DARK MATTER MODEL BY QUANTUM VACUUM

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ABSTRAT

The idea of the model is quite simple:
The physical vacuum is a quantum system with a minimum energy and mass when it is in his ground state. When the space has a gravitational field the space state increase his energy levels and the mass of the space begin to increase as well. The mass of the space would be the dark matter (D.M.).

Model refers to the same conception about 'vacuum' as the Quantum Electrodynamics (QED), which consider the space full of virtual electrons and virtual positrons.
Therefore it is easy to think that there is virtual particles which feel the gravitational forces named virtual gravitons. It is logical to think that the gravitational field excites the vacuum states in a way that "the vacuum would be heavier, the more intense gravitational field is". The hypothesis of this DM model is that virtual gravitons are Dark Matter.

The paper is organised in five parts:

The first one studies the spin speed star on galaxies and it is got the density formula for DM. $\rho(r)_{DM\ HALO} = \frac{K_G}{4\pi r^2}$
The second one explains the model theoretically in a simple way because in my opinion the ultimate theory of DM will be explain by the Quantum Gravity, which there is not exist yet.

In the third one it is got the formula, which connects DM density function with intensity of gravitational field. $\rho(r)_{DM\ HALO} \approx \frac{|E(r)|^2}{4\pi G^2 K_G}$

The fourth one explains the coherence between the DM model and experimental evidences known about DM especially DM in Bullet Cluster and other clusters.

The fifth one proposes six experimental tests to check the model with astronomical measures.

The purpose this paper is to introduce the model. To show a new origin of DM and try to convince the reader that it is worth to check the model with experimental evidences.

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1. INTRODUCTION

The idea of the model is quite simple:

The physical vacuum is a quantum system with a minimum energy when it is in his ground state. When the space has a gravitational field the space state increase his energy levels and the mass of the space begin to increase as well. The mass of the space would be the dark matter (D.M.).

Model refers to the same conception about 'vacuum' as the Quantum Electrodynamics' theory (QED). Readers with knowledge about QED know that virtual particles are able to exist during a short period of time only if $\Delta E \bullet \Delta t \le \frac{\hbar}{2}$. So according to QED virtual particles could break the conservation energy principle for a tiny period of time.

Similarly Quantum Chromo Dynamic (QCD) considers the space full of particles named virtual gluons which interact with protons, neutrons and other particles.
It is right to think that space is full of particles which are concerned by gravitational field. The amount of this particles (virtual gravitons) would be bigger as the gravitational field is bigger.

In this paper, the author try to explain the basis of his theory in a qualitative way, because the final theory will be the Quantum gravity (QG) which there is not exist yet. Theoretical physicist have been trying to develop QG for decades but they have failed for now, although there have been remarkable contributions to this theory. For instance Stephen Hawking published in 1974 his theory about Black Hole radiation.

Despite the fact the basis are explained in a qualitative way, in the third and fourth epigraph, the paper follows with physical reasons getting some original formulas and trying to explain the dark matter properties in galaxies and clusters through the theoretical model of DM by Quatum Vacuum.
The paper end in the ninth epigraph with six proofs which should confirm the model predictions to accept the model as a serious candidate to explain the DM nature.

2. ROTATIONAL SPEED CURVES OF STARS IN A GALAXY

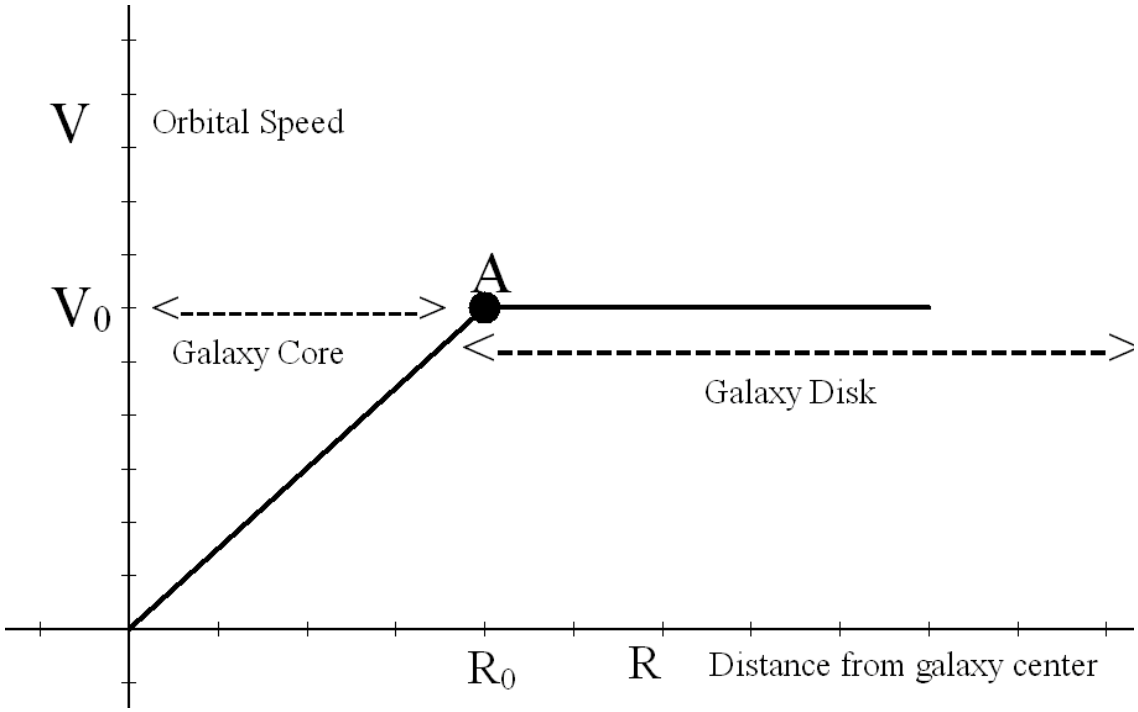
2.1 INTRODUCTION

In the annex are shown real rotational speed curves of stars around their galactic centres.

According to the experimental evidences, in the core, the angular velocity of its stars is almost constant. However in the galactic disk, the rotational speed of its stars is perceptibly constant and unexpectedly high in terms of ordinary matter (O.M.)

The rotational curve of star speed can be modelled in a easy way by the function that you can see in the picture.

Rotational speed curve model of stars around the galaxy centre.



As it is shown in the graphic, there are two regions clearly bounded:
Core or Bulge and Disk.

Core or Bulge Up to R_0 the angular speed is constant.
R_0 is the radius of galactic core.
Disk From R_0 the speed is constant and the curve is almost horizontal until the furthest stars of galaxy.

R represents the spin radius of a star around the galactic core, and M represents the total mass (ordinary and dark) contained by a sphere with radius R.

Galactic Bulge

As in this region ω= constant, from the third Keplero´s law written as $\omega^2 = \frac{GM}{R^3} = \frac{4\pi\rho G}{3} =$ constant, it is deduced that in this region, there is a density of mass constant.
Experimental evidences show that galactic core has a density of ordinary matter approximately constant with spherical symmetry and a mass density much bigger than the galactic disk. Therefore the constant angular speed can be reasonably explained by the amount of ordinary matter observed.

Galactic Disk

Disk is a large part of a galaxy which begins near the bulge, extending itself to the most external stars. Experimental data says that stars which are in this region have constant linear velocity, which means that its rotational speed is independent of the distance to the galactic core.
The spin speed of stars (from 200 km/s to 300 km/s) in this area is inexplicable through observable matter measured by astronomical methods. In all the galaxies whose mass and rotation curve have been measured, it has been checked that there is a large mass defect, which in some galaxies is 90% dark matter compared with 10% of ordinary matter or baryonic matter (O.M.).

2.2 TOTAL MASS FORMULA IN THE GALACTIC DISK

If it is considered that in this region spin speed of stars is constant, the Virial theorem confirms that $v^2 = \frac{GM}{R} =$ constant. From graphic point **A** it is deduced that $\frac{M_0}{R_0} = \frac{M}{R} = \frac{V_0^{\,2}}{G} =$ Constant=K_{GALAXY} , where M_0 represents the total mass contained by the galactic bulge, R_0 represents its radius, V_0 represents the spin speed of stars in the galactic disk, R is the spin radius of a star placed in the galactic disk and M represents the total mass enclosed by a sphere with radius R. Therefore K_G is a constant which depend on each galaxy.

In conclusion, in the galactic disk $M_{TOTAL} = K_G \cdot R$ where M_{TOTAL} represents the total mass enclosed by a sphere with radius R.
For example in the Milky Way, taking into account V_{SUN} = 220 Km/s = V_0 . It is got

$$K_{M\text{-}W} = 7{,}25 \cdot 10^{20}\ Kg/m.$$

The Virial theorem gives a useful formula because it allows to calculate masses measuring speed and distances of stars.

2.3 TOTAL MASS FORMULA IN THE GALACTIC HALO

As it is known the galactic halo is a big region around the galactic disk, where stars and ordinary matter is very scarce. However a remarkable experimental evidence shows that in the Milky Way the formula $M_{TOTAL} = K_G \cdot R$ is true in the galactic halo, which has a radius 20 times the size of our galaxy, so Milky Way halo has at least 1 million light-years.
The reader can read this important experimental evidence in the book of Jeremiah Ostriker & Simon Mitton. (2013). *El corazón de las tinieblas. Materia y energía oscuras.* Page 203.

In conclusion the main part of mass in the halo is dark matter.

2.4 MASS DENSITY FORMULA IN THE GALACTIC DISK AND HALO

Taking into account $\begin{aligned} M_{TOTAL} &= K_G \bullet R \dashrightarrow dM_T = K_G dr \\ M_{TOTAL} &= \rho \bullet V \dashrightarrow dM_T = \rho 4\pi r^2 dr \end{aligned}$ it is concluded $\rho(r)_{TOTAL\,MASS} = \frac{K_G}{4\pi r^2}$, where $\rho(r)$ is the density function of total mass (ordinary + dark) in the galactic disk and halo.

As in the halo region the amount of dark matter is much bigger than ordinary matter, it is a good approximation to consider $\rho(r)_{D.M.\ \ HALO} \approx \frac{K_G}{4\pi r^2}$.

3. DARK MATTER MODEL BY QUANTUM VACUUM

It is known that QED theory consider the space as a place plenty of virtual particles which feel the electro-weak forces. Readers with knowledge about QED know that virtual particles are able to exist during a short period of time only if $\Delta E \bullet \Delta t \le \frac{\hbar}{2}$. So according to QED virtual particles could break the conservation energy principle for a tiny period of time.

Similarly the Quantum Chromo Dynamics consider the space full of virtual particles, called gluons. Therefore it is easy to think that there is virtual particles which feel the gravitational forces named virtual gravitons.

It is logical to think that the gravitational field excites the vacuum states in a way that **"the vacuum would be heavier, the more intense gravitational field is".** This one would be the main hypothesis of Dark Matter Model by Quantum Vacuum.

In the epigraph 5 it will be got a formula to justify this weird hypothesis about DM nature.

To explain this interaction between gravity and vacuum, we are going to see the well-known case of the relationship between physical electron and nude electron according to Quantum Electrodynamics (QED).

The distinction between physical-electron and nude electron could be proved when particle accelerators had enough energy to penetrate in the physical electron. In other words, when high energy electrons are shot against the electrons, they suffer a dispersion that can not be explained by a Coulomb type potential because when the electron break through the physical electron, the net charge that is "noticed" by the projectile electron is higher than the physical electron charge. However, the physical electron is very small because the virtual positrons shield the nude electron in a very small region, so that the electric force become a Coulomb´s force in an extremely small distance around the nude electron. Readers can find lot of books about QED, for instance, my source about nude electron and physical electron is Harald Fritzsch. Los quarks, la materia prima de nuestro Universo. 1982. Alianza Editorial.

There are two main differences between electric and gravitational force

a) Intensity of gravitational force is much lower than electric force.
b) The shielding of the nude electron happens in a extremely small area around the nude electron since the virtual positrons are an opposite sign and they decrease the total charge of the physical electron. Because of the virtual positron charge is opposite to the charge of the electron, the physical electron net charge is lower than the naked electron one.

However, the gravitational force is always attractive, therefore, virtual gravitons are attractive too and because of this the total mass (usual mass + dark mass) increases as we consider a growing volume of space around ordinary matter.

For these two reasons, in a Solar System scale, the net dark matter is negligible versus ordinary matter. However, on a galaxy scale, the dark matter is dominant against ordinary matter because of the huge size of space into a galaxy.

4. THE ULTIMATE DIFFERENCE BETWEEN DARK MATTER AND ORDINARY MATTER

According this model DM is generated by ordinary matter (O.M.). In other words, DM can not exist independently from ordinary matter.

By now I do not know any experimental evidence of an astronomical region with pure DM. In my opinion this fact is surprising because it is accepted that DM is 90% in the Universe versus 10% of ordinary matter. In addition the difference between big galaxies and small galaxies is very wide. However the proportion DM versus OM is not very different all over galaxies according to the experimental measures. In my view, this fact could be explained because DM is generated by OM, so there is a functional dependence between both kind of matters.

I am going to explain the difference between DM and OM using as example the physic and nude electron from QED.

To begin I would say that virtual particles in the quantum vacuum exist because it is possible to create baryonic particles if you give the energy to that virtual particles, in other words: virtual particles + energy = baryonic particles.

Now we consider a nude electron which produces a big instability in the space surrounding it, so a virtual positrons cloud go around the nude electron. I would say that virtual positron exist because thanks to them the total charge of physic electron is lower that the charge of nude electron.

I am going to translate this ideas to try to explain the DM nature:

a) If we consider a galaxy, its ordinary matter produces a gravitational field which excite the virtual gravitons in the surrounding space, so this way the space has a bigger mass.
b) Inside a big cosmic void the gravitational field is very weak, so the space has his virtual gravitons in their ground state and as a consequence the mass of the space is minimum. I think that in this situation, it is not possible for pure DM to create central gravitational fields. In the 9 epigraph, it will be proposed a experimental proof based on gravitational lenses to check this theoretical prediction.

According this model. in what sense is real DM? DM is real because it is responsible of 90 % of total mass in a galaxy, although DM is composed by virtual particles.

This model explain in a simple way the impossibility to have a region with pure DM, also this model explain easily the proportion DM versus OM because DM depend on ordinary matter.

The ultimate explanation of the dark matter in a galaxy and of the rotation curve of the stars will only be possible when a complete theory of quantum gravity be available, which, unfortunately there is not exist nowadays despite the fact that the most brilliant theoretical physicists have been working on this theory for decades.

5. CONNECTION BETWEEN MASS DENSITY FUNCTION AND GRAVITATIONAL FIELD INTENSITY FUNCTION

5.1 GRAVITATIONAL FIELD INTENSITY

It is known that for a mass distribution with spherical symmetry the gravitational field intensity is stated by the Gauss theorem with the formula $\vec{E} = \frac{GM}{r^2}\hat{r}$ where M is the total mass enclosed by a sphere with radius r. $E(r) = \frac{GM_{Total}}{r^2}$ represents the vector magnitude.

On a galaxy, the spherical symmetry could be an acceptable approximation, so the previous formula may represents the gravitational field intensity on a point in the galactic bulge, disk or halo.

As it was shown in the epigraph 2, in the galactic disk or halo the formula $M_{Total}(r) = K_G \cdot r$ represents the total mass enclosed by a sphere with radius r. If M_{Total} formula is replaced in $E(r) = \frac{GM_{Total}}{r^2}$ this formula becomes $E(r) = \frac{GK_G}{r}$ in disk and halo. So we have found the remarkable fact that the gravitational field intensity is inversely proportional to the distance to the galactic centre.

5.2 MASS DENSITY AS FUNCTION OF GRAVITATIONAL FIELD INTENSITY

In the epigraph 2 it has been got the formula $\rho(r)_{M\,Tot} = \frac{K_G}{4\pi r^2}$ for some point in the galactic disk or halo.

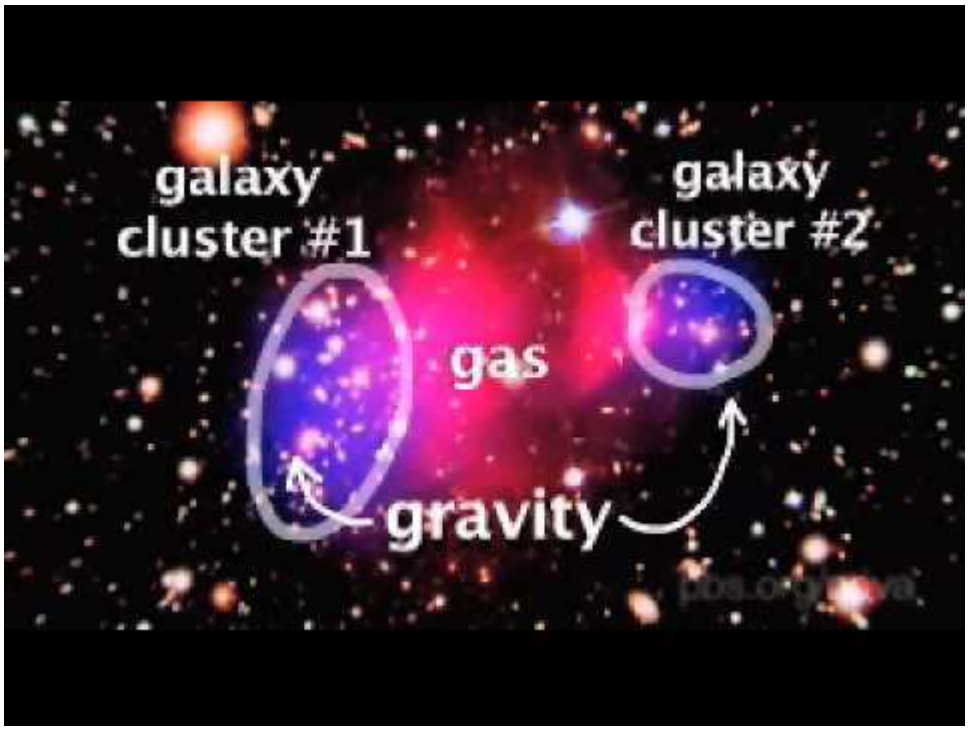
If the variable r is cleared up from $E(r) = \frac{GK_G}{r}$ and replaced in $\rho(r)_{M\,Tot} = \frac{K_G}{4\pi r^2}$ the mass density formula becomes $\rho(r)_{M\,Tot} = \frac{E^2}{4\pi G^2 K_G}$. This expression states the link between the mass density function and the gravitational field intensity for some point in the galactic disk or halo.

Particularly in the galactic halo $\rho(r)_{D.M.} \approx \frac{K_G}{4\pi r^2}$ so we can rewrite that formula as $\rho(r)_{D.M.\,HALO} \approx \frac{E^2(r)}{4\pi G^2 K_G}$ for each point in the galactic halo.

This formula stated a local connection between mass density function and gravitational field intensity for each point in the galactic halo, whereas the formula $\rho(r)_{D.M.\ HALO} \approx \frac{K_G}{4\pi r^2}$ give the DM density on a point as function its distance to the galaxy centre.

In addition the formula $\rho(r)_{D.M.HALO} \approx \frac{E^2(r)}{4\pi G^2 K_G}$ could justify the main hypothesis of the model: ***"the quantum vacuum mass is bigger, the more intense the gravitational field in the vacuum is"*** .

6. THE IMPORTANCE OF BULLET CLUSTER PHENOMENA FOR DARK MATTER ISSUE



The **Bullet Cluster** consists in two colliding clusters of galaxies. Strictly speaking, the name *Bullet Cluster* refers to the smaller sub cluster (2), moving away from the larger one (1). They move away each other at 10 million km/h. As a result their collision the gas, in red, has 70 million K of temperature and it emits a X-ray radiation.

Both clusters collided 150 millions years ago. Stars did not collided, stars simply changed a bit their trajectory. However gas interacted electromagnetically, so gas decelerated strongly. As a consequence the two gas clouds remain a bit joined at high temperature emitting X-ray radiation. In addition, there is no evidences about DM collision.

It has been estimated experimentally that gas, in red, is two times more massive than star masses, in blue. However by gravitational lens methods it has been checked that the blue area is much more massive than red area.
This fact has been the ultimate evidence to accept the DM hypothesis and refuse the MOND theory (Modified Newton Dynamic theory).
The previous information was discovered some years ago.

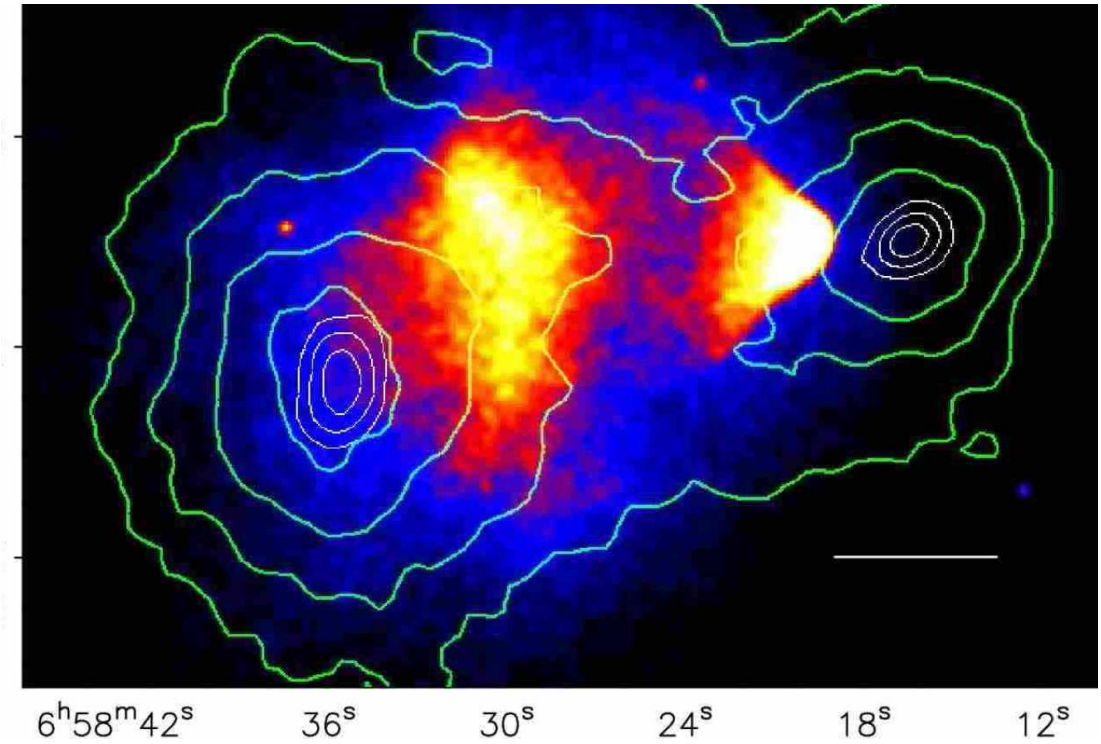
Now I would like to think about two weird evidences.

- DM is a substance which is concerned only by gravitation, moreover DM does not collided despite the fact DM is a light substance widely spread through the space.

- DM remains joined mainly to galaxy cluster although a fraction is distributed through the gas region.

  Both properties are shown in the pictures below.

  The Bullet Cluster is a pair of colliding galaxy clusters (Clowe et al. 2006)



Cloud in white yellow red and blue shows the X-ray radiation from gas as a result their collision.

Curves show density mass distribution which has a great spherical symmetry except in the inner region between clusters. This one means two things:

a) DM does not collide at all.
b) DM remain near galaxy cluster mainly, although there is a fraction of DM between clusters, where DM makes filaments.

Both evidences can be explained by the DM model.

6.1 THE DM MODEL CAN EXPLAIN THE MISTERY OF DM IN BULLET CLUSTER

Similarly to galaxies it is posible to get $\rho(r)_{DM-CLUSTER} \approx \frac{E^2(r)}{4\pi G^2 K_{CLUSTER}}$

In the 8.4 epigraph it will be explain the reasons to have the same formula for clusters that for galaxies.
The formula shows that DM depends on gravitational field, therefore DM will be a conservative field because E is a conservative field. According the model, this is the reason why DM is not able to collide whereas gas clouds in bullet cluster collided strongly.
In addition, if DM does not collide then DM will keep the spherical symmetry in the clusters.

At the beginning of epigraph it was said that gas cloud has more than two times the cluster mass, so according the model apparently they have to produce much more DM than cluster galaxies.

In the following epigraph it will be explained how the model could explain the fact that DM in gas clouds is considerably less than DM in clusters. DM in gas clouds would made filaments, which have a great deal lower DM than clusters.

Chapter bibliography
The remarkable pictures about Bullet Cluster has been taken from the paper:
Schneider, Peter (2012). Dark matter in clusters and large- scale structure.
Published in XXIV Canary Islands winter school of astrophysics.

7. DARK MATTER FILAMENTS CONNECTING CLUSTERS

The model states that DM is generated by gravitational field E, which is generated by ordinary matter, stars and gas clouds.
However there is a big difference between both types of baryonic substances. Stars are substances billion of billions more dense than gas clouds.

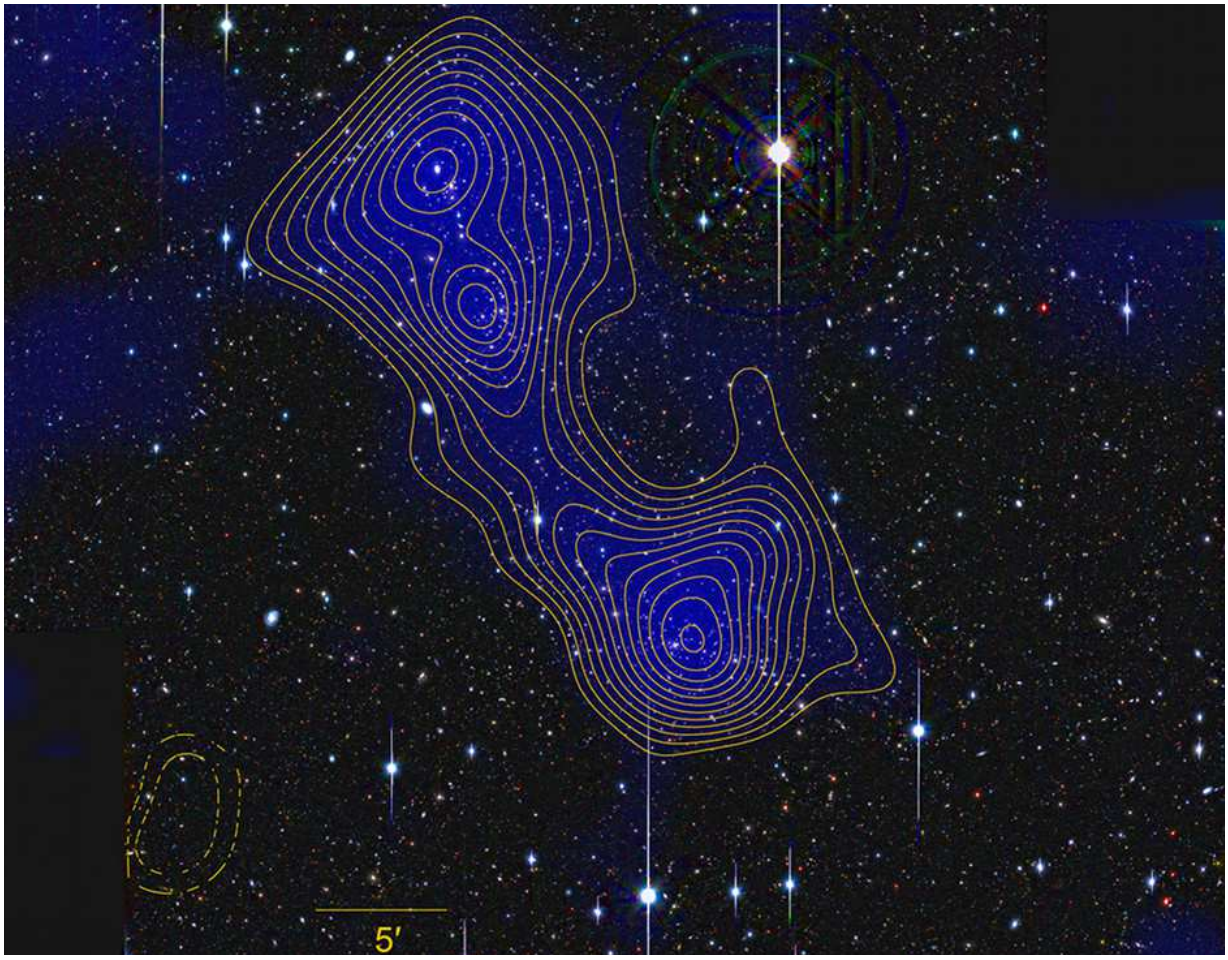
According the formula $\rho(r)_{DM-CLUSTER} \approx \frac{E^2(r)}{4\pi G^2 K_{CLUSTER}}$ density of DM depend on E^2 , therefore density of DM generated by gas cloud will be considerably less than density generated by galaxies although both have the same ordinary masses.
So the total amount of DM got by integration of $\rho(r)_{D.M.}$ all over the gas cloud is lower than DM generated by galaxies in cluster region.
This reason could explain the lower amount of DM measured in gas clouds region in Bullet Cluster compared with the amount of DM inside the clusters.
The amount of DM placed between clusters would be the filament of DM.

In the picture below it is possible to see the level of DM through the curves.
As you can see in the region between clusters there is DM filaments, which have a density of DM lower than cluster region.

In conclusion, despite the fact there is a big amount of baryonic matter as a gas cloud between clusters, the DM produced by this gas is lower that DM produced by galaxies inside the clusters.

As it has been shown, the DM model can explain easily the weird experimental evidences about DM in Bullet Cluster. Also can explain easily the filaments of DM generated by gas clouds.

The double cluster A222/A223 (Dietrich et al. 2012)



Chapter bibliography

The remarkable pictures about double cluster A222/A223 has been taken from the paper:

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8. DENSITY FUNCTION OF DARK MATTER DEPEND ON $\left|\vec{E}\right|$

In previous epigraphs it have been got $\rho(r)_{DM\ HALO} \approx \frac{\left|\vec{E}(r)\right|^2}{4\pi G^2 K_G}$ It is a simple formula, but the most important thing is that density of DM depends on intensity field. In this epigraph we are going to show how the vector trait of E has important consequences for density function of DM.

So, if DM density $\rho(r)_{D.M.}$ depend on $\left|\vec{E}\right|$, then $\rho(r)_{D.M.}$ depend on a vector field and it is known that the total field is the vector addition of partial fields.
This one would explain easily some weird characteristics of DM.

In fact it would be explain the experimental evidences about DM in regions like border halos since in that region the total field it is the addition of several galactic fields. However, in the nearby halo or galactic disk, the own gravitational field dominate over other fields so it is a good approximation to eliminate other gravitational sources and consider spherical symmetry which allow to simplify calculus like it has been made in previous epigraphs.

8.1 GALACTIC HALO

- the dark matter halo has spherical symmetry

The first consequence of DM density as a function of vector E, $\rho(\vec{E}(\vec{r}))$ would be the galactic halo concept.
The halo would be the region inside the cluster where the own galactic field dominates over the field of neighbour galaxies and over field of intergalactic gas clouds.

For example, supposing two galaxies with similar mass and similar structure separated by a distance D. In the middle of segment defined by their centres E=0, so the radius of both galaxy halos would be D/2.
For the dark matter model, it is easy to explain the spherical halo because the dark matter do not interact with radiation or any type of force, so if gravitational field has a big spherical symmetry, so does the dark matter.

The dark matter halo is much bigger than the galaxy

In the Milky Way experimentally it has been checked that its halo radius has a million light years with a total mass (dark and ordinary) equivalent to 10^{12} solar masses.
In addition it has been checked that total mass is proportional to radius until a million light years. See (Jeremiah Ostriker & Simon Mitton, 2013, El corazón de las tinieblas. Materia y Energía oscuras. Page 203).

It is known that Milky Way radius is 50000 light-year long, so its halo is 20 times bigger.

The large size of the halo could be easily explained with our model because the galaxy gravitational field is intense in the extra galactic space next to the galaxy. According to the dark matter model, the vacuum would be progressively less heavy the weaker gravitational field becomes and it would have a minimum weigh at the halo border.

It is known that Andromeda our neighbour galaxy is 2 million light years. According the model, halo is the region where the own gravitational field dominates over extragalactic field, therefore this one would be consistent with experimental distance of Andromeda because 1 million light year is a half of distance between both galaxies.
In others words, the borders of Milky Way and Andromeda is placed 1 million light years of distance because at that distance the gravitational field of both galaxies cancel each other, so density of DM at this point would be cero.

8.2 TOTAL MASS AS FUNCTION OF DISTANCE TO GALACTIC CENTRE

The formula $M_{TOTAL} = K_G \cdot R$ is got by integration of density function $\rho(r)_{TOTAL\,MASS} = \frac{K_G}{4\pi r^2}$. But, which is the region to integrate?
According the model the region would be the galactic halo. In addition, as the extragalactic field has some influence in the far halo it is right to set this inequality $\rho(r)_{DM-FAR\,HALO} < \frac{K_G}{4\pi r^2}$ and $\rho(r)_{DM\ BORDER-HALO} \approx 0$.Therefore it is right to conclude $M_{TOTAL}(R) < K_G \cdot R$ where R belong to far halo.

A right corollary would be $M_{TOTAL\ GALAXY} < K_G \cdot R_{HALO}$

8.2.1 UPPER BOUND FOR TOTAL MASS OF MILKY WAY

Currently are accepted these data:

Solar Mass $\approx 2 \cdot 10^{30}$ Kg Orbital speed for Sun $\approx$ 220 km/s
Halo Radius Milky Way 1 million light years $\approx 10^{22}$ m

so $K_{M\,W} \approx V^2_{SUN} / G \rightarrow K_{M\,W} \approx 7{,}25 \cdot 10^{20}$ Kg/m

UPPER BOUND FOR TOTAL MASS OF MILKY WAY

$M_{TOTAL\ MILKY\ WAY} < K_{M\,W} \cdot R_{HALO} = 7{,}25 \cdot 10^{42}$ Kg = $3{,}6 \cdot 10^{12}$ Solar masses

Currently are accepted for Milky Way these data:
Ordinary mass $2 \cdot 10^{11}$ Solar masses and Dark matter $2 \cdot 10^{12}$ Solar masses.

CONCLUSION

The upper bound got by the model is coherent with experimental evidences on the Milky Way.

It is remarkable the fact that a simple calculus has stated a correct upper bound for total mass of Milky Way.

8.3 SPIN SPEED CURVES ON FAR HALO

In the annex are shown the spin star curves of different galaxies. It is remarkable the fact that the curves in the far halo are lightly leaning down except one of these.
This experimental evidence can be explained by DM model because $\rho(r)_{D.M.\ \ FAR-HALO} < \frac{K}{4\pi r^2}$ due to the fact that the gravitational field the nearby galaxies decreases the total field in the far halo of a galaxy as it has been explained in 8.2 epigraph.

It is remarkable the simple way how the DM model can explain this universal characteristics of spin speed curves in galaxies.

In addition the spherical symmetry of field in the far halo is broken due to galactic field neighbours.

8.4 CLUSTER HALO

In the same sense that there is galactic halo it is possible to define the cluster halo.
Halo cluster would be the region around the cluster where the own gravitational field dominates over others gravitational fields generated by other cluster or inter cluster gas clouds.
It is known that clusters interact between them making super cluster. Currently Astrophysics consider super cluster as the bigger structures whose clusters are linked by gravitational forces. In other words super clusters do not interact each other gravitationally because of expansion of the Universe. Recently it has been published data about our local super cluster which has been named Laniakea.

According the model, galaxies not only generate DM inside the cluster but also in the cluster halo because clusters interact each other gravitationally.
Which is the size of halo cluster? By similar reasons explained in galaxies, the radius would be the half distance between clusters, although this scale Euclid space might not to be a good model and it would be necessary General Gravitation Theory.

Anyway the model of DM suggest easily the halo cluster, and in the following epigraph it will be used to explain a weird experimental evidence of DM in clusters.

8.4.1 HIPOTHESYS OF VIRIAL THEOREM IN GALAXY CLUSTERS

In order to simplify calculus it is hypothesized spherical symmetry and balanced gravitational forces over the galaxies inside the cluster, so the Virial Theorem is a good way to estimate the cluster mass.
If it is chosen a peripheral galaxy of cluster then $M_{TOTAL\ CLUSTER} \approx R \cdot V^2 / G$ where

R is its orbital radius, V is its speed and $M_{TOTAL\ CLUSTER}$ is the total mass enclosed by the sphere with R radius. It is obvious that DM belonging to cluster halo it is not included in the mass measured by this method.

By similar reasons to epigraph 2 it would be stated $\rho(r)_{DM-HALO-CLUSTER} \approx \frac{K_{CLUSTER}}{4\pi r^2}$ where $K_{CLUSTER} = \frac{V^2}{G} = Cte$

Also by similar reasons to epigraph 8.2 $K_{CLUSTER} \cdot R_{HALO}$ would be an upper bound to total mass in cluster including DM belonging its halo.

8.4.2 THE PUZZLE OF DARK MATTER IN GALAXY CLUSTERS

As the reader knows, there is a second method to measure the total mass of clusters, based on gravitational lens.
Gravitational lens method is able to measure the total mass including the halo DM of cluster on condition there is a far galaxy lined up with cluster and the Earth.

The reader can consult in the book, Battaner, E (1999). Introducción a la Astrofísica. Alianza Editorial the following weird property about DM in clusters:
In some clusters there have been measured 99% DM whereas DM in galaxies is 90%.
In other words, experimentally it has been measured that total mass in cluster is bigger than the sum total masses of its galaxies.
This weird property it would be explained by the DM belonging to cluster halo.

- As it has been shown before through the Virial Theorem it is possible to measure the total mass inside the cluster, including ordinary mass and DM mass of galaxies.
- By gravitational lens it would be possible to measure the total mass including the DM of cluster halo.

Therefore total mass measured by Virial Theorem is lower than total mass measured by gravitational lens.

As $K_{CLUSTER} \cdot R_{HALO}$ is an upper bound for total mass of cluster, it is posible to state a doublé inequality for total mass of clusters.

Total Mass $_{\text{BY VIRIAL THEOREM}}$ < **Total Mass** $_{\text{BY GRAVITATIONAL LENS}}$ < $K_{CLUSTER} \cdot R_{HALO}$

In the epigraph 9.5 it will be propose an experimental proof to check this model prediction.

8.5 COMPLEXITY OF DM DISTRIBUTION IN GALAXY CLUSTER

It is known that mass of gas clouds inside the cluster are more than two times mass of galaxies.
However by the reason explained in the epigraph 7 the gas clouds generate considerably less DM than galaxies do.
It is right to think that DM generates by gas cloud would be responsible of DM filaments. In my opinion there is two reasons to support this one.

- The total amount of mass is considerably less than DM generated by galaxies.
- The gas cloud breaks the spherical symmetry.

In conclusion the gas cloud would be the main responsible of DM complexity in galaxy cluster although asymmetry distribution of galaxies it would be another important responsible.

9. EXPERIMENTAL PROOFS TO CHECK THE DM MODEL PREDICTIONS

The model allows to deduce six astrophysics proofs in order to check the model predictions with the experimental data.
In my opinion if the experimental data of the six proofs supported the model predictions, the model of DM would be a serious candidate to explain the DM nature.

9.1 - GALAXIES

An essential test would be that the dark matter in different galaxies with similar visible mass and similar structure would be substantially the same.

It is evident that if in two similar galaxies their dark matters are quite different, the model have to be rejected.

Notice that the distance for the two galaxies should be the same to cancel the errors produced in measures on physical magnitudes due to the huge distances.

9.2 UPPER BOUND FOR TOTAL MASS OF GALAXIES

From the epigraph 8.2 it is right the following experimental proof.

For any galaxy Total Mass (including DM halo) $< K_G \cdot R_{HALO}$

It is known that gravitational lens can measure the total mass of galaxies, so

For any galaxies Total Mass $_{\text{BY GRAVITATIONAL LENS}} < K_G \cdot R_{HALO}$

9.3 GALAXY CLUSTERS WITH SIMILAR VISIBLE MASS AND SIMILAR STRUCTURE IN GALAXIES AND GAS CLOUDS

The methods to measure the total mass in galaxies cluster are the Virial theorem and gravitational lenses. X-ray radiation it is measured to calculate the gas clouds. As it was said in previous epigraphs, the DM proportion in galaxy clusters is bigger than galaxies. So, it is right to think of comparing total mass measurements with the same technique in different clusters with similar visible mass, similar structures (galaxies and gas). For example:

According the DM model, with the gravitational lens effect on the galaxy cluster scale, it should verify that the total mass obtained in two gravitational lenses with similar

visible mass, similar structure (galaxies and gas) and similar distance from Earth should be similar.

Also according the DM model, with the Virial theorem technique the total mass estimated on two galaxy clusters with similar visible and similar structure (galaxies and gas) mass should be the same if the distances to both clusters are similar as well.

Notice that the distance to the two galaxy clusters should be the same to cancel the errors produced to measure physical magnitudes due to huge distances.

9.4 - COSMIC VOIDS

The Hubble telescope took a picture of a gravitational lens composed by the Abel galaxy cluster 2218, which is placed to 2000 millions light years far away. The lens show a distorted images of a galaxy which is placed 10000 million light years far away.

Excellent picture and superb spectacle¡

It is known that a gravitational lens needs only a central gravitational field to work. So if the viewer, the lens and the object are in the same line then the viewer wil be able to see the image if he or she has a good telescope¡

We are going to propose a fourth experimental proof to check the model through the gravitational lens effect because it is obvious that the only way to look for DM pure is that effect.

According the model it is not possible that DM pure exist. If pure DM could exist the best places to look for it would be the cosmic voids. The pure DM would create central gravitational field which would be a gravitational lens. Until this moment there is not any experimental evidence of gravitational lens of pure DM. Perhaps in the future it would have been found it. However this model predicts the impossibility to find it.

By now there is no experimental evidence of pure DM, despite the fact that the sky is monitored by hundreds of telescopes with the highest technology.

In my opinion if pure DM existed it would have been already discovered.

9.5 MASSES INEQUALITIES OF GALAXY CLUSTER

By the reason explained in the epigraph 8.4 it is right to state the following experimental proof.

For any galaxy cluster with spherical symmetry and gravitational balanced forces, masses measured by gravitational lens and Virial theorem should verify the following double inequality.

$$\text{Total Mass}_{\text{BY VIRIAL THEOREM}} < \text{Total Mass}_{\text{BY GRAVITATIONAL LENS}} < K_{CLUSTER} \cdot R_{HALO}$$

9.6 - SPIN SPEED STAR CURVES ON FAR HALO IN GALAXIES

In the annex are shown the real spin star curves on galaxies. It is remarkable the fact that most of the curves has a light sloping down.

The DM model can explain this fact easily, as it has been explained in the 8.3 epigraph. However in the picture, it is possible to see a curve with a light slope up in the halo region.

According DM model this fact it can not be explained, so it would be needed to investigate this weird experimental evidence to find the reason to explain it.

9.7 CONCLUSION

If someone of these experimental proofs contradicted model predictions it would have to discard the model.
However if all the six tests supported the model it would have plenty of reasons to consider the model as a serious candidate to explain the nature of DM.

The unsuccessful search for particles responsible of the dark matter for the whole international scientific community during several decades, using the most sophisticated technology could be an indication that the dark matter has another nature.
In addition, it is accepted by the scientific community the fact that Dark Energy is a Quantum Gravity phenomenon, so for symmetry reasons DM should be produced by Quantum Gravity as well.

We can remember that in the 19 th century the atom was inexplicable because the electrons should irradiate energy and bringing down with the nucleus. It was Quantum Mechanic which could explain the atom eventually. In my opinion it will be Quantum Gravity which will explain the problem of dark energy and dark matter.

EPILOGUE

All of these calculus are very simple, but it does not matter. The purpose this paper is to introduce the model. To show a new origin of DM and try to convince the reader that it is worth to check the model with experimental proofs.

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ANNEX

REAL SPIN SPEED STAR CURVES ON GALAXIES