out to be completely different from what we assumed to be, using the principle of the center of mass that has long become customary, because almost all currently estimated celestial bodies are “weighed”, mainly, according to the formula of the first space speed of the satellite. The values of real masses, the author is sure, may turn out to be much larger than we imagine at the moment.

The benefits of re-evaluating the real mass of the Earth will make it possible to give a new assessment of its natural reserves, better study the evolution of its formation, and learn a lot about the properties of the earth’s core. Also, it will allow you to more accurately simulate weather conditions and more.

The redistribution of the basic principle gives a weighty reason for revising the cosmological concept itself, which will certainly force us to check many other models and concepts that follow from it, on which current knowledge of the Universe is based, because the most fundamental principle in classical mechanics has become its Achilles heel.

After a long absence of answers from endorsers, the author is forced to publish his work in the viXra repository, since this is the only place where his work can be read by all interested real researchers, enthusiasts, as well as amateurs. In turn, the ability to publish in this repository removes the special restrictions associated with expressing gratitude to those people to whom the author really wants to express.
THANKFULNESS & APPRECIATION

The author’s work would not have been completed without personal patience, diligence, inquisitiveness, enthusiasm, love for physics and astronomy and all his other best personal qualities, as well as the patience and support of his family and friends: mother Svetlana, father Oleg, sister Margarita, dog Martha and close friends: Nutella and Vadim. The author expresses his Thankfulness and Appreciation to all of them for their tremendous emotional, moral and material support for all these difficult years of work on translating the idea into a whole new knowledge about Nature.

RIGHTS AND COPYRIGHT

The concept and article are protected by copyright. It is forbidden to use this article for commercial purposes. Distribution of the article for educational purposes is allowed, but strictly with an indication of authorship. Illegal appropriation and modification of the idea is prohibited.
Appendix A: Summary of current classical mechanics

The classical formula for Newton’s gravitational force:

\[ F_{\text{grav}} = \frac{GMm}{R^2}. \]

Orbital velocity formula (first cosmic, circular):

\[ v_{\text{orb}} = \sqrt{\frac{GM}{R}}. \]

Mass expression from the orbital velocity formula:

\[ M = \frac{v_{\text{orb}}^2 R}{G}. \]

Virial mass from the virial theorem:

\[ U_g = -2E_k \Rightarrow G \frac{M_{\text{vir}} m}{R} = \frac{2m \langle v^2 \rangle}{2} \Rightarrow M_{\text{vir}} = \frac{(v^2)R}{G}, \]

where

\[ \langle v^2 \rangle = \frac{G}{n} \sum_{i=1}^{n} \frac{M_i}{R_i} \]

is the root mean square value of the particle velocity along the entire length of the rotation curve profile.
FIG. 10.
a) Addition of the gravitational forces of the sectors for the 4th effective radius $r_{\text{eff}}$. The gray area marks the area optional for addition: it is symmetrical to the calculated one, the resulting sum is duplicated.
b) Addition of gravitational forces of effective radii $r_{\text{eff}}$ for the control radius $R_{\text{ctrl}}$.
Appendix C: Graphs of values from received data

In Figs. 11* and 12*, the following color coding of the control radius numbers $R_{\text{ctrl}}$ will be used for the subsequent identification of the curves of the profile values of the effective radii $r_{\text{eff}}$, related to the numbers of such control radii, due to which the values of the resulting profiles from Figs. 13 and 14 were summed up:

<table>
<thead>
<tr>
<th>1 radius</th>
<th>2 radius</th>
<th>3 radius</th>
<th>4 radius</th>
<th>5 radius</th>
<th>6 radius</th>
<th>7 radius</th>
<th>8 radius</th>
</tr>
</thead>
</table>

(* – The Figures are located on the next page due to the technical features of $\LaTeX$.)
1. Gravitational force distribution models

FIG. 11. All left images are before projection, all right ones are after.
2. Mass distribution models

FIG. 12. All left images are before projection, all right ones are after.
Appendix D: Figures with profiles of gravitational forces, masses and velocities for three models

FIG. 13.
(a) Visualization of the distribution of the density values (see Table II) of the conditional substance along the control radii $R_{\text{ctrl}}$.
(b) The resulting profiles of the total values of the nominal and perceived gravitational forces of the entire disk at each of the control radii $R_{\text{ctrl}}$. The dashed lines are for the values of the nominal gravitational forces, the solid lines are for the values of the perceived ones.
(c) The resulting profiles of the total values of the nominal and projected nominal (perceived) masses of the entire disk at each of the control radii $R_{\text{ctrl}}$. The average mass (dashed) of the three models:
- first modes $\langle M_{\text{nom gen 1st mod}} \rangle \approx 570.72$ kg,
- second model $\langle M_{\text{nom gen 2nd mod}} \rangle \approx 216.7$ kg,
- third model $\langle M_{\text{nom gen 3rd mod}} \rangle \approx 132.45$ kg.
(d) Obtained profiles of curves of rotation speeds. Solid polynomials are true velocities.
Appendix E: Figures with profiles of gravitational forces, masses and velocities for first and fourth models

FIG. 14.
(a) Visualization of the distribution of the density values (see Table IV) of the conditional substance along the control radii $R_{ctrl}$.  
(b) The resulting profiles of the total values of the nominal and perceived gravitational forces of the entire disk at each of the control radii $R_{ctrl}$. The dashed lines are for the values of the nominal gravitational forces, the solid lines are for the values of the perceived ones.  
(c) The resulting profiles of the total values of the nominal and projected nominal (perceived) masses of the entire disk at each of the control radii $R_{ctrl}$. The average mass (dashed) of the fourth disk model is: $\langle M_{\text{nom gen 4th mod}} \rangle \approx 636.89 \text{ kg}$.  
(d) Obtained profiles of curves of rotation speeds. Solid polynomials are true velocities.