DARK MATTER DEPENDING ON GRAVITATIONAL FIELD IN SOLAR SYSTEM

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1. ABSTRACT

For last two years I have published several papers about DM on galaxies and cluster of galaxies. Data have been taken from recent papers written by prestigious researches. The main target of papers have been to calculate DM density through an original hypothesis which states that DM is generated by gravitational field according a Universal law. As consequence this hypothesis, gravitational field is calculated through a Bernoulli differential equation which gives rightly DM density named Bernoulli profile.

Formula which relates DM density and gravitational field is DM density = A·E^B. Where A & B are parameters which are supposed to be valid for every gravitational system. Parameters A&B come form calculus made in paper [7] Abarca, M.2016. Specifically were calculated in M31 galaxy from rotation curve data for radius bigger than 40 kpc and lower than 200 kpc. In this region gravitational field is lower than 10^-11 m/s^2. Whereas inside Solar System gravitational field is billions of times bigger. However if it is supposed that DM generation mechanism is Universal then the same parameters should be right to study Dark matter density inside Solar System.

It is remarkable the fact that through the same method I have published successful results for cluster of galaxies scale and galaxy scale.

Unfortunately there is not experimental measures for DM inside Solar System yet so it is not possible for now check theoretical results published in this paper.

The main results this paper are DM enclosed by spherical coronas defined by radius of Sun and planetary orbits. Through mass of Earth as unit of mass, results are the following ones: DM up to Mercury orbit is 71,61 M_{EARTH} , up to Venus orbit is 75.57 M_{EARTH} , up to Earth orbit is 77.33 M_{EARTH} , up to Mars orbit is 79.32 M_{EARTH} , up to Jupiter orbit is 83.76 M_{EARTH} , up to Saturn orbit is 85.37 M_{EARTH} , up to Uranus orbit is 86.85 M_{EARTH} , up to Neptune orbit is 87.63 M_{EARTH} , up to Pluto orbit is 88.056 M_{EARTH}

2. INTRODUCTION

For last two years I have published several papers about DM on galaxies and cluster of galaxies. Data have been taken from recent papers written by prestigious researches. The main target of those papers have been to calculate DM density through an original hypothesis which states that DM is generated by gravitational field according a Universal law. As consequence this hypothesis, gravitational field is calculated through a Bernoulli differential equation which gives rightly DM density named Bernoulli profile. Each Bernoulli profile calculated for each galaxy was compared with other standard DM profiles such as NFW, Burket or Pseudo-Isothemal which usually were published by researchers when they published its galactic rotation curve data. Relative differences between both kind of profiles are acceptably low by reasons explained in those papers.

Hypothesis of DM nature stated that dark matter is generated locally by gravitational field, E, according an unknown quantum mechanism. Formula which relates DM density and gravitational field is DM density = $A \cdot E^B$. Where A & B are parameters got through galactic rotation data. In paper [7] Abarca, M.2016 were got parameters A&B through Milky Way and M31 data. In that paper was shown that both couples of parameters produce a very similar DM density as power of E.

Now, in this paper Dark matter density inside Solar System will be calculated by integration of DM density whose parameters A&B come from M31.

It is remarkable the fact that inside galactic halo region gravitational field is lower than 10^{-11} m/s^2 whereas in solar surface is 270 m/s^2 decreasing up to 4.5 $\cdot 10^{-5}$ m/s^2 in Earth orbit. However if it is supposed that DM generation mechanism is Universal then the same parameters should be right to study Dark matter density inside Solar System.

Unfortunately there is not experimental measures for DM inside Solar System yet so it is not possible for now check these results.

3. PARAMETERS A&B FROM M31 OR FROM MILKY WAY

In paper [7] Abarca, M.2016. *Dark matter as power of gravitational field for Milky Way vs M31. Two similar laws*, author shows in detail method to get couple of parameters A&B for Milky Way and M31. Also it is shown how both couples of parameters give very similar results. According author`s theory generation mechanism of DM by gravitational field is universal. Results got in that paper back up this hypothesis. This is the reason to use parameters A&B to study DM in Solar System.

In this paper it will be used A&B data from M31.

A&B Data [7] Abarca,M.2016	
M31 galaxy	$D_{DM} = A \cdot E^B$
A	3,766521943774E $\cdot 10^{-6}$
B	1,668847537702

A&B Data [7] Abarca,M.2016	
MILKY WAY	$D_{DM} = A \cdot E^B$
A	1,27687739294523$\cdot 10^{-6}$
B	1,62377420773729

4. POISSON EQUATION AND GAUSS` LAW

In order to simplify calculus it will be considered region of space where baryonic matter density is negligible regarding DM density. Therefore Poisson equation become $\Delta V = 4\pi G \rho_{DM}$ and its equivalent Gauss` Law

$\vec{\nabla} \bullet \vec{E} = -4\pi G \rho_{DM}$. If it is considered spherical coordinates this equation generates a Bernoulli differential equation that will be shown in next chapter.

5. BERNOULLI DIFFERENTIAL EQUATION FOR GRAVITATIONAL FIELD IN SOLAR SYSTEM

It will be considered the region R_{SUN} < Radius where density of baryonic matter is negligible regarding DM density. So for radius bigger than R_{SUN} it will be considered that derivative of M(r) depend on dark matter density only.

As it is known in this formula $\vec{E} = -G\frac{M(r)}{r^2}\hat{r}$, M(r) represents mass enclosed by a sphere with radius r. If it is considered radius > R_{SUN} then the derivative of M(r) depend on dark matter density essentially and therefore $M'(r) = 4\pi r^2 \varphi_{DM}(r)$.

As $\varphi_{DM}(r) = A{\cdot}E^B(r)$ then $M'(r) = 4\pi r^2 \cdot A{\cdot}E^B$

If $E = G\frac{M(r)}{r^2}$, vector modulus, is differentiated then 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 then 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= 3,15843909297·10^{-15} into I.S. of units.

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:

$\alpha = 2B - 2$ = 1,3376950754

$\beta = \frac{1}{1-B}$ = -1,49510904

$D = \left(\frac{K(1-B)}{3-2B} \right)$ = 6,25568557014·10^{-15}

Initial condition for parameter C calculus

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

As dominion radius begin at $R_{SUN} = 7 \cdot 10^{8}$ m. it is right to consider as initial condition Ro = $R_{SUN} = 7 \cdot 10^{8}$ m and $E_O = E_{SUN\ SURFACE} = 271$ m/s^2 which gives C= 3,47208·10^{-14}. To calculate Esun has been considered Msun = 1.99·10^{30} kg .

Initial condition values Ro & Eo	
Ro =	7·10 ^{8} m
Eo =	271 m/s^2
C =	3,47208·10^{-14} units I.S.

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

Bernoulli Solution for Gravitational field inside Solar System R_{SUN} < Radius		
$E_{BER}(r) = \left(Cr^{\alpha} + Dr\right)^{\beta}$	C = 3,47208·10^{-14} D = 6,25568557014·10^{-15}	α = 1,3376950754 β = -1,49510904

6. BERNOULLI PROFILE OF DARK MATTER DENSITY FOR SOLAR SYSTEM

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

DM Density Bernoulli profile for Solar System R_{SUN} < Radius
$E_{BER}(r) = \left(Cr^{\alpha} + Dr\right)^{\beta}$ C = 3,47208·10^{-14} D = 6,25568557·10^{-15} α = 1,3376950754 β = -1,49510904
Density $_{D.M.\ BERNOULLI}(r) = D_{DM\,B}(r) = A\cdot E^{B}$ Where A= 3,766521943774E ·10^{-6} and B= 1,668847537702 unit density kg/m^3

7. CALCULUS OF DARK MATTER ENCLOSED BY PLANETARY ORBITS

In chapter six there is the exact DM density Bernoulli profile:

Through a definite integration it is possible to calculate total matter enclosed by spherical corona defined by radius of Sun and radius of planetary orbits.

Integration is not easy as reader can check.

$$M_{DM} = \int_{R1}^{R2} 4\pi r^2 \cdot \rho(r)dr = \int_{R1}^{R2} 4\pi r^2 AE^{B} dr = 4\pi A \int_{R1}^{R2} r^2 \left[\left(Cr^{\alpha} + Dr\right)^{\beta}\right]^{B} dr = 4\pi A \cdot I$$

Where $4\pi A = 4.733151\cdot 10^{-5}$ R1 = R_{SUN} = 7·10^8 m and R2 is planetary radius.

Thanks remarkable web site *Wolfram alpha* it is possible to calculate definite integral needed to know total dark matter enclosed inside spherical coronas.

Equivalence units used in this paper 1 U.A. = 1.5·10^{11} m and $M_{\oplus}$ = M_{EARTH} = 5.976 ·10^{24} kg

Both equivalences have not very much accuracy but enough for purpose this paper.

DARK MATTER UP TO MERCURY ORBIT

$$\int_{7\times 10^{8}}^{5.787145\times 10^{10}} x^2 \left(3.472\times 10^{-14}\, x^{1.3377} + 6.2557\times 10^{-15}\, x\right)^{-2.49511} dx$$

$$9.04098\times 10^{30}$$

Integrated by Wolfram alpha.

$DM_{CORONA} = 4\pi A\cdot I$ = DM(Rsun< R < Rmercury) = 4,279241 · 10^{26} kg = 71,61 M_{EARTH} = 71,61 $M_{\oplus}$

DARK MATTER UP TO VENUS ORBIT

$$\int_{7\times10^{8}}^{1.0813335\times10^{11}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,d$$

$$9.54108\times10^{30}$$

$DM_{CORONA} = 4\pi A\cdot I$ = DM(Rsun< R < Rvenus) = 4,5159363 · 10^{26} kg = 75.57 $M_{\oplus}$

DARK MATTER UP TO EARTH ORBIT

Definite integral:

$$\int_{7\times10^{8}}^{1.5\times10^{11}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,dx$$

Definite Integral = 9,7637*10^{30}

$DM_{CORONA} = 4\pi A\cdot I$ = DM (Rsun < R < R Earth) = 4,6213 ·10^{26} kg = 77,33 $M_{\oplus}$

DARK MATTER UP TO MARS ORBIT

$$\int_{7\times10^{8}}^{2.2779315\times10^{11}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,d$$

$$1.00144\times10^{31}$$

$DM_{CORONA} = 4\pi A\cdot I$ = DM(Rsun < R < R Mars) = 4,7399657· 10^{26} kg = 79,32 $M_{\oplus}$

DARK MATTER UP TO JUPITER ORBIT

$$\int_{7\times10^{8}}^{7.778186\times10^{11}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,dx$$

$$1.0576\times10^{31}$$

$\mathrm{DM}_{\mathrm{CORONA}} = 4\pi\mathrm{A}\cdot\mathrm{I}$ = DM(Rsun < R < R jupiter) = 5,005779·10^{26} kg = 83.76 $M_{\oplus}$

DARK MATTER UP TO SATURN ORBIT

$$\int_{7\times10^{8}}^{1.4260506\times10^{12}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,dx$$

$$1.07783\times10^{31}$$

$\mathrm{DM}_{\mathrm{CORONA}} = 4\pi\mathrm{A}\cdot\mathrm{I}$ = DM(Rsun < R < R Saturn) = 5.101531·10^{26} kg = 85.37 $M_{\oplus}$

DARK MATTER UP TO URANUS ORBIT

$$\int_{7\times10^{8}}^{2.86771\times10^{12}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,dx$$

$$1.09654\times10^{31}$$

$\mathrm{DM}_{\mathrm{CORONA}} = 4\pi\mathrm{A}\cdot\mathrm{I}$ = DM(Rsun < R < R uranus) = 5.190088·10^{26} Kg = 86.85 $M_{\oplus}$

DARK MATTER UP TO NEPTUNE ORBIT

$$\int_{7\times10^{8}}^{4.493671\times10^{12}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,d$$
$$1.10644\times10^{31}$$

$\mathrm{DM}_{\mathrm{CORONA}} = 4\pi\mathrm{A}\cdot\mathrm{I}$ = DM(Rsun < R < R neptune) = $5.23695\cdot10^{26}$ kg = 87.63 $M_{\oplus}$

DARK MATTER UP TO PLUTO ORBIT

$$\int_{7\times10^{8}}^{5.907941\times10^{12}} x^{2}\left(3.472\times10^{-14}\,x^{1.3377}+6.2557\times10^{-15}\,x\right)^{-2.49511}\,dx$$
$$1.11178\times10^{31}$$

$\mathrm{DM}_{\mathrm{CORONA}} = 4\pi\mathrm{A}\cdot\mathrm{I}$ =DM(Rsun < R < R pluto) = $5.26222\cdot10^{26}$ kg = 88.056 $M_{\oplus}$

8. CONCLUSION

As it is known mass of Sun is calculated through third Kepler`s law measuring orbit radius and years of planets. However according data got in this paper when is used Mercury data not only is calculated baryonic mass of Sun but also DM enclosed inside sphere of Mercury orbit which is equivalent to 71,61 $M_{\oplus}$.

In addition when is calculated mass of Sun with Earth data not only is calculated baryonic mass of Sun but also DM enclosed inside sphere of Earth orbit which is equivalent to 77,33 $M_{\oplus}$.

If planetary data were known with enough accuracy Sun mass though Mercury data would be $5.72\,M_{\oplus}$ lower than Sun mass calculated with Earth data.

Currently there is not measures of planetary orbit radius and periods of orbit rotation with enough accuracy to differentiate mass of Sun calculated through third Kepler` law for different planets. For example mass of sun calculated through Mercury data differs from mass of Sun through Mars data by 7.7 $M_{\oplus}$

Perhaps currently there is enough technology to measure newly planetary data with enough accuracy because differences of mass for Sun with data of different planets is not too much exiguous. In addition the more planet

distant is the more difference for Sun mass is calculated. For example difference of Solar mass with data of Mercury and Pluto is 16.45 $M_{\oplus}$. Problem is that Pluto year is 248 Earth years¡

As it was pointed at introduction epigraph, A&B parameter were calculated for M31 for radius bigger than 40 kpc where gravitational field is below 10^{-11} m/s^2. However inside Solar System gravitational field is trillions times bigger, this is the reason why DM is not negligible inside spheres defined by planet orbits.

In my opinion if measures backed up calculus of DM in planet orbits this fact would be the ultimate evidence about DM generated by gravitational field.

9. BIBLIOGRAPHIC 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.2016.viXra. 1601.0242v1

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

[4] Abarca, M.2016. viXra.1602.0047
A new Dark matter density profile for Milky Way to demonstrate that dark matter is generated by gravitational field.

[5] Abarca, M.2016. viXra:1606.0007
A new Dark matter density profile for Milky Way which depend on gravitational field.

[6] Abarca,M.2016. viXra:1606.0279v1

Dark matter density profile on big galaxies depend on gravitational field as Universal law

[7] Abarca, M.2016. vixra:1609.0233

Dark matter as power of gravitational field for Milky Way vs M31. Two similar laws.