

Theory to the Mystery of the Super Massive Black Holes

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Abstract

Vera Rubin measured the rotational speeds of galaxies, Ref. [1] 1983, and she found that the masses of galaxies were not enough to produce the measured speeds of rotation. Therefore, it was inferred that there must be an unknown matter which is many times the known visible and dark matter. In this study, the solution to the dark matter mystery of spiral galaxies is a four-dimensional mass in the space of four distance dimensions, coordinates: x, y, z, x', in which x' is the fourth distance dimension. The four-dimensional mass is a black hole, and it generates the main gravitation field of the galaxy. This mysterious black hole is located in the fourth dimension at the distance x' = X'. The rotational speed distribution curves of the galaxy NGC 3198 have been presented in Ref. [2]. The speed distribution curve of the galactic halo in that publication corresponds to the speed distribution curve of the four-dimensional black hole in this study. In order to find out how well this four-dimensional model functions, the speed distribution curve of the four-dimensional black hole was calculated, and it was compared with the halo curve of Ref. [2]. The conclusion was that the calculated speed distribution curve of the black hole was a good match to the halo curve of Ref. [2]. Furthermore, the rotational speed distribution curves of the four-dimensional black hole were calculated by using different values of the reduced distance X', which yielded at the distance X' = 0 a black hole of radius $R = 7.7 \times 10^{17}$ m. By using the relativistic Lorentz transformation, it was shown in this study that a star falling into the four-dimensional black hole remains rotating it at near speed of light, and cannot fall into the actual black hole.

Keywords

Black Hole, Galaxy Rotation, Dark Matter, Atom Theory

1. Introduction

Edwin Hubble was the first astronomer who inferred that spiral nebulae are ga-

laxies located at great distances from the Milky Way, publication 1929. The speeds of stars in these galaxies have been measured based on the redshifts of the light they emit. The speed of a star results in a change in the wavelength, which is called a redshift. In the Universe, all stars at great distances shift their wavelength towards red, and therefore, it has been inferred that the Universe is expanding. By using the redshifts, Vera Rubin measured the rotating speeds of galaxies and found that the stars rotate in the outer part of the galaxy approximately at the same speed, Ref. [1] 1983. The speed of rotation is zero at the center of the galaxy, after which it rapidly increases until at a certain value it remains constant. The matter of a spiral galaxy is concentrated into a great, dense bulge at the center of the galaxy, and the rest of the galactic matter forms a large rotating spiral disk. The gravitational force of this kind of galactic matter distribution reduces approximately inversely proportional to the square of the distance from the center of the galaxy. Therefore, the constant value speed distribution is not only resulted from the visible and dark matter in the center bulge and disk of the galaxy. There must be a great amount of some other types of dark matter affecting the rotation of stars. The question is what type of mass distribution would achieve constant rotational speed distribution on the outer part of the galactic disk. It should probably be a ball-shaped dark matter formation above the galactic disk. A sufficient amount of dark matter above the galactic disk was not found. The measurements of the space telescope Hubble have not given support to this theory, Ref. [3] 1995. It seems that dark matter in the halo of the galaxy is not so massive that it could explain the constant speed distribution. After that, the search for dark matter has primarily concentrated on fundamental particles. It must be a fundamental particle that has mass and force of gravity. The particle must not have any other forces because otherwise it would have been observed by now. Fundamental particles like this have been searched in mine shafts that enable minimal disturbing factors. Richard Panek has written on the latest difficulties in the research of the Universe, Ref. [4] 2020. Astronomers have calculated how fast the universe is expanding. Two different calculation methods have two different results. The cause of the discrepancy may be the fact that physics has new unknown phenomena. In Ref. [5] 2022, Anil Ananthaswamy has written about the same theme: How fast is the Universe expanding? How much does the matter clump up? The final conclusion is: We are missing something.

In Ref. [6] "Galaxy Rotation in the Space of Four Distance Dimensions", the dark matter mystery has been solved in the Universe of four distance dimensions. Ref. [6] presented a new idea that dark matter is located at the fourth distance dimension above the center of the galaxy. In the same manner as a structure of three dimensions can be drawn in the cross-sections of two dimensions, a structure of four dimensions can also be drawn in the cross-sections of two or three dimensions. Therefore, the determination of the location of dark matter in the fourth dimension is no problem. The study in Ref. [6] contains the solution to the dark matter mystery of spiral galaxies by using the space of four distance di-

mensions x, y, z, x', in which x' is the fourth distance dimension. The four-dimensional mass M, which generates the main gravitation field of the galaxy, is located in the fourth dimension at the distance x' = X' and the other dimensions are zero x = 0, y = 0, z = 0. The speed distribution curve of the four-dimensional mass v_M is the effect of the mass M on the total rotational speed of the galaxy. Ref. [2] has presented the rotational speed distribution curves of the galaxy NGC 3198. The speed distribution curve of the galactic halo in Ref. [2] corresponds to the speed distribution curve v_M of the four-dimensional mass M in Ref. [6]. In order to find out how well this four-dimensional model functions, the speed distribution curve v_M was calculated, and it was compared to the halo speed distribution curve of Ref. [2]. The conclusion was that the calculated distribution curve v_M is a good match to the halo curve in Ref. [2]. Furthermore, four rotational speed distribution curves v_M were calculated using different values of the distance X'_{i} , which yielded different values for the maximum radius of the galaxy. In this manner, the different galaxy models of Ref. [1] were obtained, and therefore, this solution to the dark matter mystery was proved.

Ref. [7] "The Solution to the Dark Energy Mystery in the Universe of Four Distance Dimensions" solves the mystery of dark energy by using the structure of the four-dimensional Universe. The model of the Universe is the surface volume of the four-dimensional spherical Universe. This type of structure of the Universe creates the same kind of an accelerating redshift increase that has been measured. The cause of the redshift in this model of the Universe is its structure, and therefore, there is no accelerating expansion of the Universe. In order to prove this theory, the model of the surface volume of the four-dimensional Universe was constructed, the equation of the redshift caused by this Universe was solved, and the theoretical equation was shown to be the same as the measured redshift in the Universe. The measured redshift in the Universe was obtained from the derivative of the model of the expanding Universe in Ref. [8]. A similar model of the Universe has been constructed by NASA [9]. The four-dimensional model of the Universe in this study yielded the Universe that was found to have decelerating expansion until this point of time and a Big Bang that was not very big.

Black hole is a body of space which is so massive that even the speed of light is not enough to escape it. In this publication the function of the black holes is studied in our Universe of three distance dimensions, and in the super Universe of four distance dimensions. In the for-dimensional Universe, the black holes are rotating galaxies, and if they are near enough to our three-dimensional Universe, they can act as quasars. The quasars spit matter into space, and therefore it can be inferred that their black holes are out of our three-dimensional Universe. No matter can escape the gravitational force of that kind of black hole. Astronomers have been searching for suitable black hole candidates, and the most famous are, Ref. [10]: Sagittarius A*, mass 7.8×10^{36} kg, which is the supermassive black hole at the centre of our Milky Way. It's generally inactive, with only modest X-ray outbursts as it consumes small gas clouds. The first black hole to be imaged right down to the event horizon, revealing the black hole's "shadow" on the surrounding accretion disc is Messier 87 black hole, mass 1.2×10^{40} kg. The most massive black hole is the supermassive black hole found in the quasar TON 618, mass 12.5×10^{40} kg.

2. Method of Calculation

In the following, a simple method has been presented to see the space of four distance dimensions, and to perform calculations in it. In **Figure 1**, a box is drawn in the three-dimensional space x,y,z. On **Figure 2**, the same box is drawn in the two-dimensional space z,x and on **Figure 3** it is drawn in the two-dimensional space z,y. There is still a third possible set of coordinates x,y, but it is not needed to determine the shape of the box. Here, it is seen that a structure of three dimensions can be drawn in a two-dimensional coordination system. In the same manner, a structure of four dimensions can be drawn in coordination with the three dimensions x,y,z, y,z,x', x,z,x', x,y,x'. If the structure is simple, it is possible



Figure 1. A box drawn in coordination of three-dimensional space *x*,*y*,*z*.



Figure 2. The box of Figure 1 drawn in coordination of two-dimensional space z,x.



Figure 3. The box of Figure 1 drawn in coordination of two-dimensional space *z*,*y*.

that only one two-dimensional co-ordination is needed to determine the form of the structure.

3. Calculation of the Rotational Speed of Galaxy

In Figure 4, the four-dimensional space x,y,z,x' is presented as a drawing of two-dimensional coordination system x,x'. The Universe is comprised of three dimensions x,y,z and the enlarged Universe has four dimensions x,y,z,x'. The coordination system of Figure 4 is constructed from the coordination system of Figure 1 so that the galaxy rotates at the plane of x,y coordinates and the coordinate z has been exchanged to the coordinate of the fourth-dimension x'. In the figure a star of mass m rotates round about the center of galaxy O. The rotation axis of the galaxy is the coordinate x' and the four-dimensional mass M is at the distance X' from the center of galaxy O. The mass of the star m and four-dimensional mass M draws each other with the force of gravity. Because the three-dimensional gravity force of the star is lacking the force of fourth dimension, the force that has an effect on the star is $F\cos a$.

It seems that this model fits very well for the measurements. Near the center of galaxy, rotational speeds from the redshift measurements and theoretically calculated speeds from the light intensities of rotating stars have relatively good correspondence. In the center of galaxy, the gravity force between the star of mass m and the four-dimensional mass M is in the x' axis direction, and it disappears completely. At the border areas of the galactic rotating disk the gravity force of the mass M increases in the x axis direction $F\cos a$ which is according to the redshift measurements. Even over 90% of the gravity forces acting at the border areas of galaxy cannot be explained by the masses of the known visible and dark matter. This model of the space of four dimensions can explain the weird rotation speeds of galaxies.

The mystery of dark matter in the rotation of galaxies is a common subject matter in the study books of cosmology, Ref. [11]. This mystery has been solved in this paper by the gravitational force of four-dimensional mass in the



Figure 4. A star with mass *m* rotates round about the center of galaxy *O* at the distance *R*. Fourth-dimensional mass *M* is located at the distance *X*'from the center of galaxy.

space of four dimensions. In Figure 5, the star with mass m rotates round about the center of galaxy along the circle of radius R. As the star rotates, the force of gravity which has an effect on the star is equal to the centrifugal force of its rotation movement.

The differentia of the gravitational force is equal to the differentia of the centrifugal force.

$$\frac{\gamma m \Delta M(x)}{\left(R-x\right)^2} = \frac{m}{R} d\left(v_n^2\right)$$
(1)

If x < R, the differentia of the gravitational force increases the centrifugal force.

If x > R, the differentia of the gravitational force decreases the centrifugal force.

Therefore, this equations shows that the halo mass distribution structure cannot be the solution to the galaxy rotation speed mystery because Equation (1) cancels as halo structure continues about the same mass M(x) on the both sides of the location of the mass m, and there is no rotation speed generation. The dark matter which rotates the galaxy must be on the rotation axis, or near it.

Summation yields the centrifugal force component of the visible galactic mass

$$\gamma m \sum \frac{\Delta M(x)}{\left(R-x\right)^2} = \frac{m}{R} \int d\left(v_n^2\right) = \frac{mv_n^2}{R}$$
(2)

The star's rotational speed round about the center of the galaxy is v. The speed distribution components of the star's rotational speed v are as follows: the speed distribution component from the visible mass is v_n and from the ordinary dark matter is v_p and the speed distribution component from the four-dimensional mass M is v_M . The centrifugal force components are from visible mass, from ordinary dark matter and from the four-dimensional mass M.

$$\frac{m(v_n)^2}{R} \quad \frac{m(v_p)^2}{R} \quad \frac{m(v_M)^2}{R} \quad (3)$$

The following equation is obtained by adding the three centrifugal force component.



Figure 5. Calculation of the effect of the visible galactic mass $\Delta M(x) = M(x + dx/2)dx$ on the rotational speed component v_n of the star which mass is *m*.

$$\frac{mv^2}{R} = \frac{m(v_n)^2}{R} + \frac{m(v_p)^2}{R} + \frac{m(v_M)^2}{R}$$
(4)

$$v^2 = v_n^2 + v_n^2 + v_M^2 \tag{5}$$

The total rotational speed curve v and the rotational speed curve of visible mass v_n are known, the rotational speed curve of ordinary dark matter v_n is not knows, but it can be concluded that it is the same form as the speed curve of the visible matter v_n . The rotational speed curve of the four-dimensional mass $M v_M$ is not known and it will be calculated by using the knowledge of the rotational system. In Figure 6, a star which mass is *m* rotates round about the center of galaxy O at the distance R. The four-dimensional mass M is on the rotation axis x'at the distance X' from the center of galaxy. The galaxy has two rotational axes zand x'. This can be seen as follows: The rotating star system in the four-dimensional space x, y, z, x' in Figure 6 is transformed into the system of oscillating atom about zero point O in the three-dimensional system x, y, x'. If the oscillating atom is at the point of the mass *m*, and it is oscillating along the axis *x* about the point O, it has two axes about which it oscillates y,x' in the three-dimensional space x, y, x'. In the same manner the star rotating round about point O has two axes $z_{,x}$ round about which it rotates in four-dimensional space $x_{,y,z,x}$. The gravity force of the three-dimensional mass decreases in the inverse value of the square of the distance, and it can be supposed that the gravity force of the four-dimensional mass decreases in the inverse of the cube of the distance, and therefore, the gravity force of the four-dimensional mass M is

$$F = \frac{\gamma mM}{\left(R^2 + (X')^2\right)^{3/2}}$$
(6)

in which the component at the direction of *x*-axis is

$$F\cos\alpha = \frac{\gamma mM}{\left(R^2 + (X')^2\right)^{3/2}} \cdot \frac{R}{\left(R^2 + (X')^2\right)^{1/2}}$$
(7)



Figure 6. A star of mass *m* rotates round about the center of galaxy *O* along a circle trajectory of the radius *R*. The gravity effect on the star from the four-dimensional mass *M* is at the direction of *x* axis $F\cos a$.

$$F\cos\alpha = \frac{R\gamma mM}{\left(R^2 + \left(X'\right)^2\right)^2}$$
(8)

The centrifugal force component corresponding to the four-dimensional mass $M{\rm is}$

$$\frac{m(v_M)^2}{R} \tag{9}$$

Calculation of the speed distribution curve of the four-dimensional mass v_M . The gravitational force is equal to the centrifugal force.

$$\frac{m(v_{M})^{2}}{R} = \frac{R\gamma mM}{\left(R^{2} + (X')^{2}\right)^{2}}$$
(10)

The speed distribution component of the four-dimensional mass M

$$v_{M} = \sqrt{\frac{R^{2} \gamma M}{\left(R^{2} + \left(X'\right)^{2}\right)^{2}}} = \frac{R \sqrt{\gamma M}}{R^{2} + \left(X'\right)^{2}}$$
(11)

The four-dimensional mass M

$$M = \frac{v_M^2 \left(R^2 + \left(X' \right)^2 \right)^2}{R^2 \gamma}$$
(12)

Equation (10) at the distances R_1 and R_2 from the center of galaxy

$$\frac{m_1(v_{M1})^2}{R_1} = \frac{R_1 \gamma m_1 M}{\left(R_1^2 + \left(X'\right)^2\right)^2}$$
(13)

$$\frac{m_2 \left(v_{M2}\right)^2}{R_2} = \frac{R_2 \gamma m_2 M}{\left(R_2^2 + \left(X'\right)^2\right)^2}$$
(14)

By dividing the two equations above

$$\frac{R_2^2 (v_{M1})^2}{R_1^2 (v_{M2})^2} = \frac{\left(R_2^2 + (X')^2\right)^2}{\left(R_1^2 + (X')^2\right)^2}$$
(15)

$$a = \frac{v_{M1}R_2}{v_{M2}R_1}$$
(16)

$$a\left(R_{1}^{2}+\left(X'\right)^{2}\right)=R_{2}^{2}+\left(X'\right)^{2}$$
(17)

The distance of the four-dimensional mass M from the center of galaxy

$$X' = \sqrt{\frac{R_2^2 - aR_1^2}{a - 1}}$$
(18)

The values of the total rotational speeds v have been calculated from the redshifts of the rotating stars of the galaxies. The rotational speed distribution component of the visible stars v_n has been calculated from the gravity force of their mass, which has been calculated according to their light intensity, and the result of which is like the distribution curves in **Figure 7**. It can be supposed that the speed distribution curve from the ordinary dark matter v_p is the same form as the speed distribution curve from the visible light v_n . By using these three speed distribution curves it is possible to calculate with Equation (6) the speed distribution curve which corresponds to the speed distribution curve v_M of the four-dimensional mass M. In Ref. [2] has been calculated the halo speed distribution curve, which corresponds to the curve v_M of Equation (11). They can be compared. The system of galaxy rotation of this study is a hypothesis, and it must be proved to be correct or not correct. With a pair of the rotational speeds v_{M1} and v_{M2} and the radii R_1 and R_2 it can be done.

The speed distribution curves of the galaxy NGC 3198 have been presented in Ref. [2]. The speed distribution curve of the galactic halo in that publication corresponds to the speed distribution curve v_M of the four-dimensional mass of this study. In order to find out how well this four-dimensional model functions, the speed distribution curve v_M of the four-dimensional mass has been calculated by using these rotational radius and speed values.

$$R_1 = 3 \times 10^{20} \text{ m}$$
 $R_2 = 8 \times 10^{20} \text{ m}$
 $v_{M1} = 80 \text{ km/s}$ $v_{M2} = 130 \text{ km/s}$

This is the best fitting to the halo component of the speed distribution curve in Ref. [2]. The fitting succeeded well enough, and it proved that the four-dimensional mass is real.

The distance of the four-dimensional mass M from the center of the galaxy, Equation (16) and (18)



Figure 7. Total speed distribution curve v and speed distribution curve of visible light v_n which is the same shape as the speed distribution curve of ordinary dark matter v_p . Speed distribution curve v_M of the four dimensional mass M has been calculated with Equation (11), and the speed curves v_p and v_n have been calculated from the speed curve v_M with Equation (5) using the fact that speed curve v is level shape curve.

$$a = \frac{v_{M1}R_2}{v_{M2}R_1} = \frac{0.8 \times 8}{1.3 \times 3} = 1.64$$
$$X' = \sqrt{\frac{R_2^2 - aR_1^2}{a - 1}} = \sqrt{\frac{8^2 - 1.64 \times 3^2}{0.64}} \times 10^{20} \,\mathrm{m} = 8.8 \times 10^{20} \,\mathrm{m}$$

The four-dimensional mass M, Equation (12)

$$M = \frac{v_M^2 \left(R^2 + (X')^2\right)^2}{R^2 \gamma}$$
$$M = \frac{0.8^2 \times 10^{10} \left(3^2 \times 10^{40} + 8.8^2 \times 10^{40}\right)^2}{3^2 \times 10^{40} \times 6.67 \times 10^{-11}} \text{ kg} = 79.8 \times 10^{61} \text{ kg}$$

within the accuracy of this study $M = 80 \times 10^{61}$ kg.

4. Calculation of the Black Hole

The rotational speed of the super massive black hole is the speed of light c = 300,000 km/s. The rotational speed distribution curve of the four-dimensional mass M, v_M in **Figure 8**, and it corresponds to the component of halo speed distribution curve of the galaxy NGC 3198 in Ref. [2]. The four-dimensional mass which produces the speed distribution curve is $M = 80 \times 10^{61}$ kg, and its location $X' = 8.8 \times 10^{20}$ m at the four-dimensional rotation axis. The dark matter



Figure 8. The rotational speed distribution curve v_M of the four-dimensional mass *M* has been presented as the function of the radius *R*. The rotational speed distribution curve v_M is calculated with Equation (11) by using the values of the mass $M = 80 \times 10^{61}$ kg and its distance from the center of galaxy $X' = 8.8 \times 10^{20}$ m, and it is the best fitting of Equation (11) to the component of halo speed distribution of the galaxy NGC 3198, Ref. [2]. The maximum value of the speed distribution curve is $v_M = 131$ km/s at the radius $R = 8.8 \times 10^{20}$ m (29.2 kpc), and it is about the same as the maximum radius of the galaxy NGC 3198 in Ref. [2], $R = 9.0 \times 10^{20}$ m.

must be at the galaxy's rotation axis, or near it. Otherwise, it does not rotate the galaxy. This is the only location which can generate the measured dark matter component of the galaxy's speed distribution curve. This can be inferred from Equation (1) and (2). Therefore, the dark matter of the galaxy NGC 3198 cannot be a halo structure. It could be a black hole, but because there is no black hole at that position near galaxy NGC 3198, the dark matter is not in our three-dimensional Universe. In this study, a theoretical Black Hole is calculated so that the location of the four-dimensional mass $M = 80 \times 10^{61}$ kg, $X' = 8.8 \times 10^{20}$ m is shifted at the rotational axis towards the center point of the galaxy's rotation. The maximum value of the speed distribution curve of the four-dimensional mass v_M is at the point in which the derivative of the speed distribution curve is zero. Equation (11)

$$v_{M} = \frac{R\sqrt{\gamma M}}{R^{2} + \left(X'\right)^{2}}$$
(19)

Derivation formula

$$\frac{d\left(\frac{u}{v}\right)}{dx} = \frac{\frac{du}{dx} \cdot v - \frac{dv}{dx} \cdot u}{v^2}$$
(20)

Derivation of the speed distribution curve

$$\frac{\mathrm{d}v_{M}}{\mathrm{d}R} = \sqrt{\gamma M} \frac{\left(R^{2} + \left(X'\right)^{2} - 2R \cdot R\right)}{\left(R^{2} + \left(X'\right)^{2}\right)^{2}} = \sqrt{\gamma M} \frac{\left(X'\right)^{2} - R^{2}}{\left(R^{2} + \left(X'\right)^{2}\right)^{2}}$$
(21)

The maximum value of the speed distribution curve v_{Mx} is at the radius R_x

$$\frac{\mathrm{d}v_{M}}{\mathrm{d}R} = 0 \Longrightarrow \sqrt{\gamma M} \frac{\left(X'\right)^{2} - R_{x}^{2}}{\left(R_{x}^{2} + \left(X'\right)^{2}\right)^{2}} = 0 \Longrightarrow R_{x} = X'$$
(22)

$$v_{Mx} = \sqrt{\gamma M} \frac{R_x}{R_x^2 + R_x^2} = \sqrt{\gamma M} \frac{1}{2R_x}$$
(23)

$$v_{Mx} = \sqrt{\gamma M} \frac{1}{2X'} \tag{24}$$

The maximum value of the speed distribution curve v_M is at the point X' = R. It is also about the maximum radius of the galaxy NGC 3198 $R = 9.0 \times 10^{20}$ m in Ref. [2]. In **Figure 9** the speed distribution curve v_M which is generated by the four-dimensional mass $M = 80 \times 10^{61}$ kg, $X' = 8.8 \times 10^{20}$ m is shifted toward the center point of the galaxy, and the maximum speed of the distribution curve increases.

The whole Black Hole is in our three-dimensional Universe when the galaxy's fourth dimension X' is zero.

$$X' = 0$$

$$v_{M0} = \sqrt{\gamma M} \frac{R}{R^{2} + (X')^{2}} = \sqrt{\gamma M} \frac{1}{R}$$
(25)

The radius of the Black Hole R_0 corresponds to the speed of light (300×10^3 km/s)



Figure 9. Four rotational speed distribution curves v_M presented as a function of radius *R* from the center of galaxy. The speed distribution curve v_M which is generated by the four-dimensional mass $M = 80 \times 10^{61}$ kg, $X' = 8.8 \times 10^{20}$ m is shifted toward the center point of the galaxy, and the maximum speed of the distribution curve increases. As the distance X' decreases $X' = 2 \times 10^{20}$ m $\Rightarrow X' = 0.1 \times 10^{20}$ m (6.5 kpc $\Rightarrow 0.32$ kpc) the maximum speed of the speed distribution curve increases $v_M = 577$ km/s $\Rightarrow v_M = 11,500$ km/s. The maximum speed of 11,500 km/s is enough for a quasar.

in the speed distribution curve $v_{M0} = 3 \times 10^8$ m/s. The point is indicated with dash lines in Figure 10.

$$v_{M0} = \sqrt{\gamma M} \frac{1}{R_0} = 3 \times 10^8 \,\mathrm{m/s}$$
 (26)

$$R_0 = \frac{\sqrt{6.67 \times 10^{-11} \times 79.8 \times 10^{61}}}{3 \times 10^8} = 7.7 \times 10^{17} \,\mathrm{m}$$
(27)

The surface of the four-dimensional sphere at the radius R from the center of the sphere is a volume, and therefore the surface of a Black Hole is a volume. The volume of the center of a Black Hole is infinite.

The maximum radius of the galaxy R_x is at the point of the maximum value of the speed distribution curve v_M . Between the maximum value of the speed distribution curve v_M and the center point of the galaxy there is a large hole in the gravitational field of the Black Hole, and matter falling into this hole produces the galaxy in our Universe. Therefore the maximum radius of the galaxy R_x is at the point of the maximum value of the speed distribution curve v_M . Black Hole's mass can be calculated from Equation (23).

$$v_{Mx} = \sqrt{\gamma M} \frac{1}{2R_x}$$
$$M = \frac{4R_x^2 \left(v_{Mx}\right)^2}{\gamma}$$
(28)

In Ref. [7] hard evidence has been presented that our three-dimensional Universe is the surface volume of four-dimensional sphere. In **Table 1** the fourdimensional masses of the Black Holes at the center of the sphere have been calculated, and it seems to be that at the longer distance there are more massive Black Holes, Equation (22) $X' = R_x$.

From Equation (11) the effect of four-dimensional mass M on the rotational speed distribution curve v_M is as follows:



Figure 10. Five rotational speed distribution curves v_M presented as a function of the radius R from the center of galaxy. The speed distribution curves in this figure have been derived by shifting the four-dimensional mass $M = 80 \times 10^{61}$ kg, distance $X' = 8.8 \times 10^{20}$ m towards the center point of the galaxy. This speed distribution curve of the mass $M = 80 \times 10^{61}$ kg, $X' = 8.8 \times 10^{20}$ m is in **Figure 8**, and it corresponds to the halo component of speed distribution curve of the galaxy NGC 3198. The four speed distribution curves indicate the effect of the fourth distance X' on the speed distribution curves v_M . As the distance X' decreases $X' = 4 \times 10^{17}$ m $\rightarrow X' = 3 \times 10^{17}$ m (13 pc $\rightarrow 9.7$ pc) the maximum rotational speed increases $v_M = 287,000$ km/s $\rightarrow 385,000$ km/s, Equation (24). The speed of light is 300,000 km/s, and therefore the theoretical galaxy $M = 80 \times 10^{61}$ kg, $X' = 3 \times 10^{17}$ m is a Black Hole in our three-dimensional Universe. The radius of the theoretical Black Hole $M = 80 \times 10^{61}$ kg, X' = 0 m is according to Equation (27) is $R_0 = 7.7 \times 10^{17}$ m.

Table 1.	Black Ho	ole mass 4	Mand posit	ion $X' = R$, calculated	with Equa	tion (28) f	rom Ref.
[1].								

Galaxy	R_x kpc	$R_x 10^{20} \text{ m}$	$v_{Mx} 10^5 \text{ m/s}$	$M10^{61}\mathrm{kg}$
UGC 2885	100	30.80	2.90	4800
NGC 801	50	15.40	1.85	490
NGC 2998	32	9.86	1.54	140
NGC 3198	30	9.24	1.30	87
NGC2742	12	3.70	1.20	12

$$v_{M} = \sqrt{\gamma M} \frac{R}{R^{2} + (X')^{2}} = \sqrt{M} \frac{R\sqrt{\gamma}}{R^{2} + (X')^{2}}$$
 (29)

As it is obvious that the effects of three- and four-dimensional masses are the same, except for the effect of the distance *R*, it can be inferred that the coefficients of gravity are the same, except for the quality, $\gamma = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^3 \cdot \text{kg}^{-2}$.

In **Figure 11** a star is falling into the Black Hole. The transformation of the relativity measurements compatible with the invariance of the velocity of light is according to Ref. [12] (page 123), the Lorentz transformation

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad t' = \frac{t - \frac{xv}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$
(30)

The distance of the observer from the Black Hole is x, the star is falling into the Black Hole at the speed of light v = c, time is t, the distance of the star from the Black Hole seen by the observer is x - ct, the distance of the star from the Black Hole calculated with the principal of relativity is x'

$$x' = \frac{x - ct}{\sqrt{1 - \frac{c^2}{c^2}}} = \infty \quad t' = \frac{t - \frac{xc}{c^2}}{\sqrt{1 - \frac{c^2}{c^2}}} = \infty$$
(31)

Therefore the real distance of the star from the Black Hole is infinite, and the time has stopped, and the star cannot fall into the Black Hole at any time. The speed of the star cannot be higher than *c* because otherwise $\sqrt{1-\frac{v^2}{c^2}}$ would be imaginary. Most probable is that the path of motion of the star falling into the Black Hole is rotation about it. The extreme gravitation of the Black Hole accelerates the star near the speed of light, and the falling into the Black Hole slows down.



Figure 11. A star is falling into the Black Hole. The speed of the star is v, time of the observer is t, the distance of the star from the observer is vt, and the distance of the Black Hole from the observer is x. The distance of the Black Hole from the star as seen at the star is x', and the time at the star is t'.

5. Conclusions

In **Figure 12**, a star is falling into the Black Hole. In the falling movement, the change of the kinetic energy is equal to the work that is done by the force of gravity. The first calculation is in the three-dimensional gravitational field of our



Figure 12. A star is falling into the Black Hole. The beginning of the fall is at the 0-point. The distance of the star from the 0-point is *x*, the distance from the 0-point to the Black Hole is x_0 . The Black Hole in the figure is the theoretical Black Hole $M = 80 \times 10^{61}$ kg, X' = 0 m in **Figure 10**, and the radius of the Black Hole according to Equation (26) is $R_0 = 7.7 \times 10^{17}$ m.

three-dimensional Universe, and the second calculation is in the four-dimensional gravitational field of the four-dimensional Universe.

The first calculation in the three-dimensional gravitation field: A star is falling into the Black Hole of the radius is $R_0 = 7.7 \times 10^{17}$ m, and the starting point is $x_0 = 10^{20}$ m; the speed of falling star is $v = 0 \rightarrow 3 \times 10^8$ m/s; the speed of light is $c = 3 \times 10^8$ m/s.

$$x_0 - x$$
 7.7 × 10¹⁷ m
 x_0 10²⁰ m
 c 3 × 10⁸ m/s

$$\frac{1}{2}md(v^{2}) = \frac{\gamma mM}{(x_{0} - x)^{2}}dx \quad \frac{1}{2}v^{2} = \int_{0}^{x} \frac{\gamma M}{(x_{0} - x)^{2}}dx$$
(32)

$$\frac{1}{2}v^{2} = \gamma M(-1)(-1)\left[\frac{1}{x_{0}-x} - \frac{1}{x_{0}}\right]$$
(33)

$$M = \frac{v^{-1}}{2\gamma \left[\frac{1}{x_{0} - x} - \frac{1}{x_{0}}\right]}$$
$$M = \frac{9 \times 10^{16}}{2 \times 6.67 \times 10^{-11} \times \frac{1}{7.7 \times 10^{17}}} = 5.2 \times 10^{44} \,\mathrm{kg}$$
(34)

The second calculation is performed in the four-dimensional gravitational field of the four-dimensional Universe

$$\frac{1}{2}md(v^{2}) = \frac{\gamma mM}{(x_{0} - x)^{3}}dx \quad \frac{1}{2}v^{2} = \int_{0}^{x} \frac{\gamma M}{(x_{0} - x)^{3}}dx$$
(35)

$$\frac{1}{2}v^{2} = \gamma M\left(-\frac{1}{2}\right)\left(-1\right)\left[\frac{1}{\left(x_{0}-x\right)^{2}}-\frac{1}{x_{0}^{2}}\right]$$
(36)

$$M = \frac{9 \times 10^{16}}{6.67 \times 10^{-11} \times \frac{1}{7.7^2 \times 10^{34}}} = 80 \times 10^{61} \,\mathrm{kg}$$
(37)

The speed distribution curves of the galaxy NGC 3198 have been presented in Ref. [2]. The speed distribution curve of the galactic halo in that publication

corresponds to the speed distribution curve v_M of the four-dimensional mass of this study. This speed distribution curve is in Figure 8, and it is produced by the Black Hole $M = 80 \times 10^{61}$ kg, $X' = 8.8 \times 10^{20}$ m in the four-dimensional Universe. In this study, this Black Hole has been shifted toward our three-dimensional Universe, and at the distance X' = 0 the radius of this theoretical Black Hole is 7.7×10^{17} m. According to the first calculation in the three-dimensional gravity, this theoretical Black Hole radius is resulted from the mass 5.2×10^{44} kg. It can be compared with the real masses which have been found in our three-dimensional Universe. The most massive Black Hole is the quasar TON 618 with a mass 66 billion times greater than our Sun, and its mass is $66 \times 10^9 \times 2 \times 10^{30}$ kg = 13.2×10^{40} . The first calculation yielded the mass for the theoretical Black Hole 5.2×10^{44} kg and therefore the Black Hole of this mass is not in our threedimensional Universe. The theoretical Black Hole $M = 80 \times 10^{61}$ kg, $X' = 0.1 \times$ 10^{20} in Figure 9 produces the gravity field with a maximum speed of rotation 11500 km/s, and it is enough to create the quasar. The fact that a quasar ejects matter along its rotational axis is proof that the quasar is not a Black Hole in our three-dimensional universe, but rather, as suggested by its location, exists in the fourth dimension. As it is seen in the Lorentz transformation above, the star falling into the Black Hole does not reach the Black Hole, but the observer sees that the falling stops before the Black Hole. Therefore the matter of the Black Hole is not three-dimensional matter, but it is four-dimensional matter.

The first calculation continues. The centrifugal force is equal to the gravitational force in the three-dimensional gravitational field.

$$\frac{mv^2}{R} = \frac{\gamma mM}{R^2} \quad M = \frac{v^2 R}{\gamma} = \frac{9 \times 10^{16} \times 7.7 \times 10^{17}}{6.67 \times 10^{-11}} = 10.4 \times 10^{44} \, \text{kg}$$
(38)

The second calculation for the four-dimensional gravity yielded the mass of the Black Hole $M = 80 \times 10^{61}$ kg for the direct falling into the Black Hole which is the same value that has been in the rotational speed curves indicating the rotational falling into the Black Hole. Therefore, it can be concluded that the Black Hole of the four-dimensional matter is real. The first calculation for the three-dimensional gravity yielded the mass of the Black Hole for the direct falling into the Black Hole $M = 5.2 \times 10^{44}$ kg, and in the rotational falling into the Black Hole 10.4×10^{44} kg. Therefore, it can be concluded that the Black Hole of three-dimensional mass is not real.

Justification

1) The original Black Hole theory that shifting the real Black Hole of the galaxy NGC 3198 into our three-dimensional Universe was not true. The most massive Black Hole of our Universe was not massive enough for that theory. However, there is a right kind of Black Hole for the quasar TON 618, but that Black Hole is in the four-dimensional Universe. That can explain the fact that matter can escape from the gravitation force of quasar.

2) A common belief has been that the mysterious missing dark matter could

be a halo structure around the galaxy. But it cannot be a halo structure because that kind of structure does not rotate the galaxy. That can be inferred from Equation (1). To be able to rotate the galaxy the dark matter must be on the galaxy's rotation axis, or near it. But the mass which is many times the mass of the whole galaxy would be a Black Hole, and it would destroy the galaxy. Therefore it cannot be a solution to this problem. The only option is that the mysterious missing dark matter is located out of our three-dimensional Universe.

Furthermore, the theories of Refs. [6] and [7] were proven to be true, and they also have an impact on this study. The following is presented the progress of the galaxy rotation hypothesis. This hypothesis states that the major gravitational force of the galaxy rotation is due to the four-dimensional mass which is the Black Hole of this study.

In Figure 13, the progress of the research and testing the hypothesis is presented in the same manner as in Karl Poppers's book [13]. The first step, the hypothesis, is that the major gravitational field which rotates the galaxy is due to a dark fourth-dimensional matter M which is located at the galaxy's fourth-dimensional rotation axis.

The second step is the derivation of the equations. This phase of proceeding involves the derivation of mathematics of the galaxy rotation. The speed distribution curve v_M of the four-dimensional mass M, Equation (11) and (12), has been calculated by using two pairs of rotational radius and speed values which are approximately the same as in Ref. [2] the speed distributions curves of the galactic halo of the galaxy NGC 3198.

The third step is the test prediction which is that the speed distribution curve of galactic halo in Ref. [2] corresponds to the speed distribution curve v_M of four-dimensional mass of this study.



Figure 13. The progress of testing the hypotheses of the fourth-dimensional mass is presented by using the method of Karl Popper, Ref. [13].

The fourth step is the measurements. The four-dimensional mass value $M = 80 \times 10^{61}$ kg was calculated with Equation (12) and it is the Black Hole of this study. Its distance above the center of galaxy in the four-dimensional axis $X' = 8.8 \times 10^{20}$ m was calculated with Equation (18). The rotational speed distribution component of the four-dimensional mass v_M was calculated with Equation (11), and it is presented in **Figure 8**. The rotational speed curve v_M was compared to the real measurements of Ref. [2].

The fifth step is the analysis of the result and justification.

1) By comparing the speed distribution curve of the four-dimensional mass with the speed distribution of halo in Ref. [2], it was inferred that it corresponded approximately to the halo distribution. The sources of inaccuracy are the redshift measurements and the evaluation of the mass distribution of ordinary dark matter. The halo speed distribution curve of Ref. [2] corresponds quite well to the speed distribution of four-dimensional mass v_M until the radius R = 30kpc. In Ref. [2] the speed measurements has been done until the radius R = 30kpc, which obviously is the maximum radius of galaxy, but however the halo curve continue until radius R = 50 kpc. In the region 30 - 50 kpc the halo speed curve of Ref. [2] and the four-dimensional mass speed curve v_M begins to be separated from each other significantly. The speed curve of four-dimensional mass v_M decreases in this region, but the halo speed curve of Ref. [2] continues to increase. It is possible that the maximum radius of galaxy is determined according to the point in which the speed curve v_M begins to decrease.

2) The generation process of the galactic system can be explained. The force of gravitation of the four-dimensional mass M acts on the rotational plane of galaxy. It has no component at the direction of the fourth dimension because the three-dimensional mass of galaxy of stars, planets, gas, dust and other matter have not gravity force of four-dimensional force of gravity. The result is that the four-dimensional mass M generates a gravitational field which has a great hole at the center of galaxy. The gravitational field of the four-dimensional mass accelerates the three-dimensional mass of stars, planets, dust, and other matter into the speed of rotation in which it rotates round about the center of galaxy. In this manner the hole in the gravitational field of the four-dimensional mass Mfills up, and the typical constant speed outer boundary regions of the galaxies have been generated. The gravity field of the four-dimensional mass M accelerates a star to the rotational speed somewhat above 130 km/s, in which case it retain rotating the galaxy in the border region, and if the star loses kinetic energy and speed, it begins to rotate the galaxy at the center region, and if the star accelerates considerably more than 130 km/s, then the gravity force of the four-dimensional mass cannot hold it, and it moves out of the gravity field.

3) In Ref. [6] the effect of the distance X' on the maximum radius of galaxy has been studied. As the distance X' of the four-dimensional mass M increases, the maximum radius of the galaxy increases. By applying Equation (29) for more massive four-dimensional masses, it can be obtained rotation curves of Ref. [1].

4) In Ref. [7] it was proven that the structure of our three-dimensional Un-

iverse is a surface volume of four-dimensional sphere. This type of structure of the Universe creates the same kind of an accelerating redshift increase which has been measured. This theory was proven by the same kind of Karl Poppers testing diagram as is shown above. The model of the surface volume of the four-dimensional Universe was constructed, the equation of the redshift caused by this Universe was solved, and the theoretical equation was shown to be the same as the measured redshift in the Universe. In this manner the four-dimensional surface volume Universe was proven to be real. This is also a proof that the mysterious dark matter in the galaxy rotation is a four-dimensional mass which is a Black Hole.

Karl Poppers' method of testing hypotheses has been essential in the development of the modern world. This method of progress was used for the solution to the Hill's equation. The famous British Nobel laureate A. V. Hill invented this equation in 1938. Within four rounds that problem was solved, Refs. [14] [15] [16] and [17]. This study is the third round of Karl Poppers' method for solving the structure of four-dimensional Universe.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- Rubin, V.C. (1983) The Rotation of Spiral Galaxies. *Science*, 220, 1339-1344. <u>https://doi.org/10.1126/science.220.4604.1339</u>
- van Albada, T.S., Bahcall, J.N., Begeman, K. and Sanscisi, R. (1985) Distribution of Dark Matter in the Spiral Galaxy NGC 3198. *The Astrophysical Journal*, 295, 305-313. https://doi.org/10.1086/163375
- Burrows, A. and Liebert, J. (1995) Probing Dark Matter. *Nature*, **373**, 191-192. <u>https://doi.org/10.1038/373191a0</u>
- [4] Panek, R. (2020) A Cosmic Crisis. Scientific American, 322, 30.
- [5] Ananthaswamy, A. (2022) Cosmic Conflict. *Scientific American*, 397. https://www.scientificamerican.com/issue/sa/2022/07-01/
- [6] Rahikainen, A. (2020) Galaxy Rotation in the Space of Four Distance Dimensions. World Journal of Mechanics, 10, 83-92. <u>https://doi.org/10.4236/wjm.2020.107007</u>
- [7] Rahikainen, A. (2021) The Solution to the Dark Energy Mystery in the Universe of Four Distance Dimensions. *World Journal of Mechanics*, 11, 95-110. <u>https://doi.org/10.4236/wjm.2021.115008</u>
- [8] Jarnestad, J. (2019) Grapgics, the Royal Swedish Academy of Sciences, ML/HS. Helsingin Sanomat. <u>https://www.hs.fi/tiede/art-2000006265660.html</u>
- [9] Wollack, E.J. (2012) Timeline of the Universe Image. NASA/WMAP Science Team. https://map.gsfc.nasa.gov/media/060915/index.html
- [10] Sparrow, G. (2022) Secrets of Black Holes: Places Where the Laws of Physics Are Pushed to the Extreme. *All about Space*, No. 128.
- [11] Roos, M. (2003) Introduction to Cosmology. 3rd Edition, John Wiley & Sons, Inc., Hoboken.

- [12] Alonso, M. and Finn, E.J. (1980) Fundamental University Physics, Second Edition, Volume 1, Mechanics and Thermodynamics. Addison-Wesley Publishing Company, Boston, 123.
- [13] Popper, K. (2002) Conjectures and Refutations: The Growth of Scientific Knowledge. Routledge, Milton Park.
- [14] Rahikainen, A. (2019) Constant Power Solution of Hill's Equation. Book Publisher International, Hooghly. <u>https://doi.org/10.9734/bpi/mono/978-81-940613-2-8</u>
- [15] Rahikainen, A. and Virmavirta, M. (2019) Hill's Equation in Arm Push of Shot Put and in Braking of Arm Rotation. In: Rusu, T., Ed., *Advances in Applied Science and Technology*, Vol. 6, Book Publisher International, 49-75.
- [16] Rahikainen, A. and Virmavirta, M. (2014) Constant Power Model in Arm Rotation— A New Approach to Hill's Equation. World Journal of Mechanics, 4, 157-169. <u>https://doi.org/10.4236/wjm.2014.46018</u>
- [17] Rahikainen, A. and Virmavirta, M. (2012) Modeling the Force-Velocity Relationship in Arm Movement. *World Journal of Mechanics*, 2, 90-97. https://doi.org/10.4236/wjm.2012.22011

List of Variables

Dimensions of ordinary space	х,у,Z			
Fourth distance dimension				
Four-dimensional mass	М			
Ordinary visible galactic mass	M(x)			
Location of the mass M on the fourth distance dimension	X'			
Rotational speed distribution curve	V			
Rotational speed distribution component of the mass M	V_M			
Maximum value of the speed distribution cure v_M	V_{Mx}			
Radius of the maximum value of the speed distribution cure v_M	R_x			
Rotational speed distribution component of visible mass	V _n			
Rotational speed distribution component of ordinary dark matter	V_p			
Rotational speed distribution component of visible and dark matt	ter <i>v</i> _m			
Radius of rotation of the galactic mass	R			
Radius of the Black hole	R_0			
Rotational speed distribution curve v_M at the distance $X' = 0$	V_{M0}			
Mass of a star	m			
Black hole in the four-dimensional Universe	Black Hole			