DARK MATTER DENSITY ON BIG GALAXIES DEPEND ON GRAVITATIONAL FIELD AS UNIVERSAL LAW

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1. ABSTRACT

This paper contain results from six previous paper I have published for different galaxies about dark matter density depending on gravitational field.

Galaxies studied are NGC 2841, NGC 7331, NGC 3992, M31. All of them are big galaxies bigger than Milky Way. In addition Milky Way was studied with data coming from two authors.

Also were studied two intermediate galaxies M33 (Triangulum galaxy) and NGC 3198

Each paper studied dark matter density depending on gravitational field on each galaxy. Rotation curve and dark matter density function depending on radius were taken from paper published by prestigious astrophysics and I got dark matter density depending on gravitational field through a mathematical method. I found that Dark matter density depend on gravitational field according a power function DM density = A·E^B, where A and B are parameters which depend on each galaxy.

In this paper are gathered eight different functions belonging to eight different galactic data set and they are tabulated and plotted in order to compare all of them.

Conclusion got is that dark matter density depending on gravitational field is very similar on big galaxies whereas DM density is a great deal bigger on intermediate galaxies. The less massive galaxy is the higher DM density is.

Results got for big and intermediate galaxies are consistent with author hypothesis which state that dark matter is generated by the own gravitational field.

This second version paper include an estimation of total mass in Coma Cluster got through DM density as power of E which is very close to mass calculated by cosmological standard model CDM and NFW profile in a paper published in 2015 by prestigious researchers.

This calculus is a test overcome to consider DM density as power of gravitational field as Universal law because that law was got for big galaxies and it has been used to calculated total dark matter inside a galaxy cluster which is 100 times bigger and it contains thousand of galaxies.

2. INTRODUCTION

For last two years I have published seven papers whose main hypothesis is title this new paper. Previous papers have studied dark matter density on each galaxy as power of his own gravitational field. Data of rotation curves and dark matter density came from prestigious astrophysics researchers whose papers have been published in 2015 and 2016.

The main target this work is to compare each function got on each galaxy and try to develop reasons to support title this paper.

In order this paper would be autonomous I am going to introduce results got regarding Dark matter density depending on gravitational field on each galaxy published in previous papers by me.

Briefly is going to be explained method followed on each galaxy.

Firstly are presented rotation curve and table with data about rotational velocity depending on each galaxy. Author data of rotation curve is specifically quoted for each galaxy.

Considering rotation curve on each galaxy is calculated gravitational field E. It is known that total gravitational field may be calculated through Virial theorem, whose formula is $E = v^2/R$, where v is rotation speed at a specific radius R. Its unit at I. S. is m/s^2. It is supposed spherical symmetry.

The following step is to tabulate data of dark matter density profile depending on radius. Most common profile is NFW (Navarro Frenk & White) although there are another ones such as Pseudo isothermal and Burket profiles.

The following step is to fit data of NFW DM density profile as power of gravitational field, E. Particularly formula found is $\varphi_{DM}(E) = A \cdot E^B$ Where A , B are calculated with a power regression method. Usually correlation coefficient r is bigger than 0,98. This is a magnificent result. Units are I.S.

Next step is to compare DM density as power of E and standard profiles (NFW or pseudo isothermal). Tables and plots show clearly that relative differences between both profiles are mainly under 10 % through the whole dominion of radius.

At last chapter this paper are tabulated and plotted together DM density of each one to facilitate compare data of different galaxies and get conclusions.

Reader could consult some of one these paper to have a more exact idea about followed method on each galaxy. [3] Abarca, M.2015. [4] Abarca, M.2016. [5] Abarca, M.2016. [6] Abarca, M.2016. [7] Abarca, M.2016

3. GALACTIC SAMPLE

After a meticulous research in arXiv, it has been selected five big galaxies and two intermediate galaxies.

It is a hard work measuring rotation curves. It is a great human and technological achievement to be able to measure rotation curves of galaxies which are lot of Mega parsecs away. Congratulations astrophysics teams for so meticulous and remarkable researches.

Each one these galaxies have been previously studied by the author in separated papers. Particularly NGC 2841, NGC 7331 and NGC 3992 were studied in [2] Abarca,M.2015. I suggest reader should not read firstly this paper because I have not used international system of units in this paper so it is a bit weird. Firstly, I suggest reading following papers.

Milky Way is studied in two papers: [6] Abarca, M.2016. and [7] Abarca, M.2016. because rotation curve and dark matter density data come from two different authors, Sofue,Y.2015 and Huang,Y.2016.

M31 is studied in [5] Abarca,M.2016. M33 is studied in [4] Abarca,M.2016 and NGC 3198 is studied in [3] Abarca,M.2015.

Below there are some remarkable characteristics each galaxy.

NGC 2841
It is a big spiral galaxy in the Ursa Major galaxy cluster. Its distance is 14 Mpc. Aprox. Rotation speed at radius 30 kpc is 290 km/s.

Data come from [10] Bottema,R.B. & Pestaña,J.LG.2015.

NGC 7331
It is a big spiral galaxy about 12 Mpc away in the Constelation Pegasus. This galaxy is similar in size and structure to Milky Way. Rotation speed at radius 30 kpc is 240 km/s
Data come from [10] Bottema,R.B. & Pestaña,J.LG. 2015.

NGC 3992 It is one of the most prominent members of the Ursa Major cluster of galaxies. Its approximate distance is 18 Mpc. Rotation speed at radius 30 kpc is 245 km/s.

Data come from [10] Bottema,R.B. & Pestaña,J.LG.2015.

Milky Way
Data come from [8] Sofue, Y.2015.

Milky Way
Data come from [9] Huang,Y.2016.

M31
It is the nearest major spiral galaxy to the Milky Way. M31 is 780 Kpc away to our Galaxy. It is the largest galaxy of the Local Group, which also contains the Milky Way, the Triangulum Galaxy (M33), and about 44 other smaller galaxies. Data come from [8] Sofue, Y.2015.

M33 Galaxy It is a satellite galaxy of M31. It is an intermediate galaxy whose distance to M31 is 220 kpc and its rotation speed in flat region is about 120 km/s. Data come from [11] Corbelli,E. et al.2014.

NGC 3198

It is a barred spiral galaxy belonging to Ursa Major constellation. Its distance to Milky Way is 13,8 Mpc. It is considered an intermediate galaxy because its rotation speed inside flat region is about 150 km/s. Data come from [12] Karukes,E.V.2015.

4. GALACTIC CALCULUS

Rotation curve data and DM density data have been got from paper published by astrophysics researcher. These data have been used to calculate DM density depending on gravitational field.

DM density profile are three different kind, NFW (Navarro Frenk and White) pseudo isothermal profile and Burket profile.

Function formula for NFW profile is $D_{NFW}(R) = \frac{D_0}{x \cdot (1+x)^2}$ formula for isothermal profile is $D_{ISO}(R) = \frac{D_0}{1+x^2}$ and formula for Burket profile is $D_{BURKET}(R) = \frac{D_0}{(1+x)\cdot(1+x^2)}$

Do is a parameter fitted on each galaxy called scale density and $X=R/R_c$ where R_c is a parameter called scale length which depend on each galaxy.

It is important to emphasise that Dark matter contribution is important for region outside galactic disk in other words, total dark matter enclosed by a sphere which contain galactic disk is bigger than total baryonic matter enclosed by that sphere. Therefore error in dark matter density profile are minimized outside galactic disk. This is reason why in this paper have been consider dominion radius outside galactic disk.

A second data set calculated is the gravitational field,E, which is calculated through Virial theorem, according formula $E = v^2/R$, where v is rotation speed at a radius R.

As it is known kpc is a typical units for galactic distances 1 kpc = $3{,}09\cdot10^{19}$ m. And a typical unit for DM density is 1 mMsun/ pc^3 where mMsun = Msun/ 1000 and Msun = $1{,}99\cdot10^{30}$ kg so 1 mMsun/ pc^3 = $6{,}77\cdot 10^{-23}$ Kg/m^3

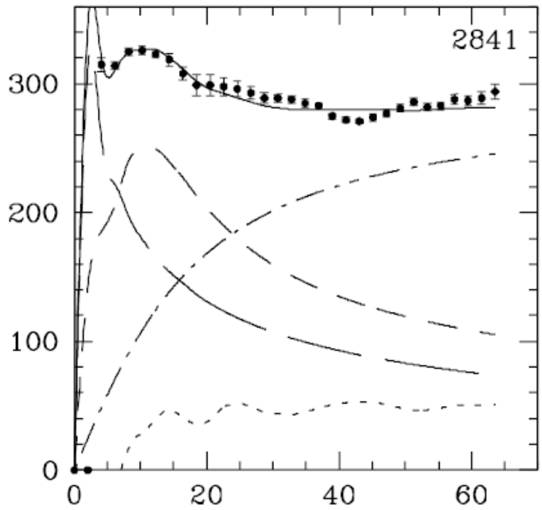
Conversion units	
mMsun/ pc^3	$6{,}77\cdot 10^{-23}$ Kg/m^3
Kpc	$3{,}09\cdot10^{19}$ m

Despite that length is given by kpc or matter density by mMsun/ pc^3, calculus are made into International system of units and results of density is given newly in mMsun/ pc^3, specially when these data are plotted.

4.1 NGC 2841

1 Name	Cluster	Distance
NGC 2841	Ursa Major	14 Mpc

Dark matter density function profile Isothermal
Rc = 6,39 ± 0,52 Kpc
Do = 32 ± 5 m Msun/pc^3



Author rotation curve and DM density profile is [10] Bottema,R.B.

Black dots are speed measures.

Dot and dashed line is DM density curve.

Dominion of distances is chosen in region where baryonic density is negligible versus DM density. Because in this region data about DM density is a bit accurate whereas data inside galactic disk are less accurate.

Radius	Radius	Speed	E	D iso	D iso
m	kpc	km/s	m/s^2	mMsun/pc^3	kg/m^3
1,23E+21	40	2,75E+02	6,13E-11	7,96E-01	5,39E-23
1,39E+21	45	2,80E+02	5,65E-11	6,32E-01	4,28E-23
1,54E+21	50	2,80E+02	5,08E-11	5,14E-01	3,48E-23
1,85E+21	60	2,80E+02	4,24E-11	3,59E-01	2,43E-23

Data to do power regression. DM density depending on E. $D_{DM} = A \cdot E^B$. International system of units.

E	D iso
m/s^2	kg/m^3
6,13E-11	5,39E-23
5,65E-11	4,28E-23
5,08E-11	3,48E-23
4,24E-11	2,43E-23

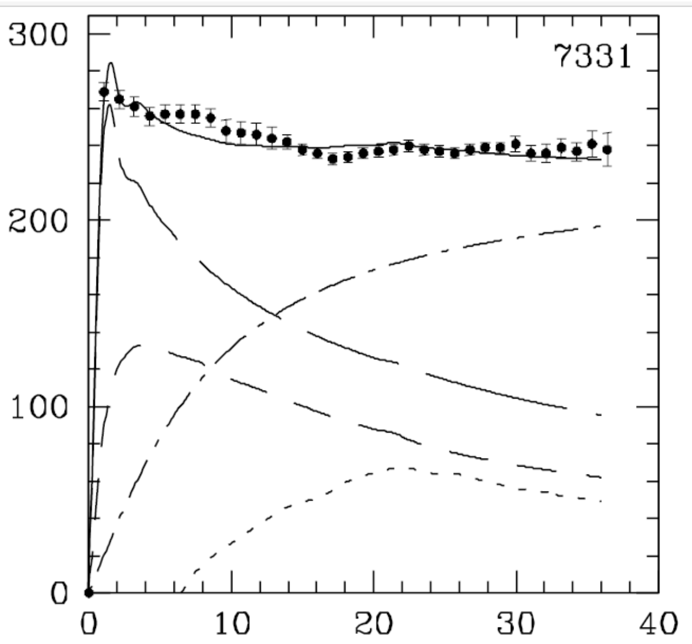
Parameters	
A	2,19E-01
B	2,12E+00
r	9,97E-01

Relative error between DM density isothermal profile and DM density as power of E.

m/s^2	mMsun/pc^3	mMsun/pc^3	Relt error
E	D isothermal	D power E	%
6,13E-11	7,96E-01	7,73E-01	-2,97E+00
5,65E-11	6,32E-01	6,50E-01	2,77E+00
5,08E-11	5,14E-01	5,20E-01	1,19E+00
4,24E-11	3,59E-01	3,54E-01	-1,44E+00

4.2 NGC 7331

3 Name	Constelation	Distance
NGC 7331	Pegasus	12 Mpc



Dark matter density function profile Isothermal
Rc = 19,46 $\pm$ 1,79 Kpc
Do = 3,5 $\pm$ 0,7 $\cdot$ mMsun/pc^3

Author rotation curve and DM density profile is

[10] Bottema,R.B. et al.

Black dots are speed measures.

Dot and dashed line is DM density curve.

Radius	Radius	Speed	E	D iso	D iso
m	kpc	km/s	m/^2	mMsun/pc^3	kg /m^3
7,71E+20	25	2,37E+02	7,28E-11	1,32E+00	8,94E-23
8,33E+20	27	2,37E+02	6,74E-11	1,20E+00	8,10E-23
8,95E+20	29	2,37E+02	6,28E-11	1,09E+00	7,36E-23
9,56E+20	31	2,37E+02	5,87E-11	9,89E-01	6,70E-23
1,02E+21	33	2,37E+02	5,52E-11	9,03E-01	6,11E-23
1,08E+21	35	2,37E+02	5,20E-11	8,26E-01	5,60E-23

Data to do power regression. DM density depending on E. $D_{DM} = A \cdot E^B$. International system of units.

E	D iso
m/^2	kg /m^3
7,28E-11	8,94E-23
6,74E-11	8,10E-23
6,28E-11	7,36E-23
5,87E-11	6,70E-23
5,52E-11	6,11E-23
5,20E-11	5,60E-23

Parameters of power regression	
A	1,22E-08
B	1,39E+00
r	0,99

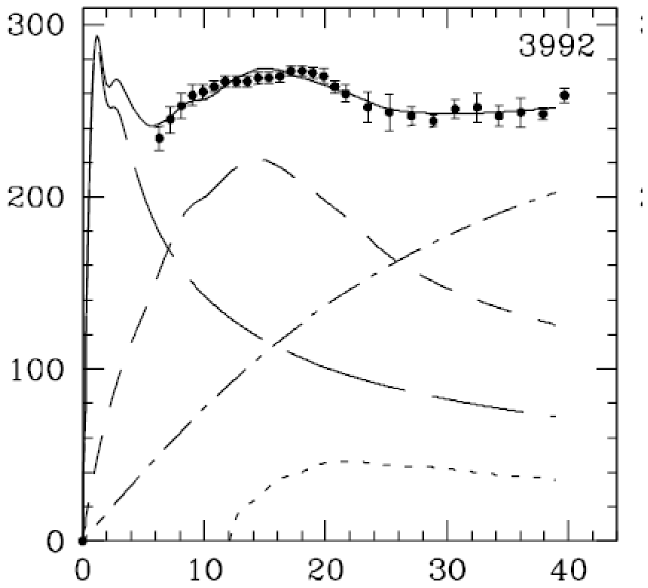
Relative error between DM density isothermal profile and DM density as power of E.

E	D iso	D power E	rel error
m/s^2	mMsun/pc^3	mMsun/pc^3	%
7,28E-11	1,32E+00	1,33E+00	6,89E-01
6,74E-11	1,20E+00	1,19E+00	-1,77E-01
6,28E-11	1,09E+00	1,08E+00	-5,07E-01
5,87E-11	9,89E-01	9,85E-01	-4,18E-01
5,52E-11	9,03E-01	9,03E-01	-6,52E-03
5,20E-11	8,26E-01	8,32E-01	6,51E-01

4.3 NGC 3992

5 Name	Cluster	Distance
NGC 3992	Ursa Major	18,6 Mpc

Dark matter density function profile Isothermal
Rc = 3,89 $\pm$ 0,34 Kpc
Do = 66 $\pm$ 11 mMsun/pc^3



Author rotation curve and DM density profile is

[10] Bottema,R.B. et al.

Black dots are speed measures.

Dot and dashed line is DM density curve.

Radius	Radius	speed	E	D iso	D iso
m	kpc	Km/s	m/s^2	Kg/m^3	mMsun/pc^3
7,40E+20	24	2,50E+02	8,44E-11	1,14E-22	1,69E+00
8,02E+20	26	2,50E+02	7,79E-11	9,78E-23	1,45E+00
8,64E+20	28	2,45E+02	6,95E-11	8,46E-23	1,25E+00
9,26E+20	30	2,47E+02	6,59E-11	7,39E-23	1,09E+00
9,87E+20	32	2,50E+02	6,33E-11	6,51E-23	9,61E-01
1,05E+21	34	2,50E+02	5,96E-11	5,77E-23	8,53E-01
1,11E+21	36	2,50E+02	5,63E-11	5,16E-23	7,62E-01
1,17E+21	38	2,50E+02	5,33E-11	4,63E-23	6,84E-01

Data to do power regression. DM density depending on E. $D_{DM} = A\cdot E^B$. International system of units.

E	D iso
m/s^2	Kg/m^3
8,44E-11	1,14E-22
7,79E-11	9,78E-23
6,95E-11	8,46E-23
6,59E-11	7,39E-23
6,33E-11	6,51E-23
5,96E-11	5,77E-23
5,63E-11	5,16E-23
5,33E-11	4,63E-23

Parameters of power regression	
A	1,34E-02
B	1,99E+00
r	9,95E-01

Relative error between DM density isothermal profile and DM density as power of E.

E	D iso	D power E	relt error
m/s^2	mMsun/pc^3		%
8,44E-11	1,69E+00	1,73E+00	2,25E+00
7,79E-11	1,45E+00	1,47E+00	1,95E+00
6,95E-11	1,25E+00	1,17E+00	-6,52E+00
6,59E-11	1,09E+00	1,06E+00	-3,31E+00
6,33E-11	9,61E-01	9,75E-01	1,39E+00
5,96E-11	8,53E-01	8,64E-01	1,28E+00
5,63E-11	7,62E-01	7,71E-01	1,19E+00
5,33E-11	6,84E-01	6,92E-01	1,12E+00

4.4 MILKY WAY BY SOFUE

Dark matter density function profile NFW
Rs = 10,7 ± 2,9 Kpc
Do = 1.2318 ·10^{-21} kg/m^3
Do = 18,2 ± 7,4 mMsun/pc^3

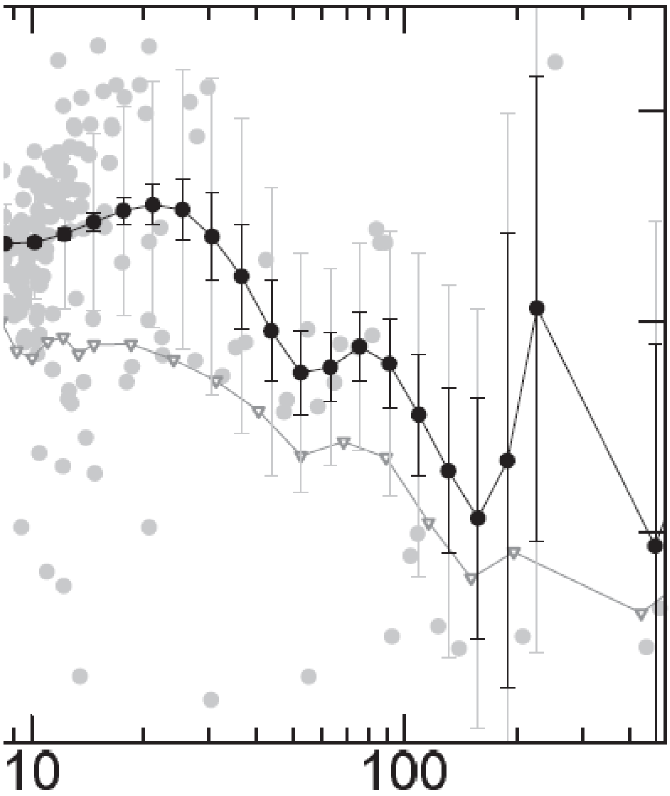
$$D_{NFW}(R) = \frac{D_0}{x \cdot (1+x)^2}$$ Where x= radius/ Rs Rs is called length scale and Do is density scale.

Author rotation curve and DM density profile is

[8] Sofue, Y.2015.

Black dots are speed measures.

Dominion of radius, from 30 kpc to 110 kpc.



Radius	Radius	Speed	E	D NFW	D NFW
m	kpc	km/s	m/s^2	Kg/m^3	mMsun/pc^3
9,26E+20	30	239	6,17E-11	3,04E-23	4,49E-01
1,10E+21	35,56	220,7	4,44E-11	1,98E-23	2,93E-01
1,36E+21	43,92	195,1	2,81E-11	1,15E-23	1,70E-01
1,57E+21	50,72	175,4	1,97E-11	7,89E-24	1,17E-01
1,97E+21	63,85	176,8	1,59E-11	4,25E-24	6,28E-02
2,34E+21	75,9	187,8	1,51E-11	2,65E-24	3,92E-02
2,81E+21	91,1	179	1,14E-11	1,60E-24	2,36E-02
3,40E+21	110,3	154,9	7,05E-12	9,35E-25	1,38E-02

Data to do power regression. DM density depending on E. $D_{DM} = A \cdot E^{B}$. International system of units.

E	D NFW
m/s^2	Kg/m^3
6,17E-11	3,04E-23
4,44E-11	1,98E-23
2,81E-11	1,15E-23
1,97E-11	7,89E-24
1,59E-11	4,25E-24
1,51E-11	2,65E-24
1,14E-11	1,60E-24
7,05E-12	9,35E-25

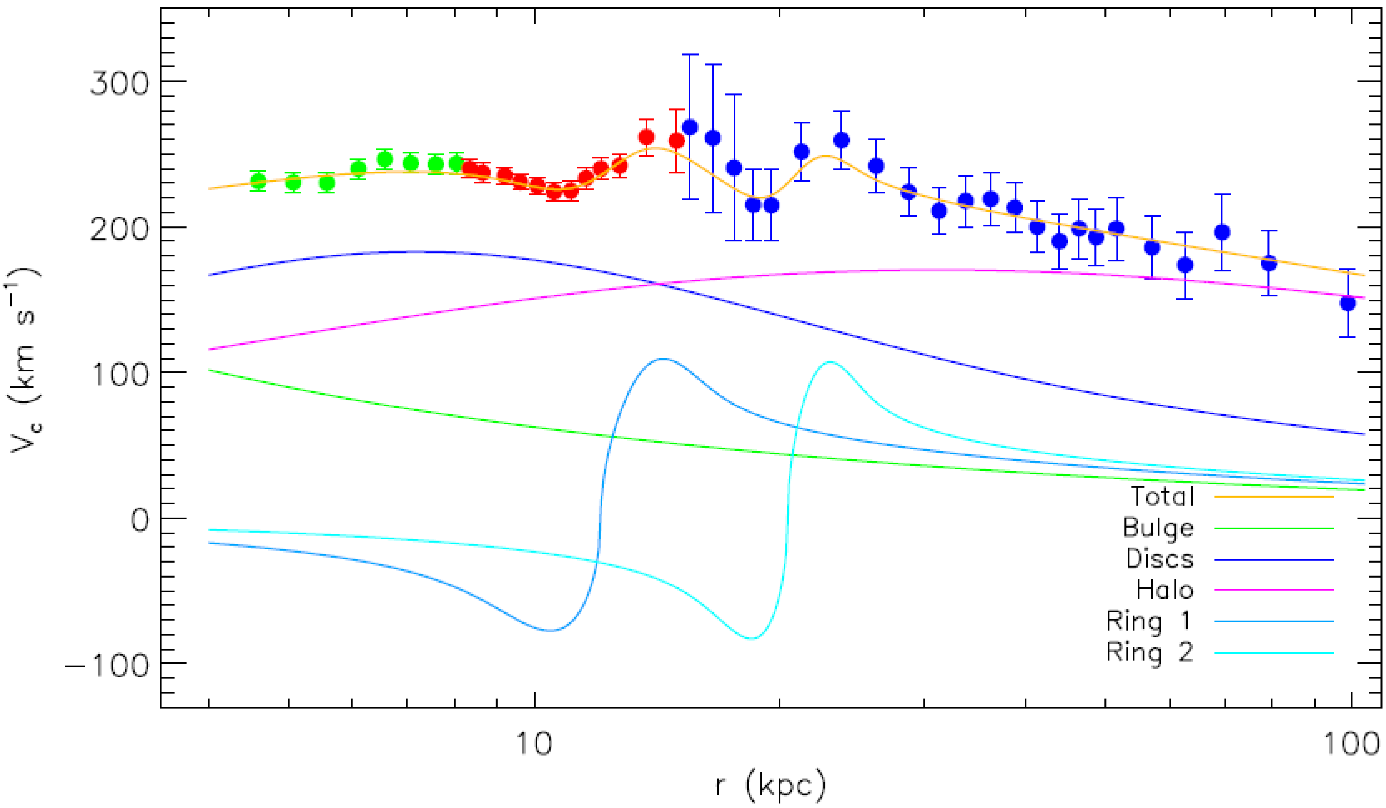
Parameters of power regression. I.System	
A	6,1677364E-06
B	1,6877224E+00
r	9,8178666E-01

Relative error between DM density NFW profile and DM density as power of E.

Radius	E	D NFW	D power E	Relt. Error
kpc	m/s^2	mMsun/pc^3	mMsun/pc^3	%
30	6,17E-11	4,49E-01	5,35E-01	1,62E+01
35,56	4,44E-11	2,93E-01	3,07E-01	4,54E+00
43,92	2,81E-11	1,70E-01	1,42E-01	-2,00E+01
50,72	1,97E-11	1,17E-01	7,76E-02	-5,01E+01
63,85	1,59E-11	6,28E-02	5,41E-02	-1,62E+01
75,9	1,51E-11	3,92E-02	4,95E-02	2,09E+01
91,1	1,14E-11	2,36E-02	3,09E-02	2,37E+01
110,3	7,05E-12	1,38E-02	1,38E-02	-3,98E-01

4.5 MILKY WAY BY HUANG

Author rotation curve and DM density profile is [9] Huang,Y.2016. et al.



r (kpc)	V_c (km s^{-1})	σ_{V_c} (km s^{-1})	tracer	r (kpc)	V_c (km s^{-1})	σ_{V_c} (km s^{-1})	tracer
4.60	231.24	7.00	H I	17.56	240.66	49.91	HKG
5.08	230.46	7.00	H I	18.54	215.31	24.80	HKG
5.58	230.01	7.00	H I	19.50	214.99	24.42	HKG
6.10	239.61	7.00	H I	21.25	251.68	19.50	HKG
6.57	246.27	7.00	H I	23.78	259.65	19.62	HKG
7.07	243.49	7.00	H I	26.22	242.02	18.66	HKG
7.58	242.71	7.00	H I	28.71	224.11	16.97	HKG
8.04	243.23	7.00	H I	31.29	211.20	16.43	HKG
8.34	239.89	5.92	MRCG	33.73	217.93	17.66	HKG
8.65	237.26	6.29	MRCG	36.19	219.33	18.44	HKG
9.20	235.30	5.60	MRCG	38.73	213.31	17.29	HKG
9.62	230.99	5.49	MRCG	41.25	200.05	17.72	HKG
10.09	228.41	5.62	MRCG	43.93	190.15	18.65	HKG
10.58	224.26	5.87	MRCG	46.43	198.95	20.70	HKG
11.09	224.94	7.02	MRCG	48.71	192.91	19.24	HKG
11.58	233.57	7.65	MRCG	51.56	198.90	21.74	HKG
12.07	240.02	6.17	MRCG	57.03	185.88	21.56	HKG
12.73	242.21	8.64	MRCG	62.55	173.89	22.87	HKG
13.72	261.78	14.89	MRCG	69.47	196.36	25.89	HKG
14.95	259.26	30.84	MRCG	79.27	175.05	22.71	HKG
15.52	268.57	49.67	HKG	98.97	147.72	23.55	HKG
16.55	261.17	50.91	HKG	–	–	–	–

Parameters of NFW profile		
Ro	14,4	kpc
Do	12,1	mMsun/pc^3

$D_{NFW}(R) = \frac{D_0}{x \cdot (1+x)^2}$ Where x= radius/ Rs Rs is called length scale and Do is density scale.

Radius kpc	Rot. Speed	Radius	Virial E	NFW DM	NFW DM
kpc	km/s	m	m/s^2	mMsun/pc^3	kg/m^3
26,22	2,420E+02	8,09E+20	7,2384E-11	0,83514199	5,6539E-23
28,71	2,241E+02	8,86E+20	5,6689E-11	0,67714801	4,5843E-23
31,29	2,112E+02	9,66E+20	4,6199E-11	0,55312714	3,7447E-23
33,73	2,179E+02	1,04E+21	4,5619E-11	0,46240741	3,1305E-23
36,19	2,193E+02	1,12E+21	4,3066E-11	0,3900811	2,6408E-23
38,73	2,133E+02	1,20E+21	3,8070E-11	0,33048041	2,2374E-23
41,25	2,000E+02	1,27E+21	3,1426E-11	0,2828255	1,9147E-23
43,93	1,901E+02	1,36E+21	2,6659E-11	0,24172841	1,6365E-23
46,43	1,989E+02	1,43E+21	2,7613E-11	0,21029964	1,4237E-23
48,71	1,929E+02	1,50E+21	2,4757E-11	0,18623374	1,2608E-23
51,56	1,989E+02	1,59E+21	2,4866E-11	0,16106406	1,0904E-23
57,03	1,86E+02	1,76E+21	1,9638E-11	0,12416757	8,4061E-24
62,55	1,74E+02	1,93E+21	1,5668E-11	0,09755023	6,6042E-24
69,47	1,96E+02	2,14E+21	1,7994E-11	0,07393707	5,0055E-24
79,27	1,75E+02	2,45E+21	1,2535E-11	0,0519473	3,5168E-24
98,97	1,48E+02	3,05E+21	7,1434E-12	0,02840357	1,9229E-24

Data to do power regression. DM density depending on E. $D_{DM} = A \cdot E^B$. International system of units.

Virial E	NFW DM
m/s^2	kg/m^3
7,2384E-11	5,6539E-23
5,6689E-11	4,5843E-23
4,6199E-11	3,7447E-23
4,5619E-11	3,1305E-23
4,3066E-11	2,6408E-23
3,8070E-11	2,2374E-23
3,1426E-11	1,9147E-23
2,6659E-11	1,6365E-23
2,7613E-11	1,4237E-23
2,4757E-11	1,2608E-23
2,4866E-11	1,0904E-23
1,9638E-11	8,4061E-24
1,5668E-11	6,6042E-24
1,7994E-11	5,0055E-24
1,2535E-11	3,5168E-24
7,1434E-12	1,9229E-24

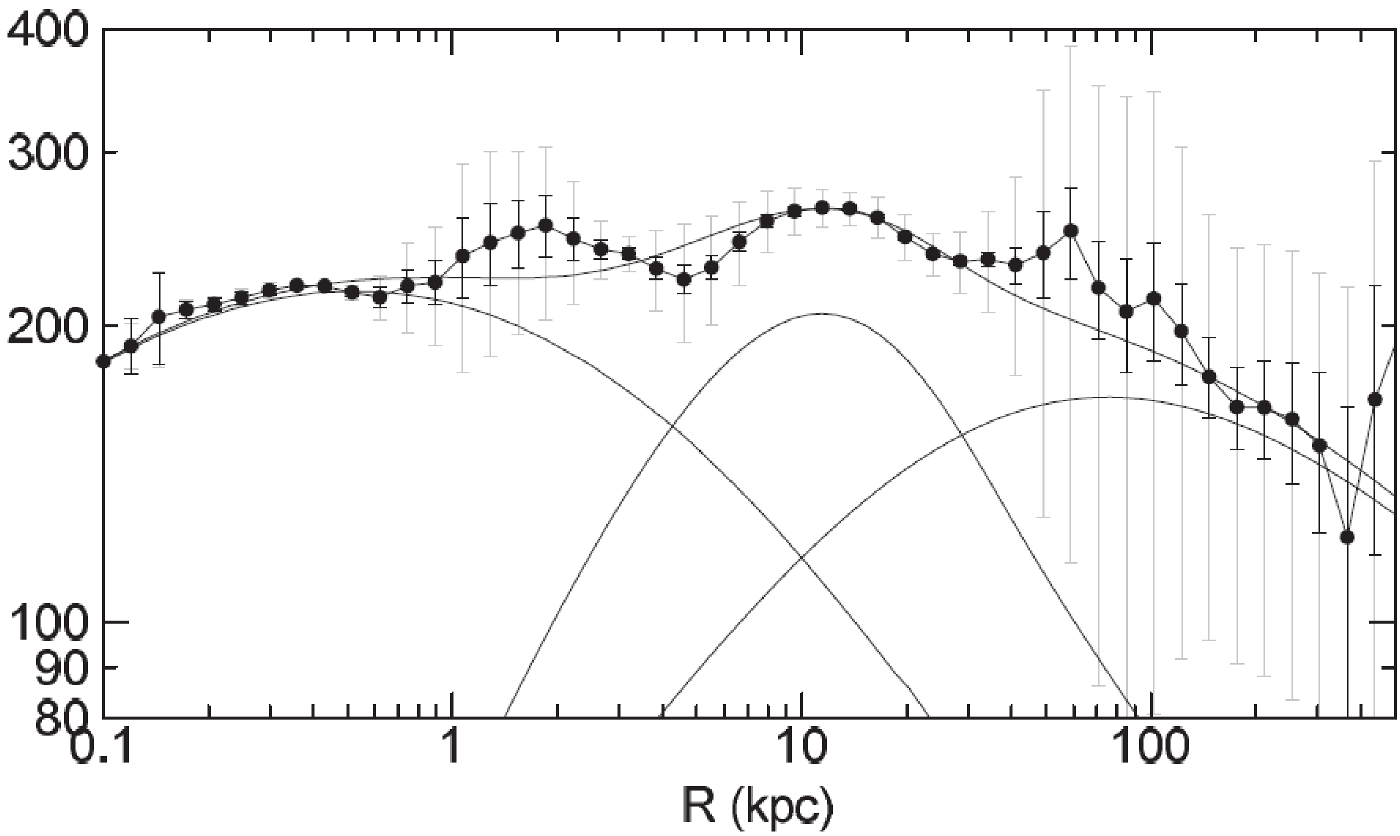
Parameters of power regression. I.S.	
A	5,1085837E-07
B	1,568156686
r	0,988636665

Relative error between DM density isothermal profile and DM density as power of E.

Radius	Virial E	NFW DM	D Power of E	Relt. Error
kpc	m/s^2	mMsun/pc^3	mMsun/pc^3	%
26,22	7,2384E-11	0,83514199	9,4634E-01	1,1750E+01
28,71	5,6689E-11	0,67714801	6,4504E-01	-4,9770E+00
31,29	4,6199E-11	0,55312714	4,6798E-01	-1,8194E+01
33,73	4,5619E-11	0,46240741	4,5881E-01	-7,8473E-01
36,19	4,3066E-11	0,3900811	4,1919E-01	6,9442E+00
38,73	3,8070E-11	0,33048041	3,4549E-01	4,3431E+00
41,25	3,1426E-11	0,2828255	2,5574E-01	-1,0589E+01
43,93	2,6659E-11	0,24172841	1,9760E-01	-2,2332E+01
46,43	2,7613E-11	0,21029964	2,0880E-01	-7,1853E-01
48,71	2,4757E-11	0,18623374	1,7594E-01	-5,8518E+00
51,56	2,4866E-11	0,16106406	1,7716E-01	9,0835E+00
57,03	1,9638E-11	0,12416757	1,2235E-01	-1,4823E+00
62,55	1,5668E-11	0,09755023	8,5863E-02	-1,3611E+01
69,47	1,7994E-11	0,07393707	1,0668E-01	3,0691E+01
79,27	1,2535E-11	0,0519473	6,0512E-02	1,4153E+01
98,97	7,1434E-12	0,02840357	2,5055E-02	-1,3367E+01

4.6 M31 GALAXY

Author rotation curve and DM density profile is [8] Sofue, Y.2015.



Dark matter density function profile NFW
Rs = 34.6 ± 2.1 Kpc
Do = 1.50926 ·10^{-22} kg/m^3
Do = 2.23 ± 0.24 mMsolar/pc^3

$$D_{NFW}(R) = \frac{D_0}{x \cdot (1+x)^2}$$ Where x= radius/ Rs Rs is called length scale and Do is density scale.

Radius	Radius	Speed	E	D NFW	D NFW
kpc	m	km/s	m/s^2	Kg/m^3	mMsun/pc^3
40	1,23E+21	214	3,710E-11	2,809E-23	0,41494976
50	1,54E+21	209,5	2,845E-11	1,747E-23	0,25812046
60	1,85E+21	202,8	2,221E-11	1,165E-23	0,1720282
70	2,16E+21	197,8	1,811E-11	8,165E-24	0,12060679
80	2,47E+21	194,7	1,536E-11	5,952E-24	0,08791722
90	2,78E+21	191,6	1,322E-11	4,476E-24	0,06610808
100	3,09E+21	188	1,145E-11	3,452E-24	0,05098507
120,1	3,71E+21	182,7	9,007E-12	2,176E-24	0,03213731

Data to do power regression. DM density depending on E. $D_{DM} = A \cdot E^B$. International system of units.

E	D NFW
m/s^2	Kg/m^3
3,710E-11	2,809E-23
2,845E-11	1,747E-23
2,221E-11	1,165E-23
1,811E-11	8,165E-24
1,536E-11	5,952E-24
1,322E-11	4,476E-24
1,145E-11	3,452E-24
9,007E-12	2,176E-24

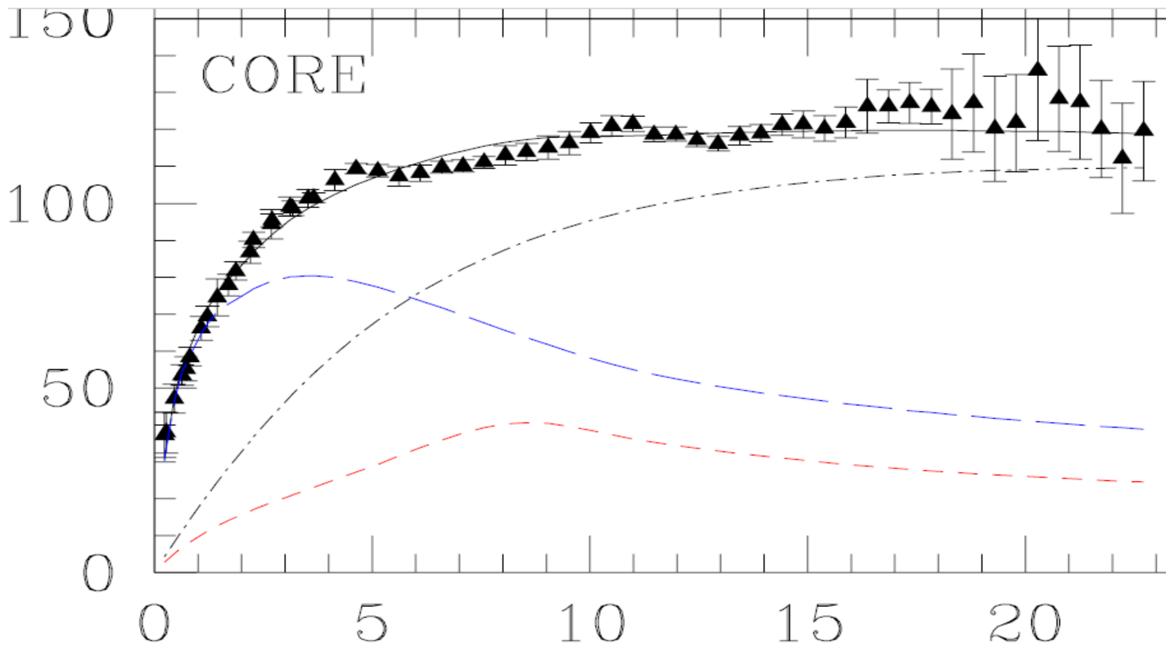
Parameters of power regression I.S.	
A	1,740601600E-04
B	1,800735172E+00
r	9,996464956E-01

Relative error between DM density NFW profile and DM density as power of E.

Radius	Radius	E	D NFW	D NFW	D power E	Rel error
kpc	m	m/s^2	Kg/m^3	mMsun/pc^3	mMsun/pc^3	%
40	1,23E+21	3,710E-11	2,809E-23	0,41494976	4,24E-01	2,14E+00
50	1,54E+21	2,845E-11	1,747E-23	0,25812046	2,63E-01	1,78E+00
60	1,85E+21	2,221E-11	1,165E-23	0,1720282	1,68E-01	-2,18E+00
70	2,16E+21	1,811E-11	8,165E-24	0,12060679	1,17E-01	-3,46E+00
80	2,47E+21	1,536E-11	5,952E-24	0,08791722	8,66E-02	-1,53E+00
90	2,78E+21	1,322E-11	4,476E-24	0,06610808	6,61E-02	2,07E-03
100	3,09E+21	1,145E-11	3,452E-24	0,05098507	5,11E-02	1,74E-01
120,1	3,71E+21	9,007E-12	2,176E-24	0,03213731	3,31E-02	3,00E+00

4.7 M33 GALAXY

Authors of rotation curve and DM density profile are [11] Corbelli,E. et al.



Triangular points are data of spin speed. Dot and dashed line is dark matter density function.

Radius	Radius	Velocity	Virial E
m	kpc	km/s	m/s^2
2,47E+20	8	116,3	5,47918E-11
2,78E+20	9	118,7	5,07347E-11
3,09E+20	10	118,7	4,56612E-11
3,39E+20	11	118,7	4,15102E-11
3,70E+20	12	119,3	3,84367E-11
4,01E+20	13	118,7	3,51240E-11
4,32E+20	14	119,3	3,29457E-11
4,63E+20	15	119,88	3,10491E-11
4,94E+20	16	119,88	2,91085E-11
5,25E+20	17	119,88	2,73962E-11
5,55E+20	18	119,88	2,58742E-11
5,86E+20	19	119,88	2,45124E-11
6,17E+20	20	119,88	2,32868E-11
6,48E+20	21	119,88	2,21779E-11
6,79E+20	22	119,3	2,09655E-11

According [4] E Corbelli, 2014. parameters of Burket profile are Rs = 7,5 Kpc and Do = 18 mMsun/pc^3.

Dark matter density Burket profile
Rs = 7,5 Kpc
Do = 18 mMsun/pc^3

$$D_{BURKET}(R) = \frac{D_0}{(1+x)\cdot(1+x^2)}$$ Where x = radius/Rs

Radius	Virial E	Burket profile of DM	Burket profile of DM
kpc	E m/s^2	Kg/m^3	mMsun/pc^3
10	4,57E-11	1,8801E-22	2,77714286
11	4,15E-11	1,5678E-22	2,31578546
12	3,84E-11	1,3166E-22	1,94468453
13	3,51E-11	1,1133E-22	1,64451423
14	3,29E-11	9,4793E-23	1,400189
15	3,10E-11	8,1240E-23	1,2
16	2,91E-11	7,0061E-23	1,03487045
17	2,74E-11	6,0778E-23	0,89775229
18	2,59E-11	5,3019E-23	0,7831535
19	2,45E-11	4,6495E-23	0,68677436
20	2,33E-11	4,0974E-23	0,60523039
21	2,22E-11	3,6276E-23	0,53584187
22	2,10E-11	3,2257E-23	0,47647433

Data in grey are used to do power regression because units are I.S.

Burket Dark Matter Density as power of Virial E for M33 inside dominion 8 kpc < Radius < 22 kpc
$D_{DM\ Pw\ VE} = A \cdot E^{B}$ I.S. of units.
A = 29,02219371 B= 2,242193511 and correlation coefficient r = 0,9990083703.

Relative error between DM density Burket profile and DM density as power of E.

Radius	Virial E	Burket DM	DM as power of E	Relt. Diff.
kpc	m/s^2	Kg/m^3	Kg/m^3	%
8	5,48E-11	2,7582E-22	2,85066E-22	3,3516E+00
9	5,07E-11	2,2701E-22	2,39901E-22	5,6778E+00
10	4,57E-11	1,8801E-22	1,89424E-22	7,5077E-01
11	4,15E-11	1,5678E-22	1,52977E-22	2,4252E+00
12	3,84E-11	1,3166E-22	1,28740E-22	2,2139E+00
13	3,51E-11	1,1133E-22	1,05185E-22	5,5230E+00
14	3,29E-11	9,4793E-23	9,11187E-23	3,8759E+00
15	3,11E-11	8,1240E-23	7,97755E-23	1,8027E+00
16	2,91E-11	7,0061E-23	6,90278E-23	1,4744E+00
17	2,74E-11	6,0778E-23	6,02545E-23	8,6112E-01
18	2,59E-11	5,3019E-23	5,30066E-23	2,4323E-02
19	2,45E-11	4,6495E-23	4,69549E-23	9,8992E-01
20	2,33E-11	4,0974E-23	4,18536E-23	2,1465E+00
21	2,22E-11	3,6276E-23	3,75165E-23	3,4182E+00
22	2,10E-11	3,2257E-23	3,30733E-23	2,5295E+00

4.8 NGC 3198

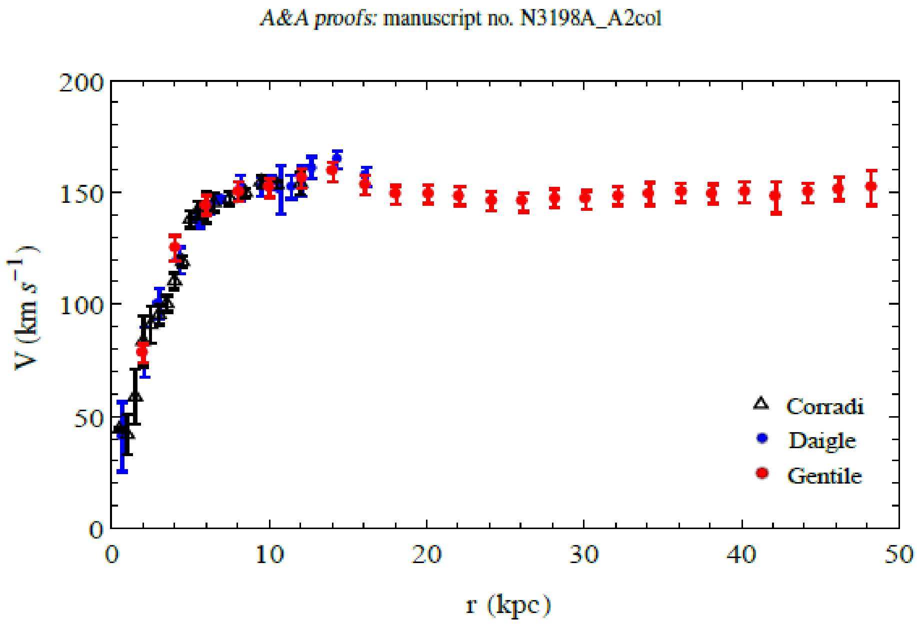


Fig. 1. Comparison between Hα and HI RCs black open triangles with error bars from Corradi et al. (1991), blue circles with error bars are from Daigle et al. (2006), and red circles with error bars are from Gentile et al. (2013).

Rotation curve and dark matter density data come from Karukes,E.V. [12]

Data DM density according Karukes,E. [12]		
Radius kpc	DM Den. data kg/m^3	DM Den. data mMsun/pc^3
20,1	5,8E-23	8,57E-01
22,1	4,80E-23	7,09E-01
24,1	4,20E-23	6,21E-01
26,1	3,60E-23	5,32E-01
28,1	3,30E-23	4,88E-01
30,2	3,00E-23	4,43E-01
32,2	2,70E-23	3,99E-01
34,2	2,50E-23	3,69E-01
36,2	2,30E-23	3,40E-01
38,2	2,10E-23	3,10E-01
40,2	2,00E-23	2,96E-01
42,1	1,80E-23	2,66E-01
44,2	1,60E-23	2,36E-01
46,2	1,30E-23	1,92E-01

In order to get DM density as power of E, below is calculated and tabulated Virial E and DM density Karukes data.

Radius kpc	Radius m	Velocity km/s	Virial E m/s^2	DM Den. data kg/m^3	DM Den. data mMsunes/pc^3
20,1	6,20E+20	1,49E+02	3,58E-11	5,8E-23	8,57E-01
22,1	6,82E+20	1,48E+02	3,23E-11	4,80E-23	7,09E-01
24,1	7,44E+20	1,46E+02	2,87E-11	4,20E-23	6,21E-01
26,1	8,05E+20	1,46E+02	2,63E-11	3,60E-23	5,32E-01
28,1	8,67E+20	1,47E+02	2,50E-11	3,30E-23	4,88E-01
30,2	9,32E+20	1,47E+02	2,30E-11	3,00E-23	4,43E-01
32,2	9,94E+20	1,48E+02	2,22E-11	2,70E-23	3,99E-01
34,2	1,06E+21	1,49E+02	2,11E-11	2,50E-23	3,69E-01
36,2	1,12E+21	1,50E+02	2,01E-11	2,30E-23	3,40E-01
38,2	1,18E+21	1,49E+02	1,89E-11	2,10E-23	3,10E-01
40,2	1,24E+21	1,50E+02	1,81E-11	2,00E-23	2,96E-01
42,1	1,30E+21	1,50E+02	1,73E-11	1,80E-23	2,66E-01
44,2	1,36E+21	1,50E+02	1,65E-11	1,60E-23	2,36E-01
46,2	1,43E+21	1,52E+02	1,61E-11	1,30E-23	1,92E-01

Parameters of power regression $D_{DM\ PwE} = A\cdot E^B$	
A	$4{,}04598703 \cdot 10^{-5}$
B	1,70654481
r	0,9899977

Data to get a power regression are shown in grey.

According Karukes its data can be fitted with a NFW profile. Below are its parameters.

Dark matter density NFW profile
Rs = 37,2 ± 11 Kpc
Do = $(8 \pm 4)\cdot 10^{-23}$ Kg/m^3
Do = 1,17 mMsolar/pc^3

$$D_{NFW}(R) = \frac{D_0}{x\cdot(1+x)^2}$$

Where x= radius/ Rs Rs is called length scale and Do is density scale.

Below are shown relative differences between Power of E versus Karukes data and NFW versus Karukes data. Reader can check that power of E fit Karukes data better than NFW do it.

Radius Kpc	Karukes data mMsun/pc^3	Power of E mMsun/pc^3	NFW profile mMsun/pc^3	Rel. Diff % Data-Power	Relt. Diff. % Data- NFW
2,01E+01	8,57E-01	8,93E-01	9,13E-01	4,00E+00	6,10E+00
2,21E+01	7,09E-01	7,47E-01	7,75E-01	5,08E+00	8,49E+00
2,41E+01	6,21E-01	6,12E-01	6,65E-01	1,33E+00	6,69E+00
2,61E+01	5,32E-01	5,26E-01	5,76E-01	1,15E+00	7,64E+00
2,81E+01	4,88E-01	4,83E-01	5,03E-01	8,53E-01	3,00E+00
3,02E+01	4,43E-01	4,20E-01	4,39E-01	5,63E+00	9,65E-01
3,22E+01	3,99E-01	3,93E-01	3,88E-01	1,50E+00	2,72E+00
3,42E+01	3,69E-01	3,62E-01	3,45E-01	2,03E+00	6,93E+00
3,62E+01	3,40E-01	3,33E-01	3,09E-01	2,02E+00	1,00E+01
3,82E+01	3,10E-01	3,00E-01	2,77E-01	3,51E+00	1,19E+01
4,02E+01	2,96E-01	2,79E-01	2,50E-01	5,85E+00	1,82E+01
4,22E+01	2,66E-01	2,57E-01	2,26E-01	3,49E+00	1,75E+01
4,42E+01	2,36E-01	2,37E-01	2,06E-01	4,42E-01	1,50E+01
4,62E+01	1,92E-01	2,30E-01	1,87E-01	1,66E+01	2,48E+00

5. COMPARISON OF DM DENSITY AS POWER OF GRAVIT. FIELD –E- FOR BIG GALAXIES

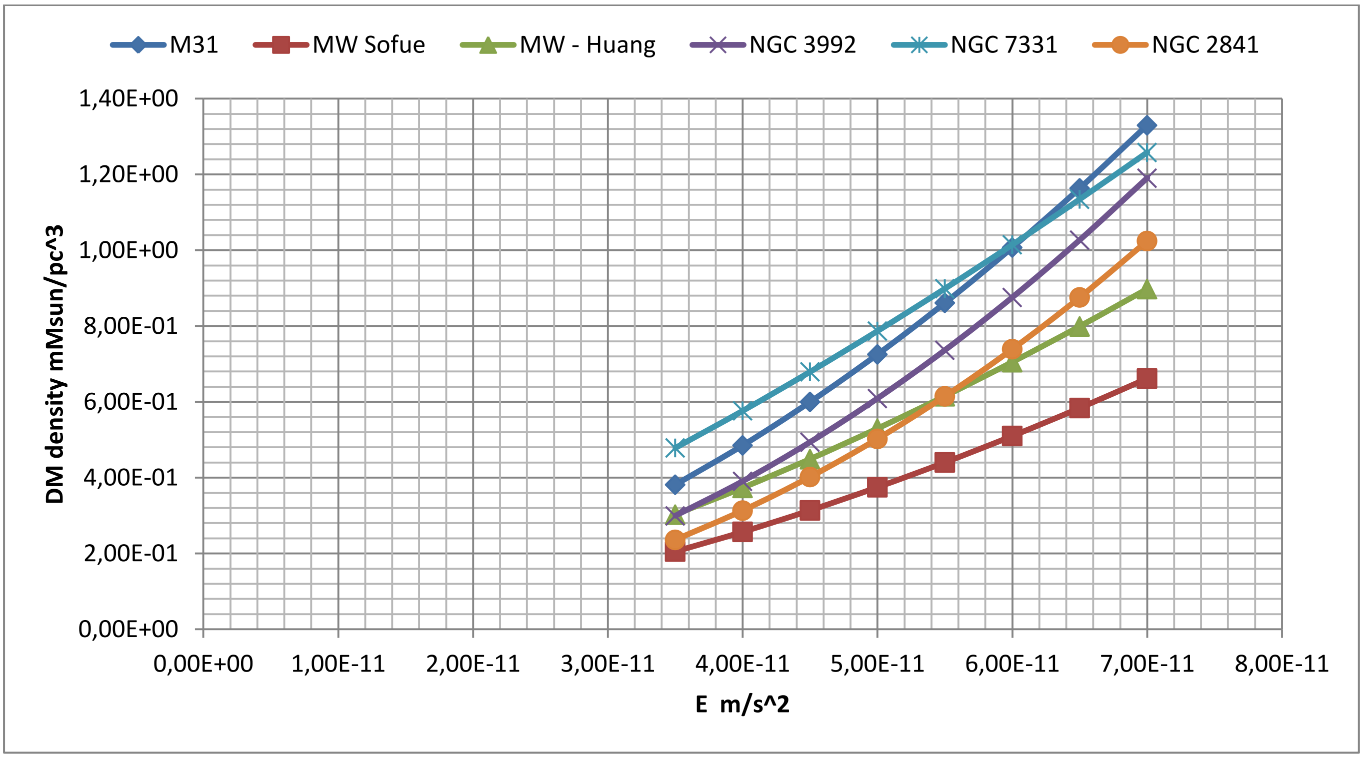
Previously it has been introduced DM density as power of E for five big galaxies: M31, Milky Way, NGC 3992, NGC 7331 and NGC 2841. Milky Way is studied by two authors.

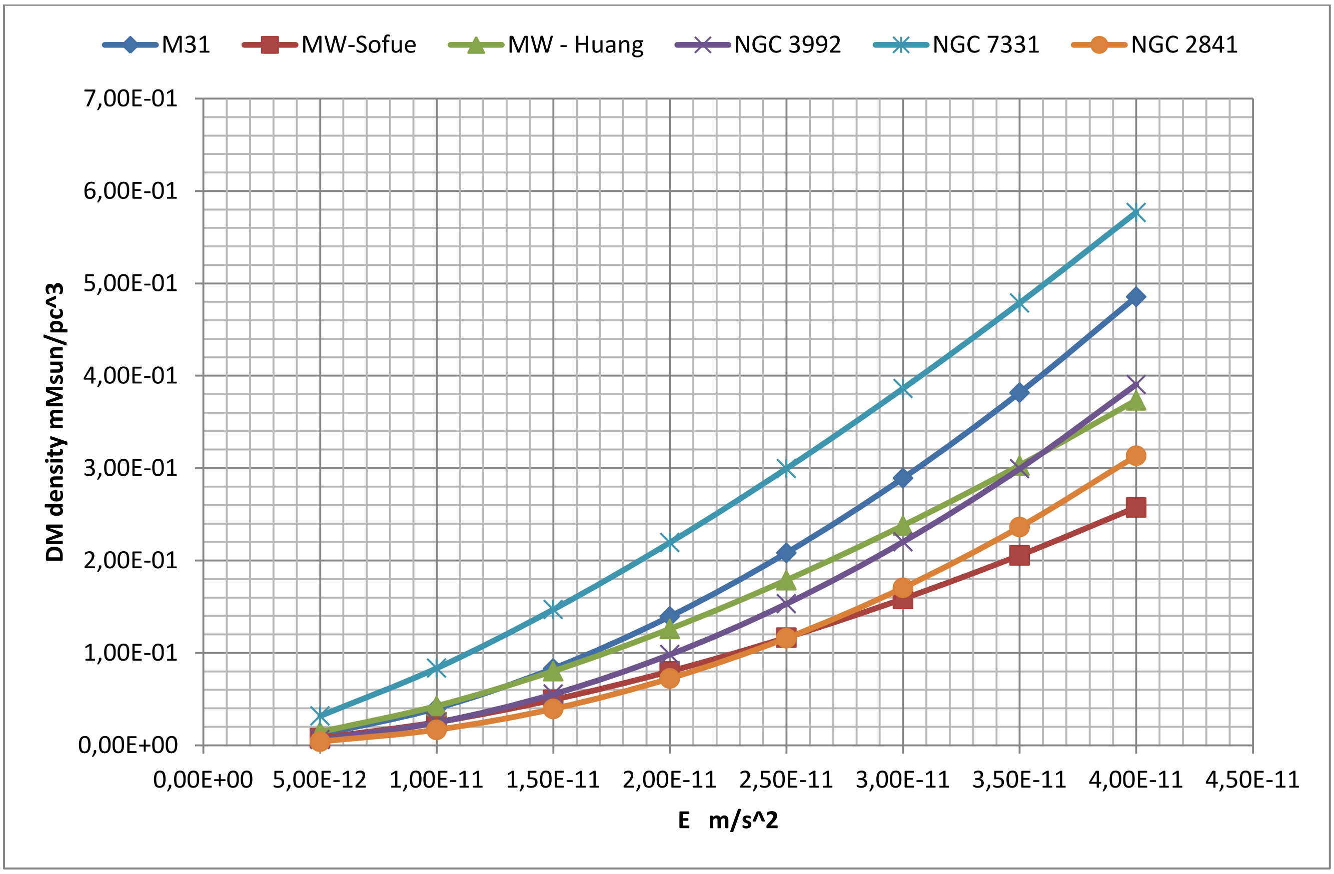
In this paragraph will be tabulated theses six data set inside a specific dominion for E. Dominion of E has been selected as common part for these six data set.

Finally this table will be plotted.

E	M31 - I -	M-W sofue -II-	M-W Huang -III-	NGC 39992 –IV-
m/s^2	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3
7,00E-11	1,3299E+00	6,6204E-01	8,9791E-01	1,1905E+00
6,50E-11	1,1638E+00	5,8420E-01	7,9940E-01	1,0272E+00
6,00E-11	1,0076E+00	5,1038E-01	7,0510E-01	8,7582E-01
5,50E-11	8,6143E-01	4,4067E-01	6,1517E-01	7,3649E-01
5,00E-11	7,2558E-01	3,7520E-01	5,2976E-01	6,0917E-01
4,50E-11	6,0019E-01	3,1407E-01	4,4908E-01	4,9387E-01
4,00E-11	4,8548E-01	2,5745E-01	3,7335E-01	3,9062E-01
3,50E-11	3,8172E-01	2,0551E-01	3,0281E-01	2,9941E-01
3,00E-11	2,8920E-01	1,5843E-01	2,3779E-01	2,2027E-01
2,50E-11	2,0826E-01	1,1647E-01	1,7866E-01	1,5320E-01
2,00E-11	1,3935E-01	7,9918E-02	1,2591E-01	9,8240E-02
1,50E-11	8,3008E-02	4,9179E-02	8,0191E-02	5,5397E-02
1,00E-11	3,9997E-02	2,4808E-02	4,2461E-02	2,4707E-02
5,00E-12	1,1480E-02	7,7008E-03	1,4319E-02	6,2138E-03

E	NGC 7331 -V-	NGC 2841 -V I -
m/s^2	mMsun/pc^3	mMsun/pc^3
7,00E-11	1,2583E+00	1,0248E+00
6,5E-11	1,1348E+00	8,7603E-01
6E-11	1,0150E+00	7,3947E-01
5,5E-11	8,9906E-01	6,1506E-01
5E-11	7,8721E-01	5,0267E-01
4,5E-11	6,7969E-01	4,0217E-01
4E-11	5,7678E-01	3,1341E-01
3,5E-11	4,7883E-01	2,3623E-01
3E-11	3,8625E-01	1,7045E-01
2,5E-11	2,9957E-01	1,1587E-01
2E-11	2,1949E-01	7,2245E-02
1,5E-11	1,4698E-01	3,9291E-02
1E-11	8,3525E-02	1,6653E-02
5,00E-12	3,1785E-02	3,8387E-03


M31
MW Sofue
MW - Huang
NGC 3992
NGC 7331
NGC 2841
DM density mMsun/pc^3
E m/s^2
1,40E+00
1,20E+00
1,00E+00
8,00E-01
6,00E-01
4,00E-01
2,00E-01
0,00E+00
0,00E+00
1,00E-11
2,00E-11
3,00E-11
4,00E-11
5,00E-11
6,00E-11
7,00E-11
8,00E-11


M31
MW-Sofue
MW - Huang
NGC 3992
NGC 7331
NGC 2841
DM density mMsun/pc^3
E m/s^2
7,00E-01
6,00E-01
5,00E-01
4,00E-01
3,00E-01
2,00E-01
1,00E-01
0,00E+00
0,00E+00
5,00E-12
1,00E-11
1,50E-11
2,00E-11
2,50E-11
3,00E-11
3,50E-11
4,00E-11
4,50E-11

Discussion

Looking at table and graphic above, it is easy see that bigger differences are between DM density values of NGC 7331 and Milky Way with Sofue data. Through dominion of E relative differences go from 47 % to 75 % as reader can see in table below. Apparently this fact would be enough to discard hypothesis of DM density depending on gravitational field as Universal law. However if reader look at relative difference between Milky Way Sofue data and Milky Way Huang data where relative differences go from 26 % to 46 % conclusion must be though more carefully.

We must think that relative difference inside Milky Way regarding two different authors, come from experimental error despite the fact that measure have been made on our own galaxy. It is right to think that measures error for galaxies which are lot of Mpc away should be a great bigger than measures inside our own Galaxy.

In my opinion it is plausible that a range of relative differences from 47 % to 75 % between Sofue data for Milky Way and NGC 7331 data might come from experimental error because NGC 7331 is 12 Mpc away.

Therefore this results could support hypothesis that DM density depend on gravitational field as Universal law.

In table below is developed relative difference for DM density through E dominion for Sofue versus Huang data and for Sofue versus NGC 7331 data.

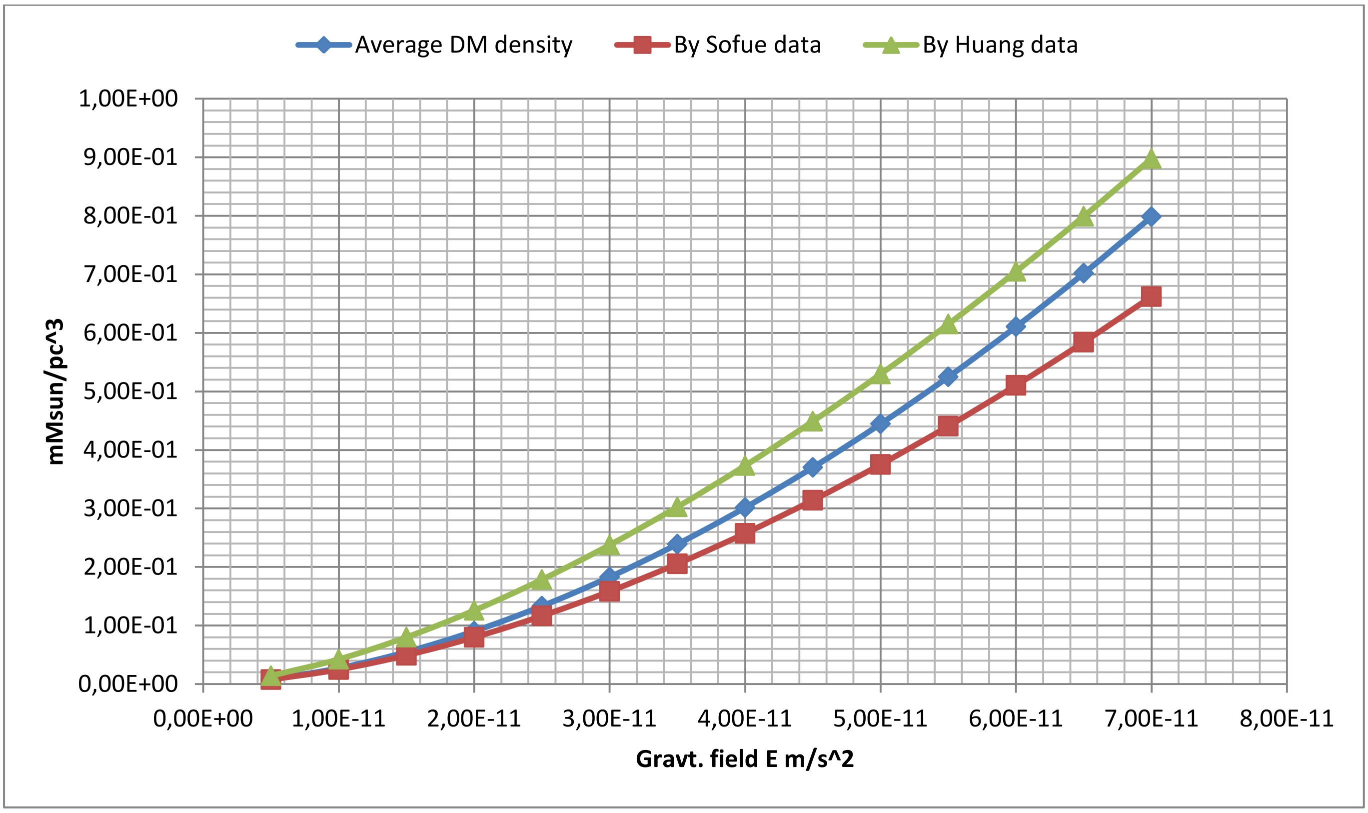
				Relative diff.	Rel. difference
Gravt. Field E	M-W sofue	M-W Huang	NGC 7331	Huang –Sofue	NGC 7331-Sofue
m/s^2	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3	%	%
7,00E-11	6,620E-01	8,9791E-01	1,26E+00	2,62E+01	4,74E+01
6,50E-11	5,842E-01	7,9940E-01	1,13E+00	2,69E+01	4,85E+01
6,00E-11	5,104E-01	7,0510E-01	1,01E+00	2,76E+01	4,97E+01
5,50E-11	4,407E-01	6,1517E-01	8,99E-01	2,83E+01	5,10E+01
5,00E-11	3,752E-01	5,2976E-01	7,87E-01	2,91E+01	5,23E+01
4,50E-11	3,141E-01	4,4908E-01	6,80E-01	3,00E+01	5,38E+01
4,00E-11	2,575E-01	3,7335E-01	5,77E-01	3,10E+01	5,54E+01
3,50E-11	2,055E-01	3,0281E-01	4,79E-01	3,21E+01	5,71E+01
3,00E-11	1,584E-01	2,3779E-01	3,86E-01	3,33E+01	5,90E+01
2,50E-11	1,165E-01	1,7866E-01	3,00E-01	3,48E+01	6,11E+01
2,00E-11	7,992E-02	1,2591E-01	2,19E-01	3,65E+01	6,36E+01
1,50E-11	4,918E-02	8,0191E-02	1,47E-01	3,86E+01	6,65E+01
1,00E-11	2,481E-02	4,2461E-02	8,35E-02	4,15E+01	7,03E+01
5,00E-12	7,701E-03	1,4319E-02	3,18E-02	4,62E+01	7,58E+01

5.1 AVERAGE DARK MATTER DENSITY DEPENDING ON GRAVITATIONAL FIELD AS UNIVERSAL LAW

In paper [2] Abarca, M.2015 the author got an average value for parameters A& B. Values found were A= $2{,}53\cdot10^{-5}$ and B= 1,74. DM density depend on gravitational field E according a power function like this one. $\varphi_{DM}(E) = A{\cdot}E^B$

Through these parameters DM density function gives values which are intermediate between data got for Milky Way studied by data Sofue and Milky Way studied by data Huang, as reader can check in table and plot below.

E	Milky Way By Sofue Data	Milky Way By Huang Data	Average DM By Abarca calculus
m/s^2	mMsun/pc^3	mMsun/pc`3	mMsun/pc^3
7,00E-11	6,6204E-01	8,9791E-01	7,9857E-01
6,50E-11	5,8420E-01	7,9940E-01	7,0196E-01
6,00E-11	5,1038E-01	7,0510E-01	6,1070E-01
5,50E-11	4,4067E-01	6,1517E-01	5,2490E-01
5,00E-11	3,7520E-01	5,2976E-01	4,4469E-01
4,50E-11	3,1407E-01	4,4908E-01	3,7020E-01
4,00E-11	2,5745E-01	3,7335E-01	3,0160E-01
3,50E-11	2,0551E-01	3,0281E-01	2,3907E-01
3,00E-11	1,5843E-01	2,3779E-01	1,8283E-01
2,50E-11	1,1647E-01	1,7866E-01	1,3313E-01
2,00E-11	7,9918E-02	1,2591E-01	9,0289E-02
1,50E-11	4,9179E-02	8,0191E-02	5,4732E-02
1,00E-11	2,4808E-02	4,2461E-02	2,7030E-02
5,00E-12	7,7008E-03	1,4319E-02	8,0919E-03



6. DARK MATTER MASS CALCULUS IN COMA CLUSTER TRHOUGH DM AS POWER OF E LAW

In paper [14] Brilenkov R. et al. 2015. *Dark and visible matter distribution in Coma Cluster: theory versus observations* has been developed details of a careful study of matter in Coma Cluster. They stated that there is a high spherical symmetry where a sphere of 3,7 Mpc of radius contains most of galaxies and the line- of- sight velocity dispersion is 1004 km/s. Through the standard cosmological model and NFW profile they calculated that total mass of Coma Cluster is inside the interval [6 - 6.9] $\cdot 10^{15}$ M_Θ of masses (1). Where $M_\Theta = 1{,}99\cdot 10^{30}$ kg.

Now it will be got total mass through DM density as power of E through a very simple calculus. Results is surprisingly similar to written above.

It will be consider $\varphi_{DM}(E) = A\cdot E^B$ where A= $2{,}53\cdot 10^{-5}$ and B= 1,74 according [2] Abarca, M.2015.

According Virial theorem $E = v^2/R$ where v= 1004 km/s and R = 3,7 Mpc. 1 Mpc = $3.0857\cdot 10^{22}$ m.

Calculus made into I.S. it is got $E = 8.83\cdot 10^{-12}$ m/s^2 and a DM density = $1{,}48\cdot 10^{-24}$ Kg/m^3.

As a huge simplification it is considered Coma Cluster a sphere with radius 3.7 Mpc with a DM density in average equal to $1{,}48 \cdot 10^{-24}$ Kg/m^3 .Total mass calculated is $4.6 \cdot 10^{15}$ M_Θ .(2)

Reader can check that results (1) & (2) are very closed.

This calculus has proved that formula got for DM density for big galaxies is right for galaxy cluster scale.

Therefore dark matter density as power of E has overcome a new test to be considered a universal law.

6.1 CALCULUS OF DYNAMICAL MASS IN COMA CLUSTER

As it is known $M_{DYNAMICAL} = V^2\cdot R/ G_N$ where V is velocity and R is cluster radius.

Made calculus it is got M= $8.66\cdot 10^{14}$ M_Θ, which is a good approximation of Coma Cluster matter but worse than calculus of matter made above through DM density as power of E.

7. COMPARISON OF DM DENSITY AS POWER OF E FOR BIG AND INTERMEDIATE GALAXIES

In this paragraph will be compared seven galaxies, the five big galaxies previously studied and two intermediate galaxies M33 and NGC 3198.

E	M31 - I -	M-W sofue -II-	M-W Huang -III-	NGC 39992 –IV-
m/s^2	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3
7,00E-11	1,3299E+00	6,6204E-01	8,9791E-01	1,1905E+00
6,50E-11	1,1638E+00	5,8420E-01	7,9940E-01	1,0272E+00
6,00E-11	1,0076E+00	5,1038E-01	7,0510E-01	8,7582E-01
5,50E-11	8,6143E-01	4,4067E-01	6,1517E-01	7,3649E-01
5,00E-11	7,2558E-01	3,7520E-01	5,2976E-01	6,0917E-01
4,50E-11	6,0019E-01	3,1407E-01	4,4908E-01	4,9387E-01
4,00E-11	4,8548E-01	2,5745E-01	3,7335E-01	3,9062E-01
3,50E-11	3,8172E-01	2,0551E-01	3,0281E-01	2,9941E-01
3,00E-11	2,8920E-01	1,5843E-01	2,3779E-01	2,2027E-01
2,50E-11	2,0826E-01	1,1647E-01	1,7866E-01	1,5320E-01
2,00E-11	1,3935E-01	7,9918E-02	1,2591E-01	9,8240E-02
1,50E-11	8,3008E-02	4,9179E-02	8,0191E-02	5,5397E-02
1,00E-11	3,9997E-02	2,4808E-02	4,2461E-02	2,4707E-02
5,00E-12	1,1480E-02	7,7008E-03	1,4319E-02	6,2138E-03

Dominion of gravitational field for intermediate galaxies is a bit reduced because these galaxies are not so massive.

E	NGC 7331 -V-	NGC 2841 -V I -	M33 -VII-	NGC 3198 -VIII-
m/S^2	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3	mMsun/pc^3
7,00E-11	1,2583E+00	1,0248E+00		
6,5E-11	1,1348E+00	8,7603E-01		
6E-11	1,0150E+00	7,3947E-01		
5,5E-11	8,9906E-01	6,1506E-01		
5E-11	7,8721E-01	5,0267E-01	3,5763E+00	1,5749E+00
4,5E-11	6,7969E-01	4,0217E-01	2,8038E+00	1,3158E+00
4E-11	5,7678E-01	3,1341E-01	2,1359E+00	1,0762E+00
3,5E-11	4,7883E-01	2,3623E-01	1,5690E+00	8,5688E-01
3E-11	3,8625E-01	1,7045E-01	1,0990E+00	6,5868E-01
2,5E-11	2,9957E-01	1,1587E-01	7,2128E-01	4,8255E-01
2E-11	2,1949E-01	7,2245E-02	4,3078E-01	3,2973E-01
1,5E-11	1,4698E-01	3,9291E-02	2,2165E-01	2,0181E-01
1E-11	8,3525E-02	1,6653E-02		
5,00E-12	3,1785E-02	3,8387E-03		

Looking at table and graphics reader can check that DM density is a great deal bigger inside intermediate galaxies than DM density inside big galaxies. In addition, DM density inside M33 is bigger than NGC 3198 because M33 is less massive than NGC 3198. Remember that rotation speed in flat region for M33 is 120 km/s whereas for NGC 3198 is 150 km/s.

It is well known by astrophysicist this remarkable fact. In general inside dwarf and intermediate galaxies DM density is bigger than DM density inside big galaxies.

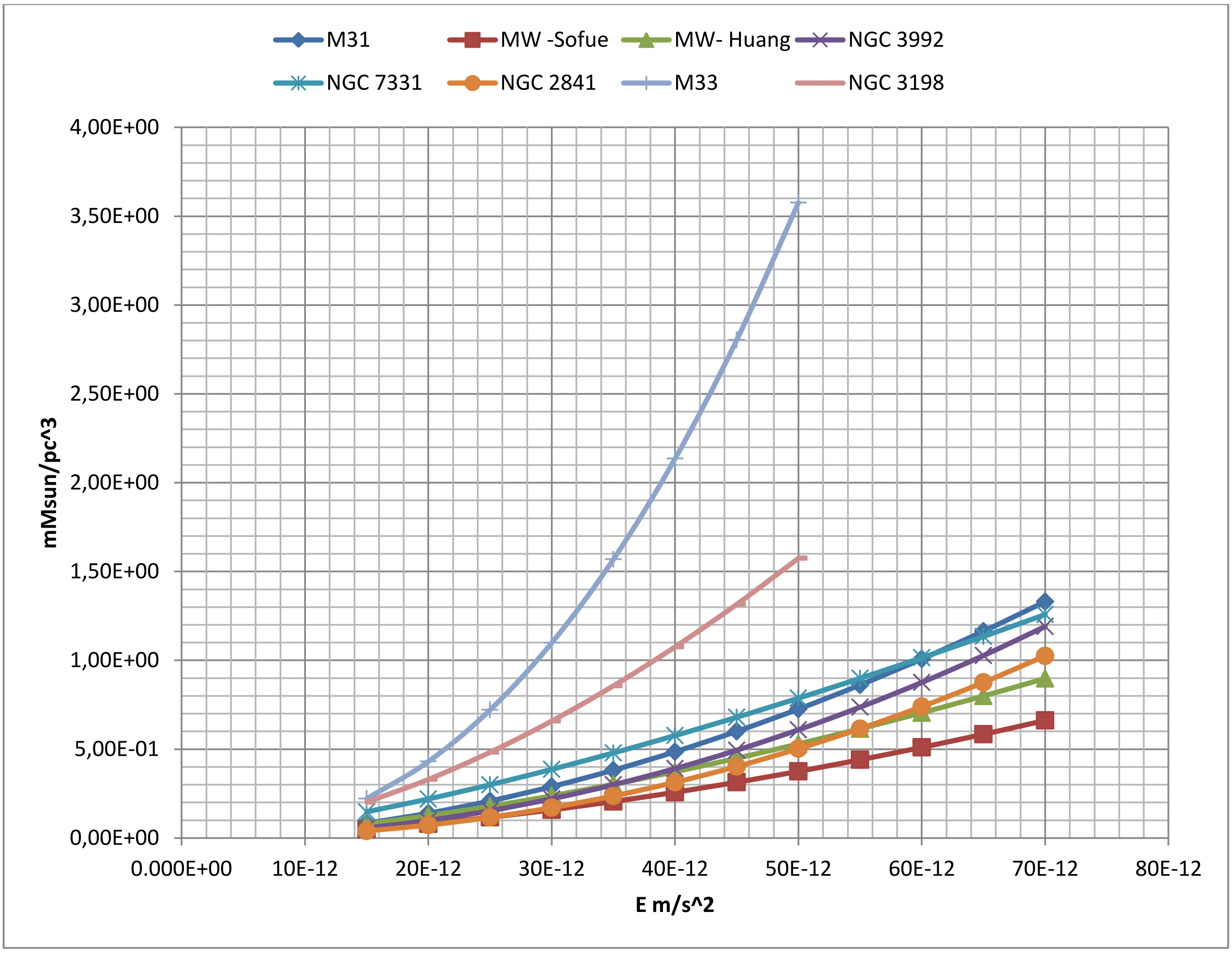
Reason why this fact support theory of DM density depending on gravitational field as Universal law is explained in several papers published previously. [2] Abarca, M.2015. [3] Abarca, M.2015. [4] Abarca, M.2015.

Briefly will be pointed some ideas. It is known that intermediate and dwarf galaxies are always orbiting near big galaxies. Therefore gravitational field generated by big galaxies inside areas near dwarf galaxies may generate DM density which may be associated to dwarf galaxies although this amount of DM has been generated by gravitational field of its neighbour big galaxy. Therefore DM density inside dwarf and intermediate galaxies is bigger compared with DM density inside big galaxies.

Another reason to explain this over density of DM might be explained by different sources of DM such us cold clouds of baryonic gas and MACHOs.

According [13] Nieuwenhuizen, Theo M. et al. 2012. Inside Large and Small Magellanic clouds there is a huge number of cold clouds of baryonic gas at 15 K with an average radius of 1.7 pc. This kind of clouds are very difficult to observe so it is logic to consider this kind of baryonic matter as dark matter.

In graph below it is shown clearly that DM density for intermediate galaxies is a great deal bigger than DM density for big galaxies. In addition DM density inside M33 is bigger than inside NGC 3198 because M33 is less massive than NGC 3198 although both are intermediate galaxies compared with the five galaxies previously studied.



This chapter has shown clearly that DM density inside big galaxies may be generated by gravitational field according a Universal law despite relative differences between DM densities for different big galaxies. Because their relative differences are small if they are compared with DM density inside intermediate galaxies as graphic shows clearly.

8. CONCLUSION

The main goal this paper has been try to show evidences that DM density inside big galaxies depend on gravitational field according a Universal because relative differences of DM density found between different big galaxies might come from error in its measures and another sources of dark matter such as cold clouds of baryonic gas and MACHOs.

It is remarkable the fact that relative differences between DM density for Milky Way studied for two authors are lightly lower than relative differences between DM density belonging to galaxies which are 12 Mpc away.

Also has been pointed reason why DM density inside intermediate galaxies is bigger than DM density inside big galaxy according hypothesis of DM density generated by gravitational field.

Therefore this fact suggest that it is necessary to look for more evidences to check author hypothesis between big galaxies. As according this theory DM is generated by gravitational field, it is not possible to study initially this theory in region near dwarf and intermediate galaxies because in these region total gravitational field is vector addition of gravitational field generated by intermediate galaxy and its nearby big galaxy. In addition these kind of galaxies contain a bigger proportion of baryonic dark matter as cold clouds and MACHOs.

It is remarkable a very simple calculus of total dark matter in Coma Cluster through DM density as power of gravitational field whose results is very similar to complex calculus made through cosmological standard model and NFW profile. This calculus might be considered a new test overcome to consider DM density as power of gravitational field as a Universal law.

In addition, as I published in [1] Abarca, M.2014. the ultimate theory of DM density will be a quantum gravity theory.

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