A NEW DARK MATTER DENSITY PROFILE FOR MILKY WAY TO DEMONSTRATE THAT DARK MATTER IS GENERATED BY GRAVITATIONAL FIELD

Author Manuel Abarca Hernandez **email** mabarcaher1@gmail.com

1. ABSTRACT

The main target this paper is to check a theory about dark matter nature, which was published by the author in previous papers. It was postulated that dark matter density is a function which depend on E, gravitational field.

In this work has been calculated a new function for DM density for Milky Way. Reader could think, why disturb me with a new DM density profile, called Bernoulli profile in this paper, whose values have relative differences with NFW ones below 15%?

The reason is clear. This DM profile has been got starting from hypothesis that DM is generated by the own gravitational field. Therefore if DM Bernoulli profile fits perfectly to NFW DM profile then it is possible conclude that observational data supports author´s hypothesis about DM nature.

To find reasons that author has to do so daring statement, reader can consult [1] Abarca,M.2014. *Dark matter model by quantum vacuum*. [2] Abarca,M.2015. *Dark matter density function depending on gravitational field as Universal law.* [3] Abarca,M.2015. *A new dark matter density profile for NGC 3198 galaxy to demonstrate that dark matter is generated by gravitational field.* [4] Abarca, M.2016.*A New Dark Matter Density Profile for M33 Galaxy to Demonstrate that Dark Matter is Generated by Gravitational Field*. [5] Abarca, M.2016.*A New Dark Matter Density Profile for M31 Galaxy to Demonstrate that Dark Matter is Generated by Gravitational Field*.

Briefly will be explained method followed to develop this paper. Firstly are presented rotation curve and table with data about rotational velocity depending on radius inside Milky Way galaxy. These data come from [6] Sofue,Y.2015.

In fourth epigraph, velocity data has been fitted as power function depending on radius. In fifth chapter, it has been calculated and tabulated gravitational field through Virial theorem, which it is got as a direct calculus having velocity data depending on radius. In this paper, dominion of gravitational E extends from 30 kpc to 200 kpc.

In sixth epigraphs it has been tabulated data of NFW DM density profile published by [6] Sofue, Y.2015. for Milky Way.

In seventh epigraph has been fitted data of NFW DM density profile as power of gravitational field, E, with a correlation coefficient bigger than 0,999. Particularly formula found is $\varphi_{D\,M}(r) = A \cdot E^{B}$ .Where A = 7.310686 $\cdot 10^{-7}$ B= 1,59883364 and correlation coefficient r = 0,9997776774 into I.S. of units.

In eighth epigraph it has been compared DM density as power of E and NFW profiles. Tables and plots show clearly that relative differences between both profiles are almost everywhere below 6%.

In ninth epigraph it is considered derivative of gravitational field in halo region (30 to 200 kpc) where density of baryonic matter is negligible regarding DM density. As consequence $M'(r) = 4\pi r^2 \varphi_{DM}(r)$ and considering that $\varphi_{DM}(r) = A \cdot E^{B}(r)$ then $M'(r) = 4\pi r^2 \cdot A \cdot E^{B}$. If M´(r) is replaced on derivative of E (r) then it is got a Bernoulli differential equation whose solution allows to get a new DM density profile, called Bernoulli profile, through formula $\varphi_{DM}(r) = A \cdot E^{B}(r)$.

In tenth epigraph Bernoulli and NFW DM density profiles have been compared. Its relative differences are below 16% for radius bigger than 60 kpc, and below 18% in the whole dominion, from 30 kpc to 200 kpc. This is a superb result, specially if it is considered that Do parameter of NFW profile has 40 % as relative error and velocity measures of rotation curve have error bigger than 15% in the whole dominion.

2. INTRODUCTION

As reader knows Milky Way radius is approximately 20 kpc. According [6] Sofue, Y. 2015. Baryonic mass of Milky Way is $M_{BARYONIC} = 1{,}37 \cdot 10^{11} M_{SUN}$
As radius is 20 kpc, it is supposed that for radius bigger than 30 kpc baryonic matter density is negligible versus DM density. This is the reason why radius dominion in this work is from 30 kpc to 200 kpc. In chapter eight it will be got a simple Bernoulli differential equation for gravitational field. However to get a so simple differential equation it is needed that $M'(r) = 4\pi r^2 \varphi_{DM}(r)$ .In other words, it is needed that density of baryonic matter would be negligible versus D.M. density.

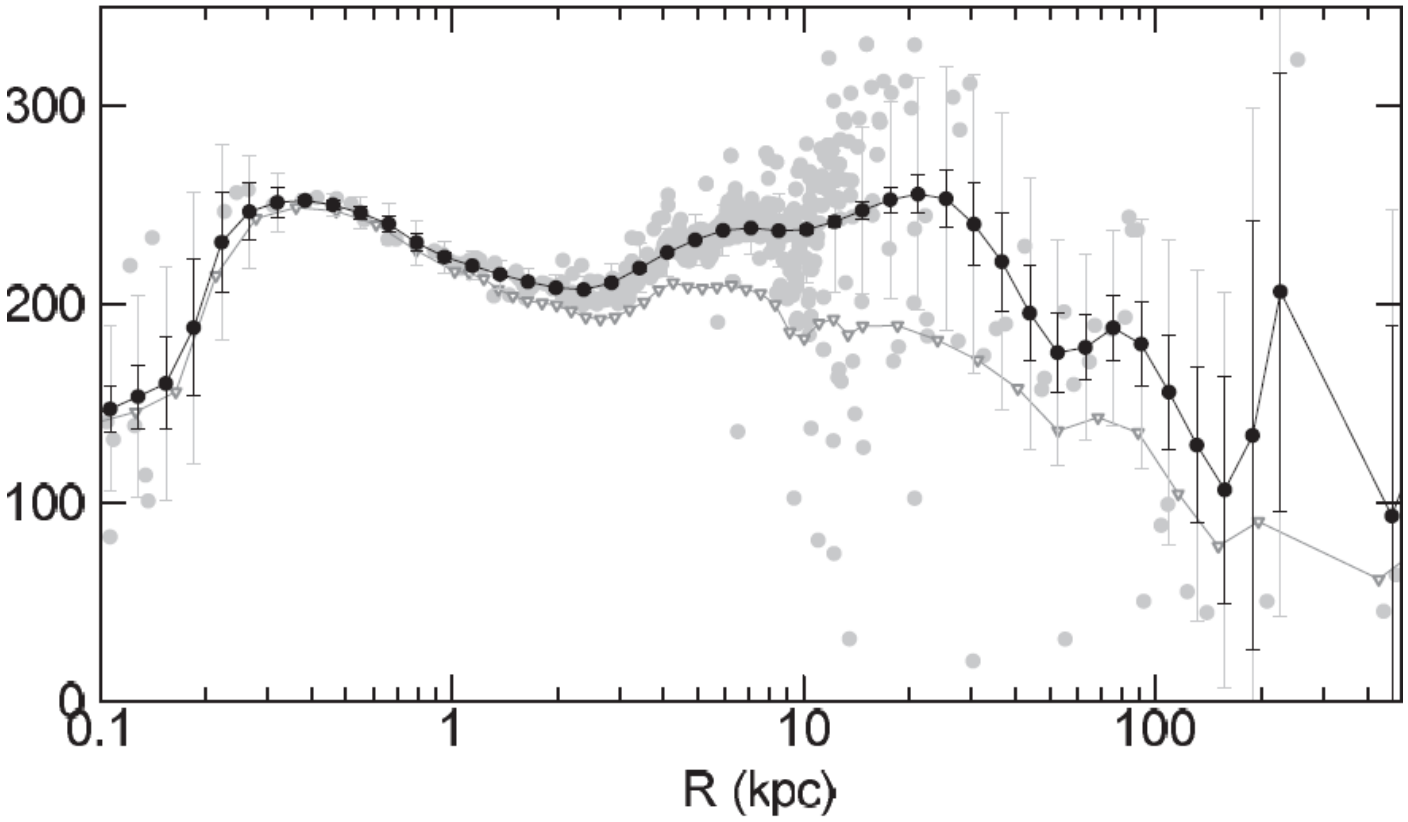
In paper [1] Abarca,M.2014, it was postulated that DM density depends on gravitational field. Further papers has studied DM density as power of gravitational field in several galaxies: M31, M33, NGC3198 and others galaxies. Correlation coefficient of both magnitudes has been always higher than 0,99.

In paper [2] Abarca,M.2015 it was justified properly that DM density is a function as power of E. $\varphi_{DM}(r) = A \cdot E^B$
Where A and B may be got by statistical regression and its values depend on each galaxy, although galaxies with similar mass have similar coefficients A & B.

Having formula $\varphi_{DM}(r) = A \cdot E^B$ it is right to get a Bernoulli equation for galactic E, whose solution allows to get a DM density profile called in this paper Bernoulli profile.

The main target this paper is to get Bernoulli profile for Milky Way and compare its values with NFW profile got by Sofue.2015. Results have been successful because relative differences are under 15 % inside main part of dominion despite the fact that error in measures of rotation curve are bigger than 15% in the whole dominion considered, from 30 kpc to 200 kpc.

3. OBSERVATIONAL DATA FROM SOFUE. 2015 PAPER.

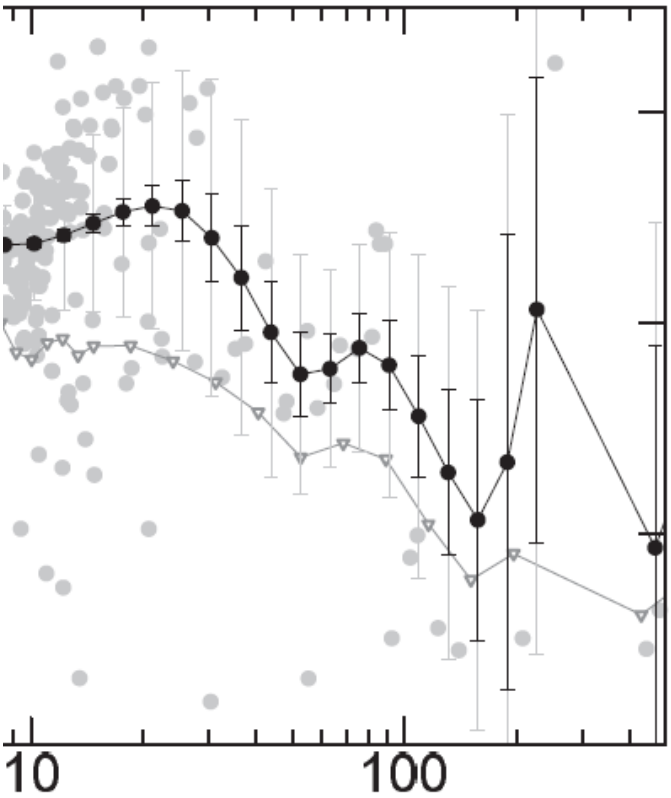


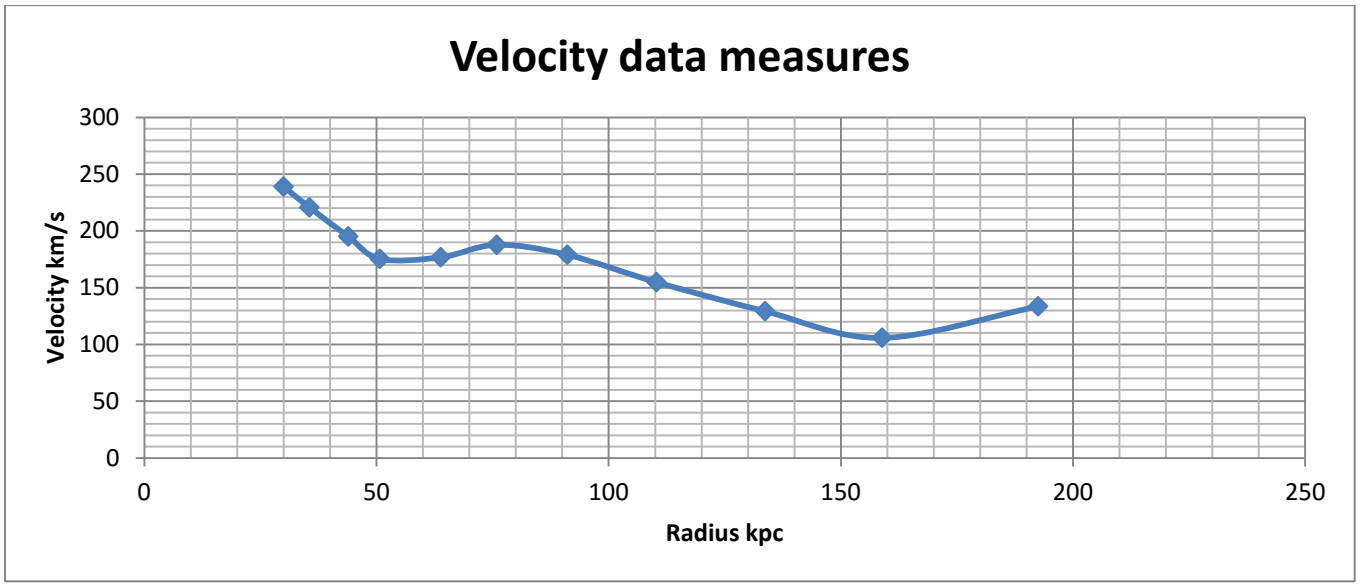
Graphic come from [6] Sofue,Y. 2015.

Table data have been got from graphic. As scale axis X is logarithmic, calculus have been made carefully to get table results. Velocity data have been got from experimental measures with radius bigger than 30 kpc up to 200 kpc.

Radius	Velocity
kpc	km/s
30	239
35,56	220,7
43,92	195,1
50,72	175,4
63,85	176,8
75,9	187,8
91,1	179
110,3	154,9
133,7	129,3
158,9	105,9
192,5	133,6

As Milky Way radius is 20 kpc it is sure that baryonic density is negligible versus DM density for radius bigger than 30 kpc. This hypothesis will be used in this work to introduce a new DM density profile called Bernoulli profile because it is got through a Berrnoulli differential equation for gravitational field.




Velocity data measures
Velocity km/s
300
250
200
150
100
50
0
0
50
100
150
200
250
Radius kpc

4. REGRESSION CURVE AS POWER OF RADIUS FOR ROTATIONAL VELOCITY DATA

Radius	Experimental Data	Regression curve	Rel. Diff
kpc	Km/s	Km/s	%
30	239	233,79	-2,23
35,56	220,7	220,07	-0,29
43,92	195,1	204,15	4,43
50,72	175,4	193,96	9,57
63,85	176,8	178,72	1,07
75,9	187,8	168,06	-11,74
91,1	179	157,50	-13,65
110,3	154,9	147,15	-5,27
133,7	129,3	137,41	5,91
158,9	105,9	129,23	18,05
192,5	133,6	120,71	-10,68

If it is fitted a power regression for rotational speed through this formula from experimental data it is right to get

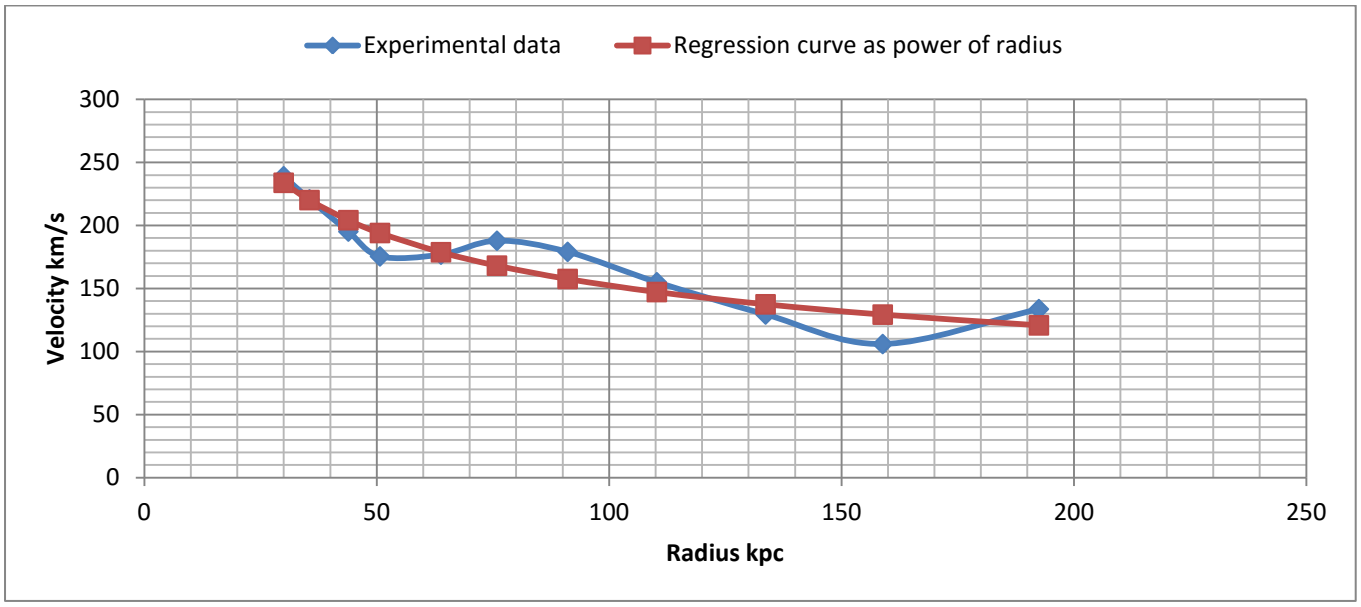
Vel (Km/s) = $A \cdot R^B$ where R represents radius in kpc, A= 783,570756 B= -0,35559623 and correlation coefficient is r= -0,91222841.

Radius is measured in kpc and velocity in km/s.

Table beside shows results this formula and its relative difference with experimental data.

To fit a power function to velocity data is a way to minimize and soften velocity decreasing, because errors in measures are important. In addition, relative differences between experimental data and regression curve are lower than experimental errors.

Reader can see in rotational curve that error in experimental data are bigger than 50% for radius bigger than 100 kpc, whereas relative differences are lower than 18%.



5. GRAVITATIONAL FIELD E THROUGH VIRIAL THEOREM

In this work dominion of radius extends from 30 kpc to 200 kpc. Despite the fact that rotation curve has accuracy measures for radius lower than 30 kpc.

As it is known total gravitational field may be calculated through Virial theorem, formula is $E = v^2/R$ whose I.S. unit is m/s^2. Hereafter, gravitational field got through this formula will be called Virial E. In fourth column is shown results of Virial E. Reader can check these data taking into account that 1 Kpc = $3{,}0857 \cdot 10^{19}$ m.
Data of velocity have been calculated by regression formula of previous chapter.

Radius kpc	Regression Vel.	Radius	Virial E
kpc	km/s	m	m/s^2
30	2,338E+02	9,26E+20	5,9042E-11
35,56	2,201E+02	1,10E+21	4,4138E-11
43,92	2,042E+02	1,36E+21	3,0753E-11
50,72	1,940E+02	1,57E+21	2,4039E-11
63,85	1,787E+02	1,97E+21	1,6212E-11
75,9	1,681E+02	2,34E+21	1,2060E-11
91,1	1,575E+02	2,81E+21	8,8245E-12
110,3	1,471E+02	3,40E+21	6,3615E-12
133,7	1,374E+02	4,13E+21	4,5770E-12
158,9	1,292E+02	4,90E+21	3,4061E-12
192,5	1,207E+02	5,94E+21	2,4530E-12

Through formula Velocity = $A \cdot R^B$ where $A = 783{,}570756$ and $B = -0{,}3555962$ it is possible to extrapolate easily velocity for radius 30 to 200 kpc stepping 10 kpc.

Radius kpc	Radius m	Velocity km/s	Virial E
30	9,26E+20	233,786525	5,90424E-11
40	1,23E+21	211,053099	3,60886E-11
50	1,54E+21	194,953438	2,46342E-11
60	1,85E+21	182,715061	1,80320E-11
70	2,16E+21	172,969018	1,38511E-11
80	2,47E+21	164,947829	1,10217E-11
90	2,78E+21	158,181962	9,00985E-12
100	3,09E+21	152,365194	7,52346E-12
110	3,39E+21	147,28777	6,39127E-12
120	3,70E+21	142,800332	5,50711E-12
130	4,01E+21	138,793121	4,80218E-12
140	4,32E+21	135,183346	4,23024E-12
150	4,63E+21	131,907163	3,75917E-12
160	4,94E+21	128,914412	3,36612E-12
170	5,25E+21	126,165032	3,03442E-12
180	5,55E+21	123,626573	2,75168E-12
190	5,86E+21	121,272419	2,50852E-12
200	6,17E+21	119,080497	2,29772E-12

6. NFW DARK MATTER DENSITY PROFILE

According [6] Sofue,Y., 2015. Parameters of NFW profile for Milky Way are

Dark matter density function profile NFW
Rs = $10,7 \pm 2,9$ Kpc
Do = $1.2318 \cdot 10^{-21}$ kg/m^3
Do = $18,2 \pm 7,4 \cdot 10^{-3}$ Msolar/pc^3 = 18,2 mMsolar/pc^3

Knowing that mMsolar/pc^3 = $6,768 \cdot 10^{-23}$ Kg /m^3
Unit of Do has been changed into mMsolar/pc^3 which is a very common unit for galactic densities.

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

Below are tabulated NFW DM density depending on radius. This data will be used in next chapter to get a power regression of DM density as power of gravitational field E.

Radius Kpc	NFW DM density Kg/m^3	NFW density mMsun/pc^3
3,00E+01	3,04E-23	4,49E-01
4,00E+01	1,47E-23	2,17E-01
5,00E+01	8,19E-24	1,21E-01
6,00E+01	5,03E-24	7,43E-02
7,00E+01	3,31E-24	4,89E-02
8,00E+01	2,29E-24	3,39E-02
9,00E+01	1,65E-24	2,44E-02
1,00E+02	1,23E-24	1,82E-02
1,10E+02	9,42E-25	1,39E-02
1,20E+02	7,36E-25	1,09E-02
1,30E+02	5,87E-25	8,66E-03
1,40E+02	4,75E-25	7,01E-03
1,50E+02	3,90E-25	5,76E-03
1,60E+02	3,24E-25	4,78E-03
1,70E+02	2,72E-25	4,02E-03
1,80E+02	2,31E-25	3,41E-03
1,90E+02	1,97E-25	2,91E-03
2,00E+02	1,70E-25	2,51E-03

7. NFW D.M. DENSITY AS POWER OF VIRIAL FIELD E

Below are tabulated values of gravitational field E and NFW DM density, because DM density will be fitted with a power function of E. Units are International System.
Reason why the author has decided to fit this function is explained in [2] Abarca,M.2015. & [1] Abarca,M.2014. Briefly, the author defends hypothesis that DM is generated by the own gravitational field. Therefore it is right to look for a function of DM density depending on E.

Data for Virial E comes from velocity fitted as power regression of radius, see chapter 4.Data of NFW DM density comes from chapter 6.

Radius	Virial E	NFW Density
kpc	m/s^2	Kg/m^3
30	5,9042E-11	3,0374E-23
35,56	4,4138E-11	1,9835E-23
43,92	3,0753E-11	1,1520E-23
50,72	2,4039E-11	7,8888E-24
63,85	1,6212E-11	4,2536E-24
75,9	1,2060E-11	2,6518E-24
91,1	8,8245E-12	1,5988E-24
110,3	6,3615E-12	9,3468E-25
133,7	4,5770E-12	5,4143E-25
158,9	3,4061E-12	3,3024E-25
192,5	2,4530E-12	1,8990E-25

Doing power regression of DM density versus gravitational field according formula Density $_{DARK\ MATTER} = A \cdot E^B$ through International System of units, it is right to get A= $7.310686 \cdot 10^{-7}$ and B= 1,59883364 being coefficient regression r= 0,9997776774 . Therefore there is a very high correlation between DM density and gravitational field.

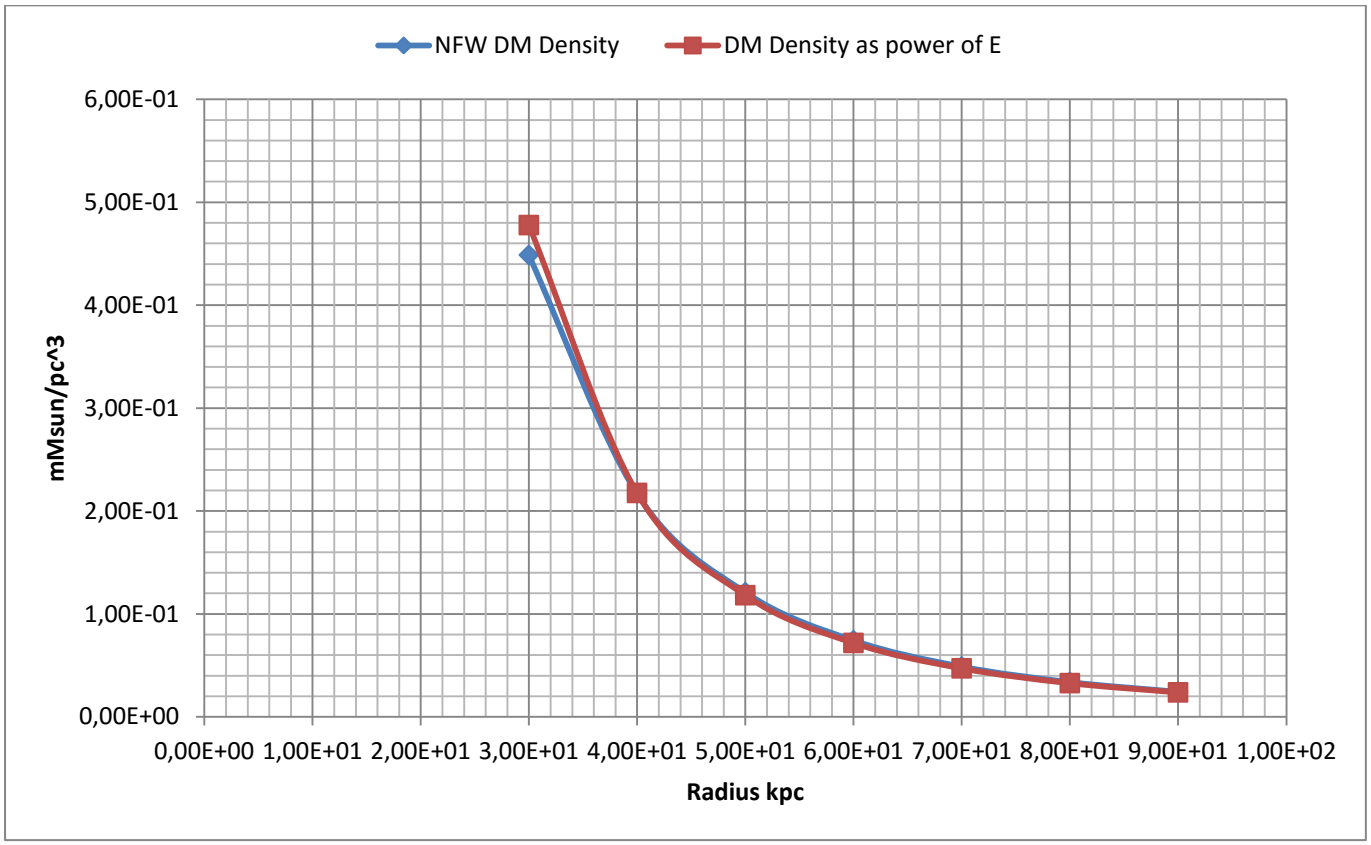
NFW Dark Matter Density as power of Virial E for M31 inside dominion 30 kpc < radius < 200kpc
$D_{DM\ Pw\ VE} = A \cdot E^B$
A = $7.310686 \cdot 10^{-7}$ B= 1,59883364 and correlation coefficient r = 0,9997776774

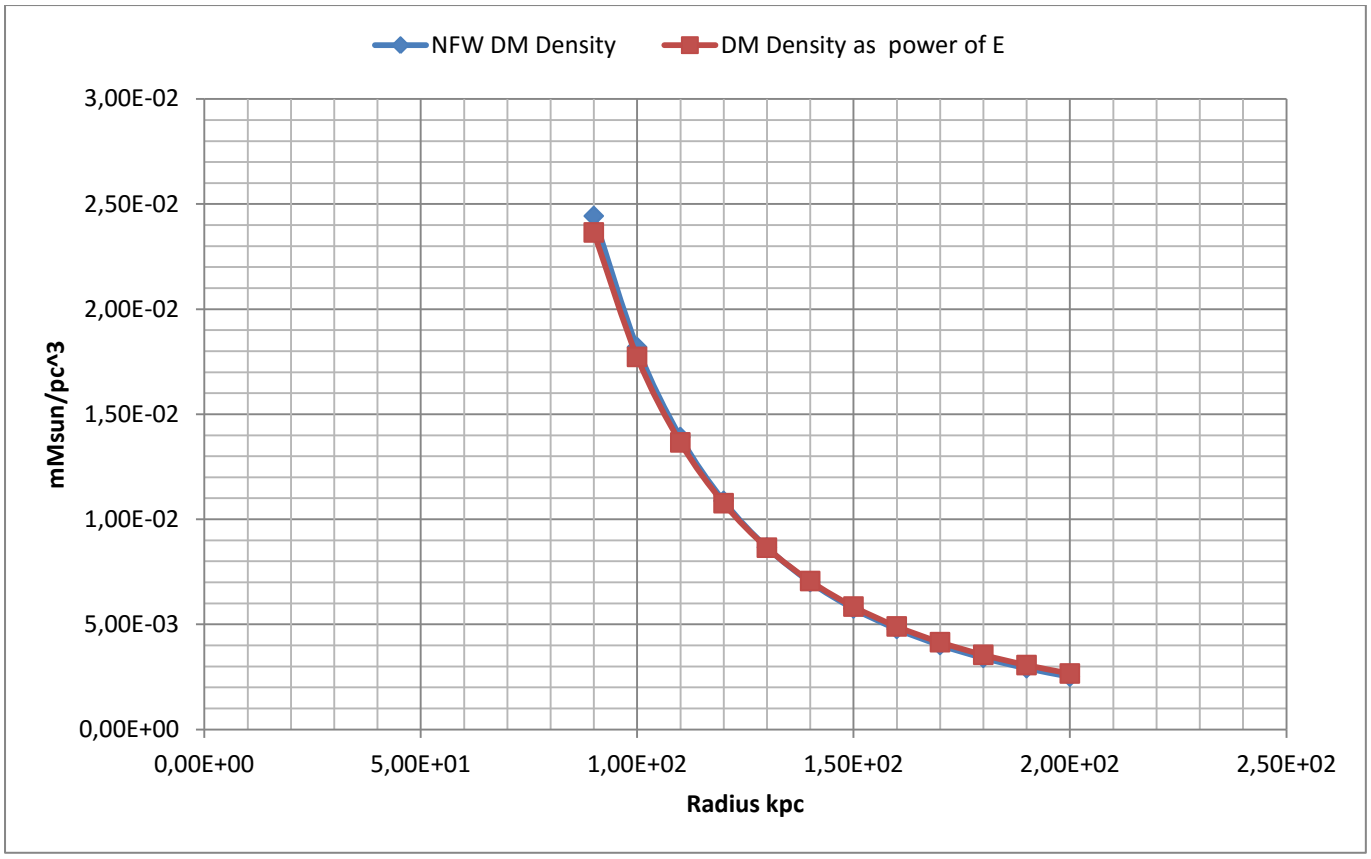
Hereafter dark matter density as power of Virial E will be shortened as $D_{DM\ Pw\ VE} = A \cdot E^B$

8. COMPARISON BETWEEN DM DENSITY AS POWER OF E AND NFWDENSITY PROFILE

In this paragraph will be compared NFW DM density introduced in chapter 5 and DM density as power of E got in chapter 6.As reader can see relative differences are below 6,5% everywhere.

Radius	Virial E	NFW DM	Relative diff.	DM power E
kpc	m/s^2	Kg/m^3	%	Kg/m^3
30	5,90424E-11	3,03740E-23	-6,47550E+00	3,23E-23
40	3,60886E-11	1,46803E-23	-2,75336E-01	1,47E-23
50	2,46342E-11	8,19340E-24	2,42730E+00	7,99E-24
60	1,80320E-11	5,03293E-24	3,54204E+00	4,85E-24
70	1,38511E-11	3,31105E-24	3,83155E+00	3,18E-24
80	1,10217E-11	2,29354E-24	3,65456E+00	2,21E-24
90	9,00985E-12	1,65390E-24	3,19913E+00	1,60E-24
100	7,52346E-12	1,23173E-24	2,57182E+00	1,20E-24
110	6,39127E-12	9,41899E-25	1,83655E+00	9,25E-25
120	5,50711E-12	7,36341E-25	1,03336E+00	7,29E-25
130	4,80218E-12	5,86516E-25	1,88197E-01	5,85E-25
140	4,23024E-12	4,74741E-25	-6,81675E-01	4,78E-25
150	3,75917E-12	3,89662E-25	-1,56455E+00	3,96E-25
160	3,36612E-12	3,23761E-25	-2,45238E+00	3,32E-25
170	3,03442E-12	2,71923E-25	-3,33956E+00	2,81E-25
180	2,75168E-12	2,30588E-25	-4,22217E+00	2,40E-25
190	2,50852E-12	1,97225E-25	-5,09749E+00	2,07E-25
200	2,29772E-12	1,70001E-25	-5,96363E+00	1,80E-25




NFW DM Density
DM Density as power of E
3,00E-02
2,50E-02
2,00E-02
1,50E-02
1,00E-02
5,00E-03
0,00E+00
mMsun/pc^3
0,00E+00
5,00E+01
1,00E+02
1,50E+02
2,00E+02
2,50E+02
Radius kpc

9. BERNOULLI DIFFERENTIAL EQUATION FOR GRAVITATIONAL FIELD IN MILKY WAY HALO

It will be considered the region 30 Kpc < Radius < 200 Kpc where density of baryonic matter is negligible versus baryonic density. So for radius bigger than 30 Kpc, it will be considered that derivative of M(r) depend on dark matter density only.

As it is known in this formula $E = G\frac{M(r)}{r^2}$, M(r) represents mass enclosed by a sphere with radius r. If it is considered radius > 30 Kpc then the derivative of M(r) depend on dark matter density only and therefore $M'(r) = 4\pi r^2 \varphi_{DM}(r)$ As $\varphi_{DM}(r) = A{\cdot}E^B(r)$ Where A = 7,310686·10^{-7} and B= 1,59883364 then $M'(r) = 4\pi r^2 \cdot A{\cdot}E^B$

Now it will differentiated E(r) when r > 30 Kpc

If $E = G\frac{M(r)}{r^2}$ is differentiated it is got $E'(r) = G\frac{M'(r){\cdot}r^2 - 2rM(r)}{r^4}$

If $M'(r) = 4\pi r^2 \varphi_{DM}(r)$ is replaced above it is got $E'(r) = 4\pi G\varphi_{DM}(r) - 2G\frac{M(r)}{r3}$ As $\varphi_{DM}(r) = A{\cdot}E^B(r)$ it is right to get $E'(r) = 4\pi{\cdot}G{\cdot}A{\cdot}E^B(r) - 2\frac{E(r)}{r}$ which is a Bernoulli differential equation.

$E'(r) = K{\cdot}E^B(r) - 2\frac{E(r)}{r}$ being $K = 4\pi{\cdot}G{\cdot}A$ then K = 6,13041867365·10^{-16} I.S. as A=7,310686·10^{-7}

Calling ***y*** to E, the differential equation is written this way $y` = K{\cdot}y^B - \frac{2{\cdot}y}{r}$

Bernoulli family equations $y` = K{\cdot}y^B - \frac{2{\cdot}y}{r}$ may be converted into a differential linear equation with this variable change $u = y^{1-B}$.

General solution is $E(r) = \left(Cr^{2B-2} + \frac{Kr(1-B)}{3-2B}\right)^{\frac{1}{1-B}}$ $with\ B \neq 1\ and\ B \neq 3/2$ where C is the parameter of initial condition of gravitational field at a specific radius.

Calling $\alpha = 2B-2$ $\beta = \frac{1}{1-B}$ and $D = \left(\frac{K(1-B)}{3-2B}\right)$ formula may be written as

$E(r) = \left(Cr^{\alpha} + Dr\right)^{\beta}$ Where specifically values for these parameters are the following ones:

$\alpha = 2B-2$ = 1,1976672860 $\beta = \frac{1}{1-B}$ = -1,6699128576 $D = \left(\frac{K(1-B)}{3-2B}\right)$ = 1,85721219821·10^{-15}

Initial condition for parameter C calculus

Suppose R_0 *and* E_0 are specific initial conditions for radius and gravitational field then $C = \frac{E_0^{\,1/\beta} - D \cdot R_0}{R_0^{\,\alpha}}$

In order to check calculus it will be calculated parameter C for different initial condition.

Radius	radius	Velocity	E virial	param. C
kpc	m	Km/s	m/s^2	
30	9,26E+20	233,786525	5,90424E-11	-2,97937E-20
40	1,23E+21	211,053099	3,60886E-11	-2,74496E-20
50	1,54E+21	194,953438	2,46342E-11	-2,57445E-20
60	1,85E+21	182,715061	1,80320E-11	-2,44207E-20
70	2,16E+21	172,969018	1,38511E-11	-2,33482E-20
80	2,47E+21	164,947829	1,10217E-11	-2,24524E-20
90	2,78E+21	158,181962	9,00985E-12	-2,16871E-20
100	3,09E+21	152,365194	7,52346E-12	-2,10217E-20
110	3,39E+21	147,28777	6,39127E-12	-2,04351E-20
120	3,70E+21	142,800332	5,50711E-12	-1,99118E-20
130	4,01E+21	138,793121	4,80218E-12	-1,94406E-20
140	4,32E+21	135,183346	4,23024E-12	-1,90129E-20
150	4,63E+21	131,907163	3,75917E-12	-1,86220E-20
160	4,94E+21	128,914412	3,36612E-12	-1,82626E-20
170	5,25E+21	126,165032	3,03442E-12	-1,79303E-20
180	5,55E+21	123,626573	2,75168E-12	-1,76218E-20
190	5,86E+21	121,272419	2,50852E-12	-1,73341E-20
200	6,17E+21	119,080497	2,29772E-12	-1,70649E-20
128	3,95E+21	139,560433	4,93129E-12	-1,95311E-20

As it was expected parameter C is very similar for different initial condition.

Numerically may be checked that data below minimize relative difference between NFW DM density and DM density got through Bernoulli solution therefore these values will be considered as initial condition.

Initial condition values Ro & Eo	
Ro =	128 Kpc
Eo =	$4{,}93129 \cdot 10^{-12}$
C =	$-1.95311 \cdot 10^{-20}$ units I.S.

Finally it is possible to write formula for DM density profile got through Bernoulli method.

Bernoulli Solution for Gravitational field inside halo 30 kpc < Radius < 200 kpc
$E_{BER}(r) = \left(Cr^{\alpha} + Dr\right)^{\beta}$ C = -1.95311· 10 $^{-20}$ D= 1,85721219821·10^{-15} α = 1,1976672860 β = -1,6699128576

9.1 BERNOULLI PROFILE OF DARK MATTER DENSITY FOR MILKY WAY

Thanks Bernoulli solution for gravitational field is right to get DM density through power of E formula.

DM Density Bernoulli profile for M33 inside halo 40 kpc < radius < 300 kpc
$E_{BER}(r) = \left(Cr^{\alpha} + Dr\right)^{\beta}$ C = -1.95311· 10 $^{-20}$ D= 1,85721219821·10^{-15} α = 1,1976672860 β = -1,6699128576
Density $_{D.M.\ BERNOULLI}$ (r) = $D_{DM\ B}$(r) = A· E^B Where A = 7.310686 ·10^{-7} & B= 1.59883364 Unit Kg/ m^3

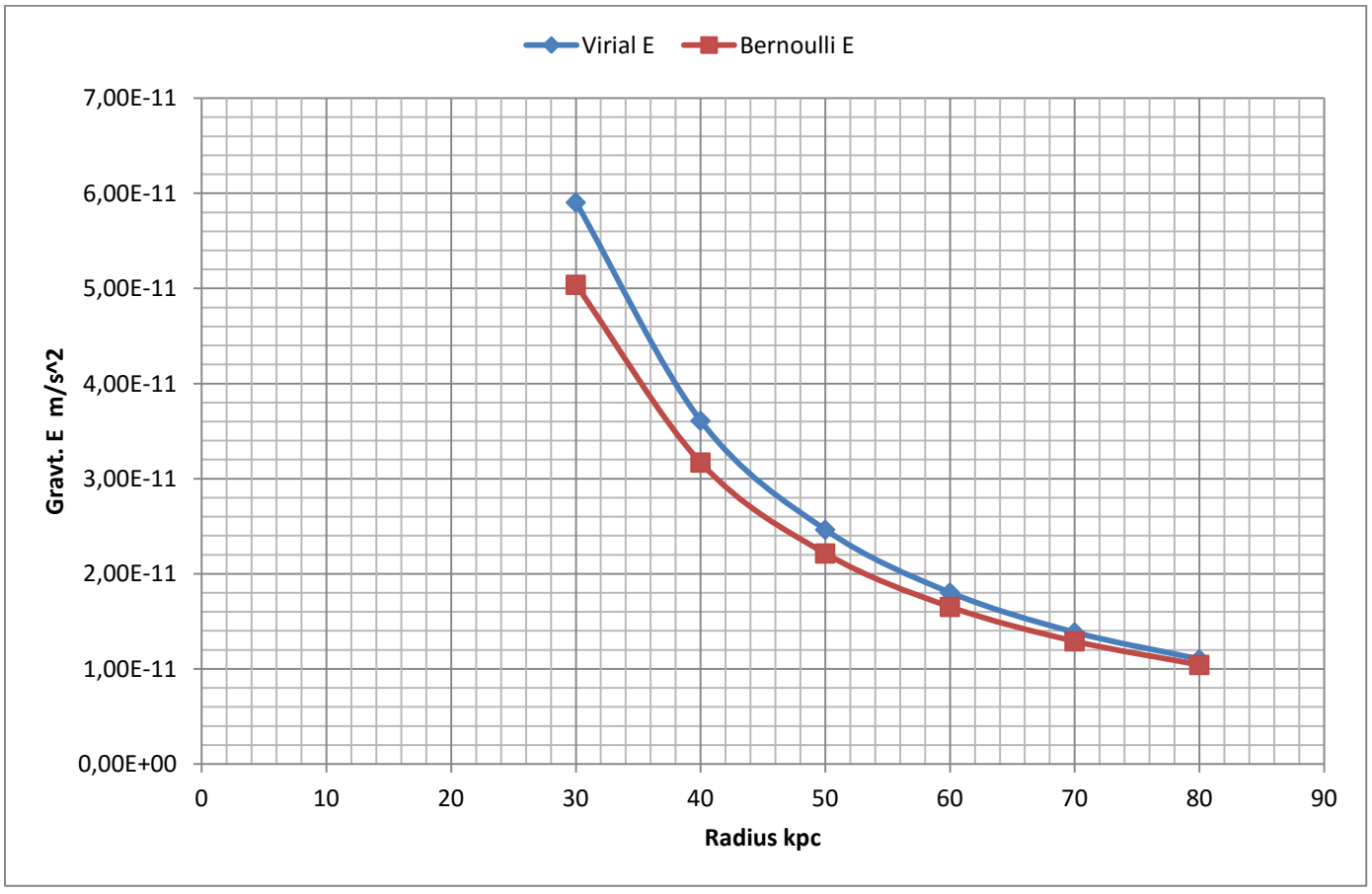
10. COMPARISON BETWEEN BERNOULLI AND NFW PROFILES

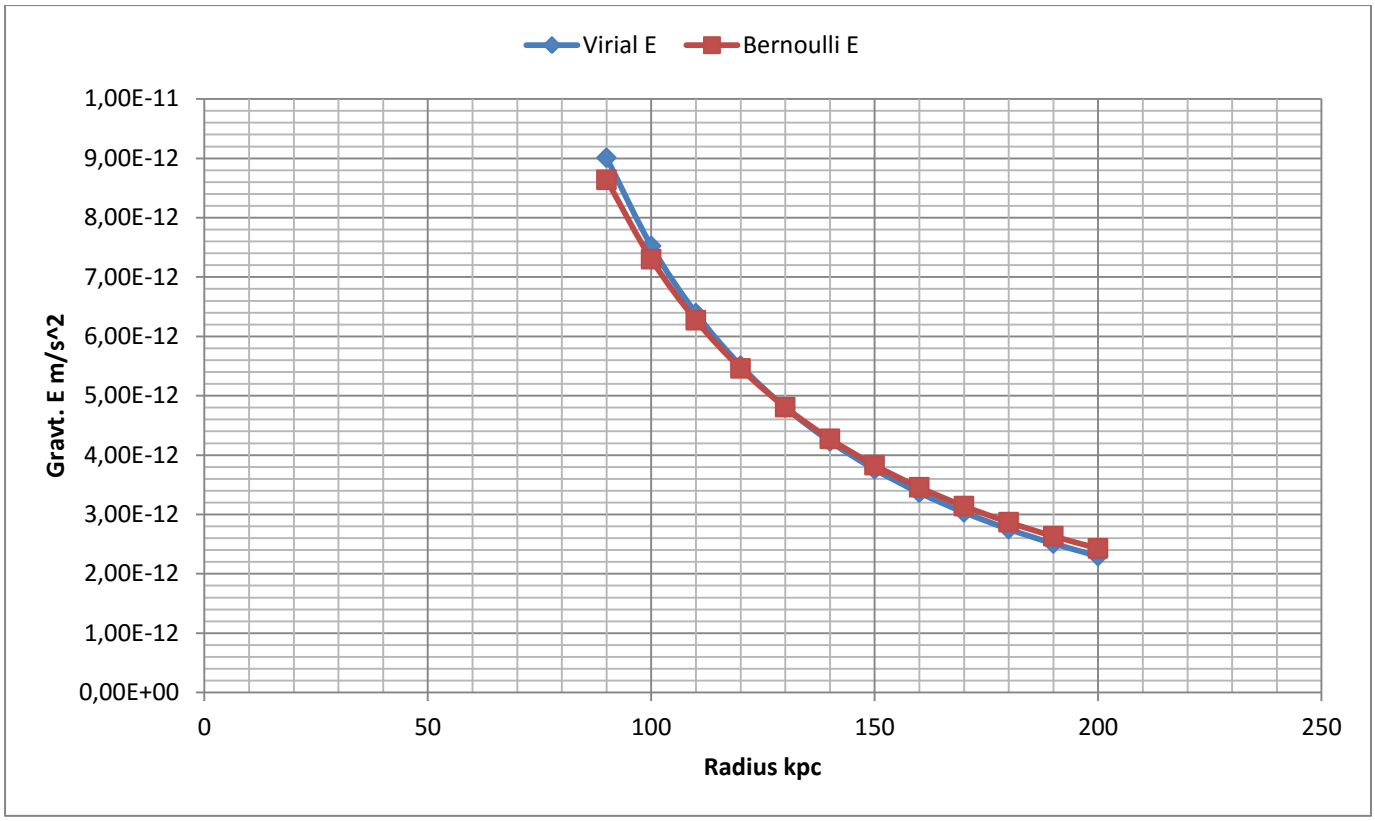
10.1 COMPARISON BETWEEN VIRIAL GRAVT. FIELD AND BERNOULLI SOLUTION FOR E

Radius	Virial E	Bernoulli E	Relative diff.
kpc	m/s^2	m/s^2	%
30	5,90E-11	5,04E-11	1,47E+01
40	3,61E-11	3,17E-11	1,22E+01
50	2,46E-11	2,21E-11	1,01E+01
60	1,80E-11	1,65E-11	8,36E+00
70	1,39E-11	1,29E-11	6,80E+00
80	1,10E-11	1,04E-11	5,40E+00
90	9,01E-12	8,64E-12	4,13E+00
100	7,52E-12	7,30E-12	2,95E+00
110	6,39E-12	6,27E-12	1,86E+00
120	5,51E-12	5,46E-12	8,40E-01
130	4,80E-12	4,81E-12	-1,24E-01
140	4,23E-12	4,27E-12	-1,04E+00
150	3,76E-12	3,83E-12	-1,90E+00
160	3,37E-12	3,46E-12	-2,73E+00
170	3,03E-12	3,14E-12	-3,52E+00
180	2,75E-12	2,87E-12	-4,28E+00
190	2,51E-12	2,63E-12	-5,01E+00
200	2,30E-12	2,43E-12	-5,71E+00

Relative difference between Virial E and Bernoulli E is decreasing from 14,7% at 30 kpc and it is under 6 % for radius bigger than 80 kpc.

It is an acceptable error specially if it is considered that velocity measures in rotation curve have error bigger than 15 %.



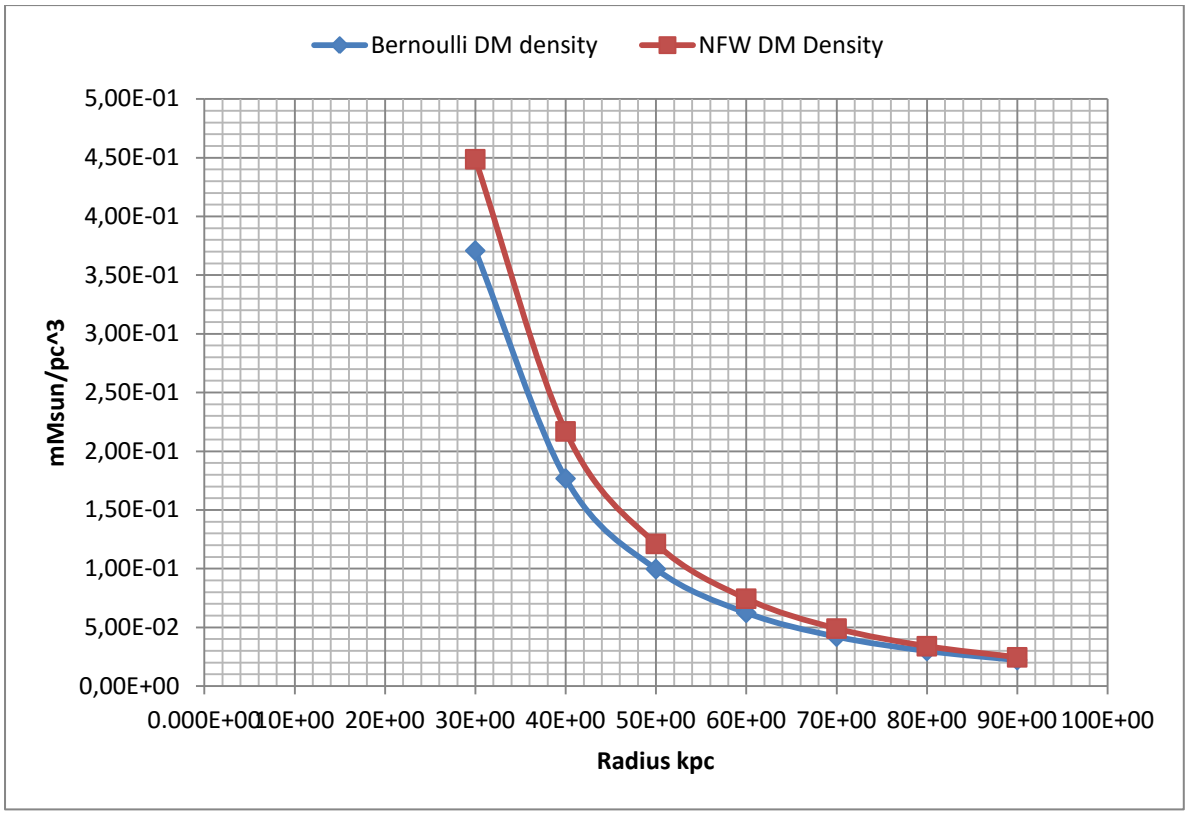


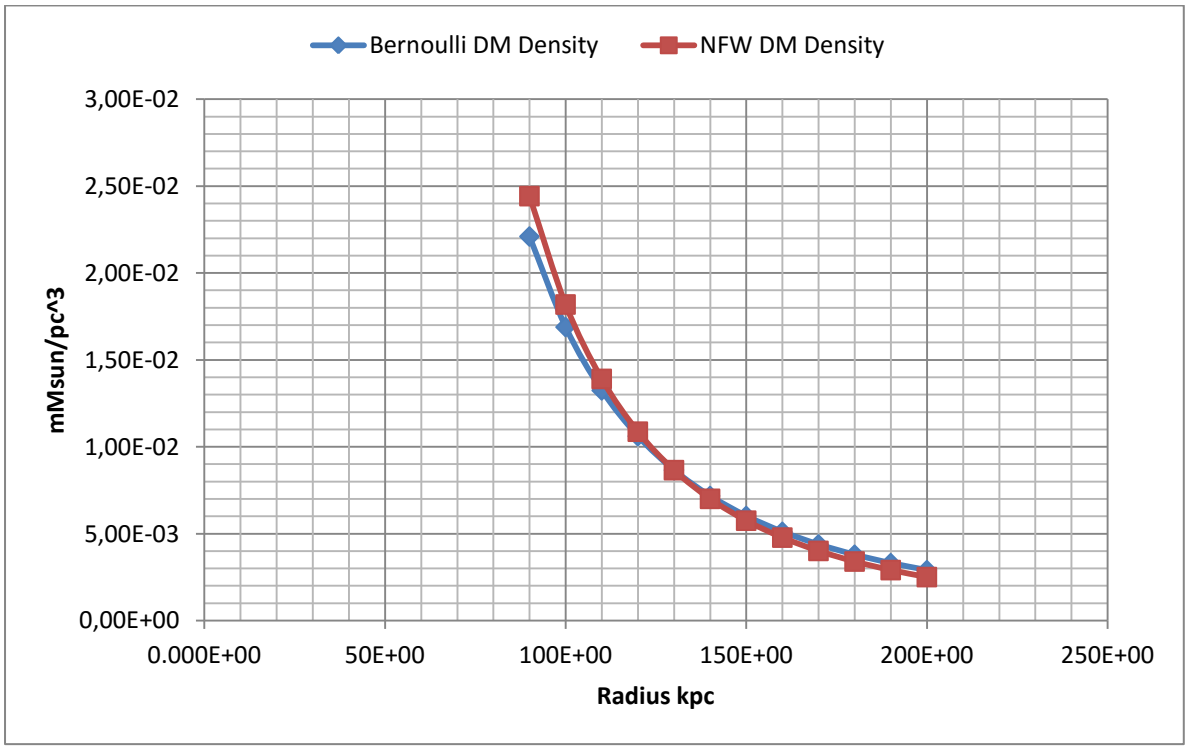
Bernoulli solution for gravitational field fits almost perfectly to Virial gravitational data got through observational values of spin speed of rotational curve of Milky Way.

10.2 COMPARISON BETWEEN NFW DM PROFILE AND BERNOULLI DM PROFILE

Radius	Bernoulli DM	NFW DM	Relative diff.
kpc	mMsun/pc^3	mMsun/pc^3	%
3,00E+01	3,71E-01	4,49E-01	1,73572E+01
4,00E+01	1,77E-01	2,17E-01	1,85125E+01
5,00E+01	9,96E-02	1,21E-01	1,77283E+01
6,00E+01	6,24E-02	7,43E-02	1,61044E+01
7,00E+01	4,20E-02	4,89E-02	1,40762E+01
8,00E+01	2,99E-02	3,39E-02	1,18444E+01
9,00E+01	2,21E-02	2,44E-02	9,51163E+00
1,00E+02	1,69E-02	1,82E-02	7,13394E+00
1,10E+02	1,33E-02	1,39E-02	4,74330E+00
1,20E+02	1,06E-02	1,09E-02	2,35851E+00
1,30E+02	8,66E-03	8,66E-03	9,23571E-03
1,40E+02	7,18E-03	7,01E-03	2,35328E+00
1,50E+02	6,02E-03	5,76E-03	4,66979E+00
1,60E+02	5,11E-03	4,78E-03	6,95669E+00
1,70E+02	4,39E-03	4,02E-03	9,21302E+00
1,80E+02	3,80E-03	3,41E-03	1,14386E+01
1,90E+02	3,31E-03	2,91E-03	1,36336E+01
2,00E+02	2,91E-03	2,51E-03	1,67644E+02

Through 9.1 formula it is right to calculate DM density called in paper, Bernoulli profile. Therefore it is possible to compare rightly Bernoulli profile with NFW profile. Table beside and plot below show results.





Reader can check that maximum relative difference is lower than 18% and is lower than 15 % inside main part of dominion. This result is superb because error of velocity measures in rotation curve published by Sofue are bigger than 15 %. See chapter 3. In addition error of scale density parameter Do = $18{,}2 \pm 7{,}4$ m Msolar/pc^3 , belonging to NFW profile, is 40 %. See chapter 6.

11. CONCLUSION

It seem clear that inner logic of development this paper allows to state that this paper suggests that DM origin is gravitational field.

This is the inner logic: NFW DM density profile, which has been got by meticulous measures of Milky Way rotation curve, is fitted with a function as power of E with a correlation coefficient bigger than 0.999. Particularly formula found in chapter 7 was $D_{DM} = A \cdot E^B$ where $A = 7.310686 \cdot 10^{-7}$ & $B = 1{,}59883364$ into I.S. of units.

Thanks this function it has been possible to state a Bernoulli differential equation for gravitational field E, inside galactic halo where density of baryonic mass is negligible in comparison with DM density.

Solution of Bernoulli for gravitational field is used to get a new DM profile called Bernoulli DM profile, which has been compared with NFW DM density getting relative differences under 15 % inside main part of dominion despite the fact that rotation curve measures have error bigger 15% in the whole dominion considered from 30 kpc to 200 kpc.

In my opinion these results suggest strongly that DM density is generated according a Universal law as power of E $D_{DM} = A \cdot E^B$ where A and B are parameters which depend on each galaxy, more exactly, values of coefficients A and B depend on mass of galaxies. Results of previous author´s papers also suggest that two galaxies with similar mass have similar DM density at a specific value of E.

12. BIBLIOGRAPHYC REFERENCES

[1] Abarca,M.2014,viXra:1410.0200

Dark matter model by quantum vacuum

[2] Abarca,M.2015,viXra:1510.0324
Dark matter density function depending on gravitational field as Universal law

[3] Abarca,M.2015. viXra.org/abs/1512.0309
A new dark matter density profile for NGC 3198 galaxy to demonstrate that dark matter is generated by gravitational field.

[4] Abarca, M.2016.viXra. 1601.0014
A New Dark Matter Density Profile for M33 Galaxy to Demonstrate that Dark Matter is Generated by Gravitational Field

[5] Abarca, M.2016.viXra. 1601.0242v1

A New Dark Matter Density Profile for M31 Galaxy to Demonstrate that Dark Matter is Generated by Gravitational Field.

[6] Sofue, Y.2015. arXiv:1504.05368v1
Dark halos of M31 and the Milky Way.