International Journal of Physics, 2021, Vol. 9, No. 1, 36-41
Available online at http://pubs.sciepub.com/ijp/9/1/4
Published by Science and Education Publishing
DOI:10.12691/ijp-9-1-4

The Galaxies and the Dark Matter

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Received November 13, 2020; Revised December 14, 2020; Accepted December 21, 2020

Abstract To understand the rotation of galaxies, the idea of the existence of dark matter was created. Through a better observation of reality, analyzing the distribution of matter, we conclude that this distribution is very close to that proportional to the radius cube, thus remembering the spherical distribution. With the appearance of the accretion disk, it retained a large part of the matter that gravitated the gravitational sphere of the galaxy, maintaining its distribution proportional to the cube of the radius, part of the total matter will be contained in the Accretion Disc and the rest will continue to gravitate to the galaxy. Given the large size of the galaxy, the latter may be practically printable given its dispersion in the total volume of the galaxy. We conclude that the idea of the existence of dark matter is not necessary to justify the rotation of the galaxy.

Keywords: *universe, gravitation, potential, gravity, velocity, mass, physics, variable*

Cite This Article: José Luís Pereira Rebelo Fernandes, "The Galaxies and the Dark Matter." *International Journal of Physics*, vol. 9, no. 1 (2021): 36-41. doi: 10.12691/ijp-9-1-4.

1. Introduction

1.1. Dark Matter Concept

In cosmology, dark matter is a speculative type of matter that interacts only gravitationally and, therefore, its presence can be inferred from gravitational effects on visible matter, such as galaxies. Although not directly observable, scientists believe that dark matter exists due to its consequences on gravitational effects, as visible matter moves and distributes itself in space, explaining the rotation curves of galaxies.

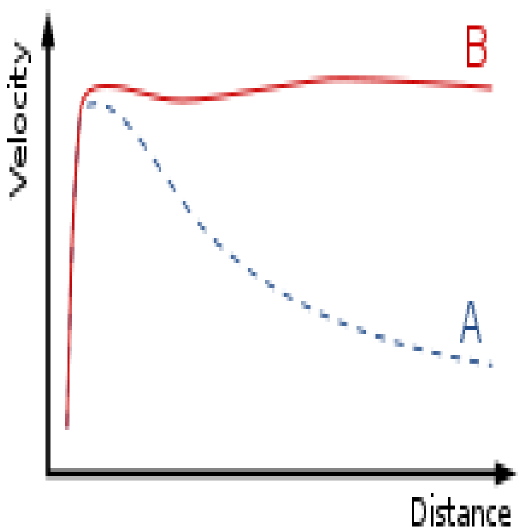

Figure 1. Rotation curve of a typical spiral galaxy: predicted (**A**) and observed (**B**). Dark matter can explain the 'flat' appearance of the velocity curve out to a large radius. Dark matter - Wikipedia

2. Study Method

2.1. Galactic structure analysis

Four arms were drawn, the outer arm in orange, the Scutum-Centaurus arm in yellow, the Sagittarius arm in blue and the Perseus arm in red.

We divided the plane of the galaxy into eight quadrants, 0.125 turns, to study the radius value of each arm between each quadrant.

We consider that there is a symmetry at the moment of the galaxy's initial creation and, therefore, we measure what the gravitational radius is for an initial exterior location and which gravitational radii for the locations located in multiple positions of +0.125 turn, that is, in the locations of n + 0125, n + 0.25, n + 0.375, etc.

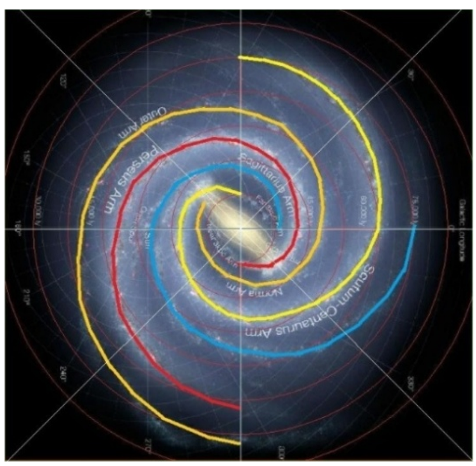

Figure 2. Milk Way, Marking of arms and 8 quadrants from Milky Way - Wikipedia

Table 1. Radius and nº of laps

Orange

Radius	Laps
ly	n
62 570	n
55 880	n+0,125
45 960	n+0.250
40 510	n+0,375
34 230	n+0,500
29 000	n+0,625
22 930	n+0,750
19 750	n+0,875
14 960	n+1,000
12 390	N+1,125

Yellow

Radius	Laps
52 320	n
43 660	n+0,125
35 480	n+0,250
30 410	n+0,375
25 280	n+0,500
19 960	n+0,625
16 220	n+0,750
14 040	n+0,875
10 450	N+1,000

Blue

Radius	Laps
50 570	n+0,125
42 730	n+0,250
35 520	n+0,375
29 800	n+0,500
25 600	n+0,625
21 200	n+0,750
17 550	n+0,875
13 890	n+1,000
10 940	N+1,125

Red

Radius	Laps
50 000	n
45 900	n+0,125
39 900	n+0,250
30 420	n+0,375
25 810	n+0,500
20 230	n+0,625
17 450	n+0,750
15 090	n+0,875
10 000	N+1,000

It can be seen that the masses located at the same distance from the center of the Galaxy made about the same number of turns. So we can consider the largest radius in which matter is, 62570 ly and make the calculations for every tenth of that radius.

2.2. Motion Analysis

We take for granted the information that the Sun is 26000 ly (light years) from the center of the galaxy and that it has a rotation speed of 220,000 ms^{-1} within the galaxy. We were thus able to define the number of turns taken at each point in the galaxy.

For this purpose, we must not forget that the galaxy is expanding, "Ref. [2]", "Ref. [3]", "Ref. [4]" and as such we should consider the average translation perimeter of the Sun, for calculations.

The average perimeter.

Being:

L - Total distance traveled by the Sun in its translation movement.

P_m - Average translation perimeter of the Sun.

I - Age of the universe, 15 224 021 588 years,]", "Ref. [4]"

V_{tSun} - Sun's translation speed.

C - Speed of Light

$$L = I * 365.2564 * 24 * 3600 * V_{tSun} \quad (1.2)$$

$$L = 1,05697x10^{\wedge}23\ m \quad (2.2)$$

$$P_m = \frac{2*\pi*26000*365.2564*24*3600*C}{2} \quad (3.2)$$

$$P_m = 7,72779x10^{\wedge}20\ m \quad (4.2)$$

$$\text{Nº Laps} = \frac{L}{P_m} = 136,7754488 \quad (5.2)$$

Table 2. Radius, Average Perimeter and Rotation Velocity (E->10^)

Radius	Perimeter	Aver. **Perimeter**	Velocity
ly	m	m	m/s
6 257	3,71945E+20	1,8597E+20	52 778
12 514	7,43889E+20	3,7194E+20	105 672
18 771	1,11583E+21	5,5792E+20	158 683
25 028	1,48778E+21	7,4389E+20	211 812
31 285	1,85972E+21	9,2986E+20	264 472
37 542	2,23167E+21	1,1158E+21	317 718
43 799	2,60361E+21	1,3018E+21	371 080
50 056	2,97556E+21	1,4878E+21	424 559
56 313	3,34750E+21	1,6738E+21	478 155
62 570	3,71945E+21	1,8597E+21	531 867

Table 3. Radius, Travelled distance, nº of laps and Mass (E->10^)

Radius	Travelled dist.	Nº of laps	Mass
ly	m	n	kg
6 257	2,5357E+22	136,3459	2,4706E+39
12 514	5,0769E+22	136,4969	1,9808E+40
18 771	7,6238E+22	136,6479	6,7001E+40
25 028	1,0176E+23	136,7989	1,5917E+41
31 285	1,2706E+23	136,6479	3,1019E+41
37 542	1,5264E+23	136,7989	5,3720E+41
43 799	1,7828E+23	136,9499	8,5493E+41
50 056	2,0398E+23	137,1009	1,2790E+42
56 313	2,2973E+23	137,2519	1,8251E+42
62 570	2,5553E+23	137,4029	2,5090E+42

Table 4. Radius, Mass variation, Volume density, Density Accretion Disc with 5 ly thickness (E->10^)

Radius	Mass var.	M/(4/3πR^3)	M/(πR^2*(5ly))
ly	kg	Kg/m^3	Kg/m^3
6257	2,4706E+39	2,8432E-21	4,7441E-18
12514	1,7338E+40	2,8504E-21	1,1098E-17
18771	4,7193E+40	2,8585E-21	1,8124E-17
25028	9,2168E+40	2,8668E-21	2,5284E-17
31285	1,5102E+41	2,8492E-21	3,2222E-17
37542	2,2700E+41	2,8708E-21	3,9628E-17
43799	3,1774E+41	2,8792E-21	4,6933E-17
50056	4,2405E+41	2,8877E-21	5,4286E-17
56313	5,4608E+41	2,8961E-21	6,1683E-17
62570	6,8396E+41	2,9046E-21	6,9126E-17

2.3. Analysis of the Quantity of Matter and Its Distribution

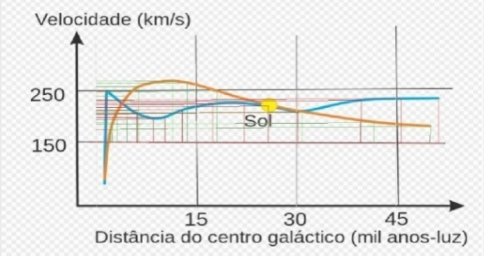

Figure 3. Speed measured from the Solar System (Blue), speed calculated based on the visible masses (orange). Milky Way - Wikipedia

For the calculation of the material necessary to bring about the balance of the previous table, we will consider that only the material inside the calculation radius participates in the calculation of its potential.

$$M=\frac{R\, V_{tSun}^{2}}{G} \qquad (6.2)$$

When considering the measured masses, from Figure 3. we will have an external speed of 183000 m/s for a radius of 51500 ly which will imply a quantity of matter of 2,445 x 10 ^ 41 Kg.

If we take into account the speeds measured by man, from Figure 3. we will have a speed of 238000 m/s, for a radius of 51800 ly which will imply a quantity of matter of 4.159x10 ^ 41 Kg.

As we see the calculation we did, it gives us a quantity of matter of 2.509x10 ^ 42 kg for a speed of 531867 m/s in a radius of 62,570 ly, which is 5 and 10 times more than we imagined.

Thus, most of the matter continues to gravitate out of the Accretion Disc.

The distribution of matter necessary to obtain the results we can see, is practically a density of constant, in volume proportion, distributed in the Accretion Disc. There is a variation in density from the periphery to the central zone of +1.90%.

This distribution did not seem unreal to us because the galaxy, before presenting a significant accretion disk, started like all other structures in its spherical shape and the accretion disk captured much of the matter in the respective gravity ray, that is, it maintained the position now associated with the accretion disk. The existence of Dark Matter does not seem necessary to explain the movement in galaxies.

Perhaps some feel that there is a flaw in the number of stars in the periphery, but if we take into account that considering 5 ly of the disk thickness, we can have between a maximum density around 6,9126x10^-17kgm^(-3) and a minimum of less than 4,7441x10^-18kgm^(-3). If we discount the star material then this density drops significantly. As the largest amount of this gas will undoubtedly be hydrogen and helium, they would be very dispersed. Much of that gas and others elements, will continue to belong to the initial spherical surface. If the material is hydrogen, we would have a maximum part in volume of 6.014 x 10^-25. In the case of being helium we would have a maximum part in volume of 9.797 x 10^-26, which seems to be undetectable.

Today it is news that the solar system is going through material from a supernova and in reality nothing tells us that it is not residual material that gravitates our galaxy.

2.4. Values Measured from the Solar System.

The values measured from the Solar System regarding the rotation of the galaxy are apparently at odds with the proposal previously made.

2.4.1. Regarding Speeds

Let us now analyze these measured values from Figure 3.

Table 5. Radius and Speeds

Radius	Speed
al	m/s
1 496	250 000
6 157	205 900
8 557	196 070
10 393	199 150
13 002	213 680
17 598	225 310
22 397	227 070
26 000	221 550
30 455	209 760
40 011	233 570
46 104	237 190
51 747	237 820

What will be equivalent for the radius considered previously to:

Table 6. - Radius and Speeds equivalents

Radius	Speed
al	m/s
6 257	205 492
12 514	210 963
18 771	214 110
25 028	224 044
31 285	211 828
37 542	227 418
43 799	235 821
50 056	237 631
56313	238 330

Let us compare the two speeds obtained, the apparent measured from the Solar System, the theoretical and the differential between them.

Table 7. Radius, Apparent speed. Theoretical speed and Differential Speeds

Radius	Apparent speed	Theoretical speed	Differential Speeds
al	m/s	m/s	m/s
6 257	205 492	53 313	152 179
12 514	210 963	106 394	104 569
18 771	214 110	159 244	54 866
25 028	224 044	211 862	12 182
31 285	211 828	264 249	-52 421
37 542	227 418	316 404	-88 986
43 799	235 821	368 328	-132 507
50 056	237 631	420 020	-182 388
56 313	238 330	471 480	-233 150

Let see its graphic representation.

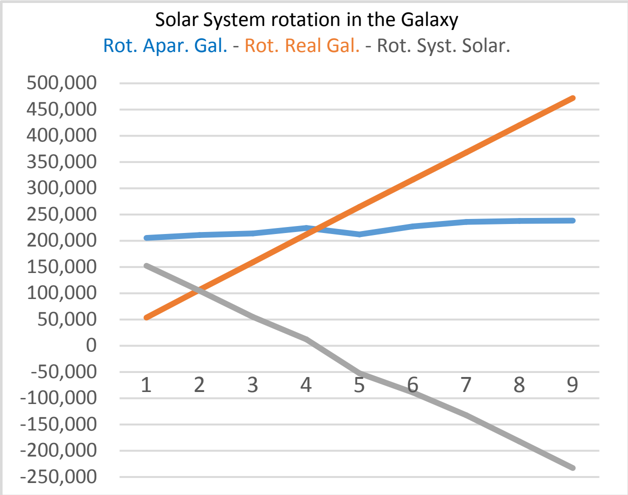

Figure 4. Radius, V Apparent Med, V theoretical and differential

Now, we see that the Solar System rotates about itself in the same direction as the Milky Way.

Discounting the translation speed of the solar system, we will have:

Table 8. Differential of speeds and respective rotation

Radius	Diff.Theor. Vel.	Diff.Theor. Vel.	Difference
ly	m/s	m/s	m/s
	-14 508	-166 687	152 179
	-9 037	-113 606	104 569
	-5 890	-60 756	54 866
	4 044	-8 138	12 182
	-8 172	44 249	-52 421
	7 418	96 404	-88 986
	15 821	148 328	-132 507
	17 631	200 020	-182 388
	18 330	251 480	-233 150
Rotation (m/s/ly)	0,73485	8,44285	-7,708

Let's see its graphic representation.

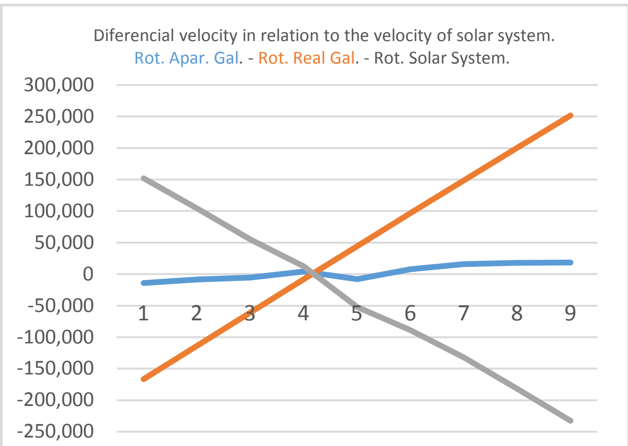

Figure 5. Radius, V Apparent Med, V theoretical and differential centered on the Solar System.

As it turns out, Milk Way has an apparent rotation of 0,73485 ms^{-1}ly, theoretical of 8,44285 $ms^{-1}ly$, t follows that the solar system has a same rotation to the Milk Way of more 7,7080 $ms^{-1}ly$. This rotation is what causes the discrepancy between measured and actual values.

3. Verification, Pinwheel Galaxy

We are going to look at another galaxy in order to verify if the theory pointed out is verifiable in other galaxies with Accretion Discs and arms.

For this purpose, we chose the Pinwheel galaxy, with a diameter of 170000 ly.

Pinwheel Galaxy has a rotation speed of 241000 m / s on its periphery

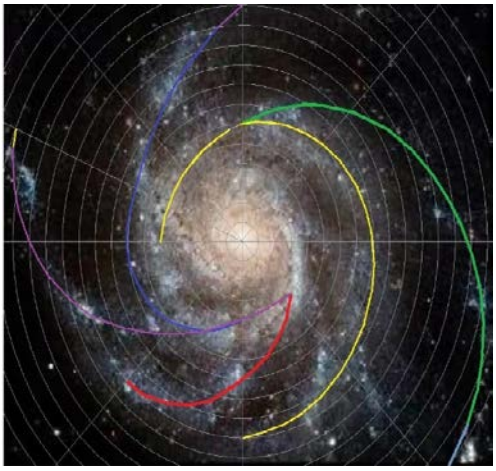

Figure 6. Pinwheel Galaxy, Marking of arms and 8quadrants (https://en.wikipedia.org/wiki/Pinwheel_Galaxy#:~:text=%20%20%20%20Pinwheel%20Galaxy%20%20,m%2012.6%20s%20%2013%20more%20rows%20)

Table 9. Radius and nº of laps

Green

Radius	Laps
29 530,0	n0+0,375
47 770,0	n0+0,250
67 830,0	n0+0,125
85 000,0	n0

Yellow

Radius	Laps
20 340,0	n1+0,75
24 660,0	n1+0,625
29 560,0	n1+0,500
34 530,0	n1+0,375
39 450,0	n1+0,250
43 830,0	n1+0,125
49 200,0	n1

n1=n0+0,24109

Red

Radius	Laps
25 420	n2+0,25
42 000	n2+0,125
60 000	n2 n2+no+0,17379

Blue

Radius	Laps
19720	n3+0,375
24290	n3+0,250
31410	n3+0,125
38730	n3

n3+0,43795

Magenta

Radius	Laps
12000	n4+0,375
19720	n4+0,250
32740	n4+0,125
64370	n4

3.1. Motion Analysis

We take for granted the information that it has a rotation speed of 241.000 ms^{-1} at the outer edge of the galaxy. We were thus able to define the number of turns taken at each point in the galaxy.

For that purpose we must not forget that the galaxy is expanding, "Ref. [2]", "Ref. [3]" and "Ref. [4]" as such we should consider the average perimeter for the calculations.

Being:

L - Total distance traveled by the stars at the outer edge of the galaxy.

P_m - Average translation perimeter.

I - Age of the universe 15 224 021 588 years.

V_{tSun} - Travel speed at the edge of the galaxy.

C - Speed of light

$$L = I * 365.2564 * 24 * 3600 * V_{tSun} \quad (1.3)$$

$$L = 1{,}1579 * 10\text{^} + 23\ m \quad (2.3)$$

$$P_m = \frac{2 * \pi * 85000 * 365.2564 * 24 * 3600 * C}{2} \quad (3.3)$$

$$P_m = 2{,}5264\text{x}10\text{^}{+}21\ \text{m} \quad (4.3)$$

$$Nº\ laps = \frac{L}{P_m} = 45{,}83075 \quad (5.3)$$

Table 10. Radius, Average Perimeter and Rotation Velocity (E->10^)

Radius	Perimeter	Average. Perim.	Velocity
ly	m	m	m/s
8 500	5,0528E+20	2,5264E+20	23 556
17 000	1,0106E+21	5,0528E+20	47 232
25 500	1,5158E+21	7,5792E+20	71 030
34 000	2,0211E+21	1,0106E+21	94 948
42 500	2,5264E+21	1,2632E+21	118 988
51 000	3,0317E+21	1,5158E+21	143 148
59 500	3,5370E+21	1,7685E+21	167 430
68 000	4,0422E+21	2,0211E+21	191 832
76 500	4,5475E+21	2,2738E+21	216 356
85 000	5,0528E+21	2,5264E+21	241 000

Table 11. Radius, Travelled distance, nº of laps and Mass (E->10^)

Radius	Travelled dist.	Nº of laps	Mass
ly	m	n	kg
8 500	1,1317E+22	44,79552	6,6856E+38
17 000	2,2692E+22	44,91055	5,3760E+39
25 500	3,4126E+22	45,02557	1,8237E+40
34 000	4,5617E+22	45,14060	4,3450E+40
42 500	5,7167E+22	45,25562	8,5296E+40
51 000	6,8774E+22	45,37065	1,4814E+41
59 500	8,0440E+22	45,48567	2,3644E+41
68 000	9,2164E+22	45,60070	3,5472E+41
76 500	1,0395E+23	45,71572	5,0761E+41
85 000	1,1579E+23	45,83075	6,9982E+41

Table 12. Radius, Mass variation, Volume density, Density Accretion Disc with 5 ly thickness (E->10^)

Radius	Mass var.	M/(4/3πR^3)	M/(πR^2*(5ly))
ly	kg	Kg/m^3	Kg/m^3
8 500	6,6856E+38	3,0690E-22	3,47821E-18
17 000	4,7074E+39	3,0848E-22	6,9922E-18
25 500	1,2861E+40	3,1006E-22	1,05421E-17
34 000	2,5213E+40	3,1165E-22	1,4128E-17
42 500	4,1846E+40	3,1324E-22	1,77502E-17
51 000	6,2845E+40	3,1483E-22	2,14086E-17
59 500	8,8296E+40	3,1643E-22	2,51035E-17
68 000	1,1828E+41	3,1803E-22	2,8835E-17
76 500	1,5289E+41	3,1964E-22	3,26032E-17
85 000	1,9221E+41	3,2125E-22	3,64083E-17

3.2. Analysis of the Quantity of Matter and Its Distribution

Analysis of the quantity of matter and its distribution.

$$M = \frac{R\ {V_{tSun}}^2}{G} \quad (6.3)$$

Once again we verify that the mass distribution is very close to the proportionality to the radius cube and that its density is practically constant throughout the radius. In this galaxy we find that this density decreases from the periphery to the center by -4.47%.

The distribution of matter necessary to obtain the results we can see, is practically a density of constant, in volume proportion, distributed in the Accretion Disc and all spherical gravitational field.

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