DARK MATTER MODEL BY QUANTUM VACUUM

Author: Manuel Abarca Hernández **October 2014**
@mabarcaher1

1. ABSTRAT

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 (QED), which consider the space full of virtual electrons and virtual positrons. Similarly, the Quantum Chromo Dynamics (QCD) 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".
The hypothesis of this DM model is that virtual gravitons are Dark Matter.

With this paper, the author try to explain his theory in a qualitative way, because the final theory will be the Quantum gravity (QG) which there is not exist yet.

The paper is organised in four parts:

The first one explain the model theoretically in a simple way because in my opinion the ultimate theory of DM will be explain by the Quantum Gravity.
The second one study the spin speed star on galaxies. It is got the density formula for DM. $\rho(r)_{D.M.\ HALO} = \frac{K}{4\pi r^2}$ and the formula $\rho(r)_{D.M.HALO} \approx \frac{|E^2(r)|}{4\pi G^2 K}$, which connects DM density with intensity field.
The third one explain the coherence between the DM model and experimental evidences known about DM.
The fourth one propose six experimental test 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.

2. ROTATIONAL SPEED CURVES OF STARS IN A GALAXY

At first, we focus the attention on rotational speed curve of stars around galactic bulge. In annex I, it is shown a simplified model about the speed curve. In annex graphic, there are two regions clearly bounded: Core or Bulge and Disk.
Galaxy core has an ordinary mass distribution almost with spherical symmetry and a mass density much bigger than the galactic disk. As it is shown in graphic, angular velocity of its stars is relatively constant.
In galactic disk, the rotational speed of its stars is perceptibly constant and unexpectedly high in terms of observable matter (O.M.)

2.1 GALACTIC DISK

Disk is a large part of a galaxy which begins near the bulge, extending itself to the most external stars. Experimental data say that the 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 annex I shows some calculations leading to the mass density function $\rho(r) = \dfrac{K}{4\pi r^2}$ that explain the experimental plane curve of galactic disk.
The velocity curve in this area is inexplicable through observable matter measured by astronomical methods. In all the galaxies whose mass and rotation curve have been measured, we may say 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.).

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 $\Delta E \bullet \Delta t \leq \dfrac{\hbar}{2}$. 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". Dark matter model proposed could justify qualitatively the total mass density function $\rho(r) = \dfrac{K}{4\pi r^2}$, which is ordinary and dark matter, in galactic disk region.
See annex I.

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.

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, the gravitational force has a Newtonian behaviour in a Solar System level, as, on this scale, the net dark matter is negligible versus ordinary matter. However, on a galaxy scale, the dark matter is dominant against ordinary matter and, as a result, the real rotation velocity of the stars is faster than the rotational one that they could have if only ordinary matter exist.

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

It has been got in the annex I, the mass density function for galactic disk $\rho(r)_{M\,Total} = \frac{K}{4\pi r^2}$

Where $K = \frac{M_{NUCLEUS}}{R_{NUCLEUS}} = \frac{V_0^{\,2}}{G}$ .In the annex is explained this constant. As in the halo the ordinary matter is insignificant it could be consider $\rho(r)_{D.M.HALO} \approx \frac{K}{4\pi r^2}$ as a good formula for D.M. in the galactic halo.

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 annex, in the galactic disk or halo the formula $M_{Total}(r) = K \bullet r$ 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 $E(r) = \frac{GK}{r}$ 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

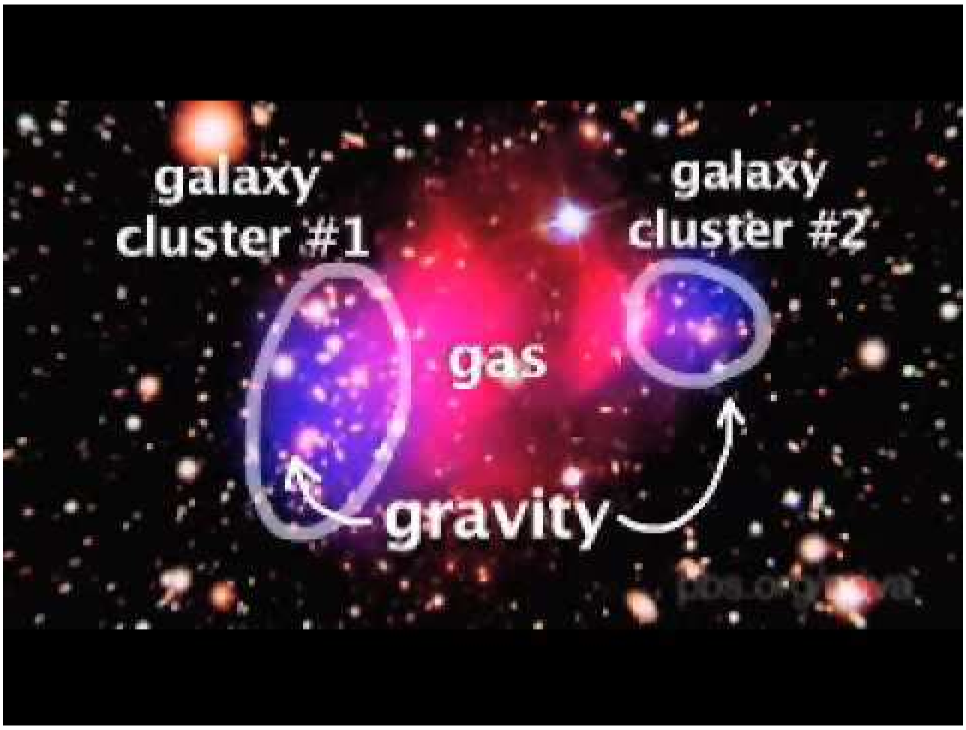
In the annex it has been got the formula $\rho(r)_{M\,Tot} = \frac{K}{4\pi r^2}$ for some point in the galactic disk or halo.

If the variable r is cleared up from $E(r) = \frac{GK}{r}$ and replaced in $\rho(r)_{M\,Tot} = \frac{K}{4\pi r^2}$ the mass density formula becomes $\rho(r)_{M\,Tot} = \frac{E^2}{4\pi G^2 K}$. 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 $\rho(r)_{D.M.} \approx \frac{K}{4\pi r^2}$ so we can rewrite that formula as $\rho(r)_{D.M.\,HALO} \approx \frac{E^2(r)}{4\pi G^2 K}$ 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 $\rho(r)_{D.M.\ HALO} \approx \frac{K}{4\pi r^2}$ give the DM density on a point as function its distance to the galaxy centre.

6. DM MODEL EXPLAINS BULLET CLUSTER PHENOMENA



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 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 model because the only way to have more matter in the cluster region is to sum the extra matter created by DM.

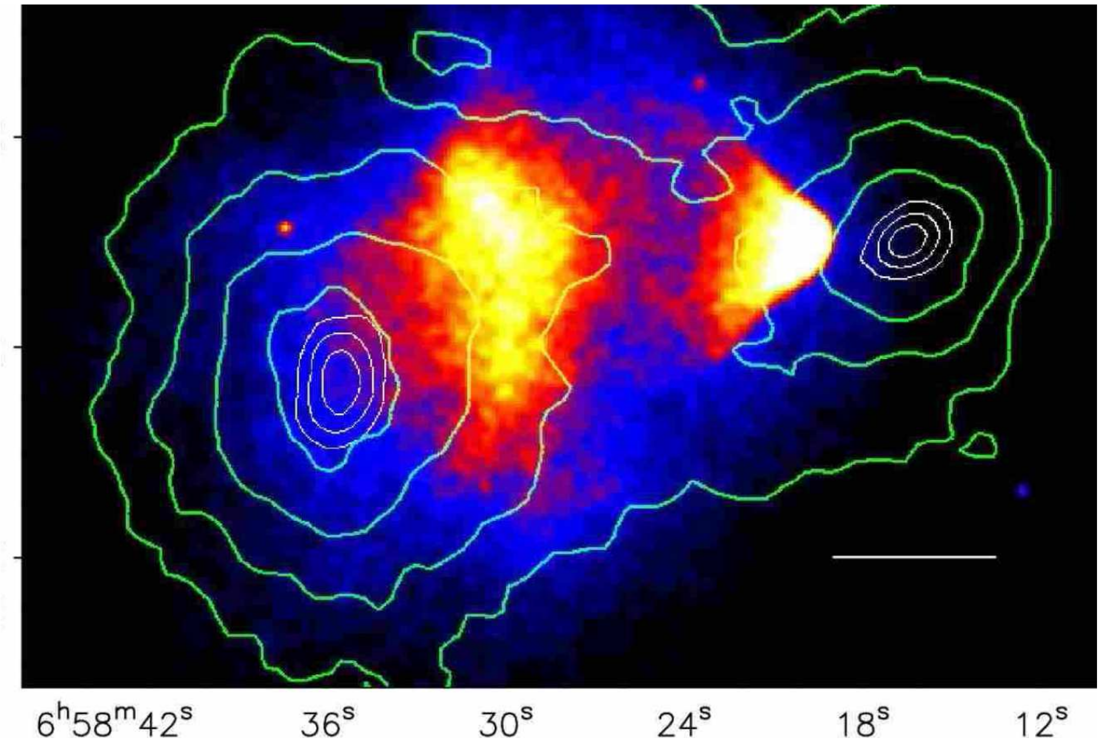
The previous information was discovered some years ago.

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 picture below.



Cloud in red and yellow show 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.

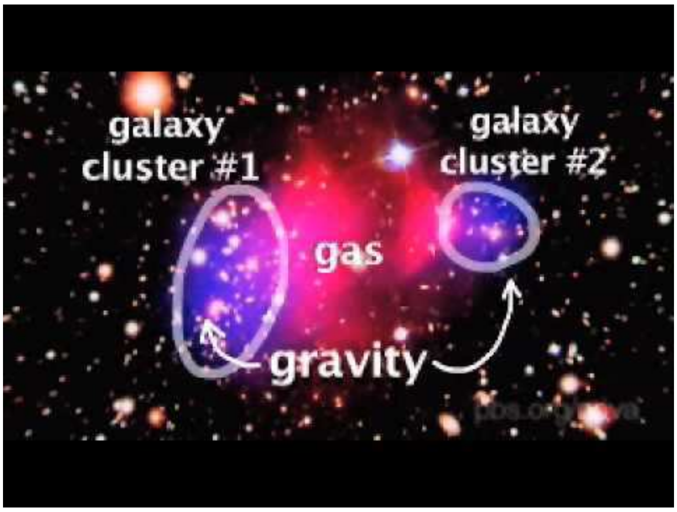
Both evidences can be explained by the DM model.

According the model, DM can not exist independently from ordinary matter. DM could be considerate as a conservative field of virtual gravitons , which depend on gravitational intensity field E, which has been created initially by an amount of ordinary matter. Remember the formula $\rho(r)_{D.M.} \approx \frac{E^2(r)}{4\pi G^2 K}$

Collision between clusters is like a conservative field superposition as concerns to DM. Therefore DM does not collide, does not emit energy during clusters collision. DM curves have spherical symmetry in the outside region of collision and makes filaments of DM in the inner collision region.
The following epigraph talks specifically about DM filaments.

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 billions of billion more dense than gas clouds. So in a region like the Milky Way and its halo DM it is 10 times bigger than ordinary matter.

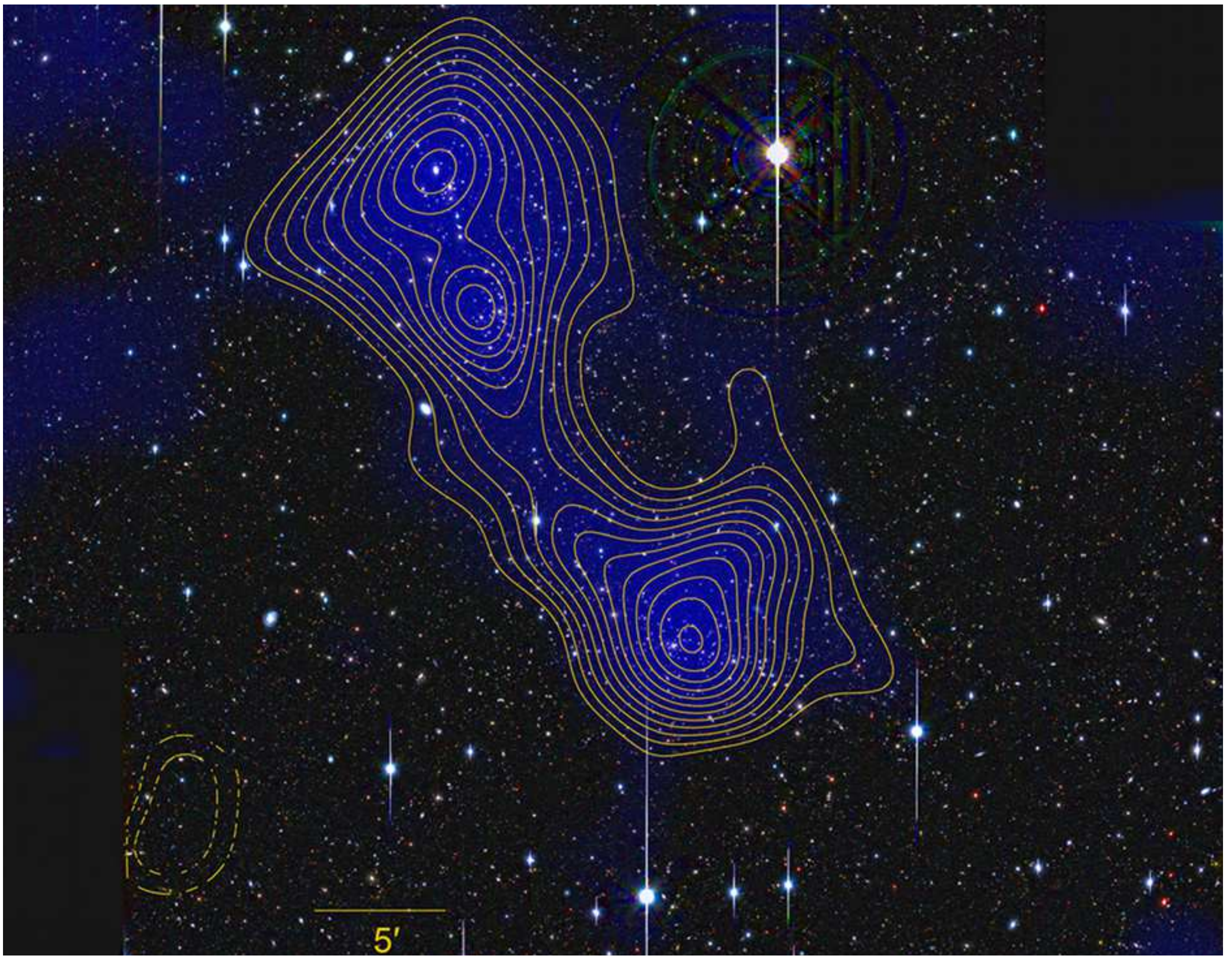


However according the DM model, a gas cloud with the same size of Milky Way halo and the same baryonic mass would have considerably less DM than Milky Way halo. We are going to explain the previous affirmation through a simple rational thought.
Although the formula $\rho(r)_{D.M.} \approx \frac{E^2(r)}{4\pi G^2 K}$ was obtained for galaxies, not for gas clouds, it shows that density of DM depend on E^2 . It is known that inside a gas cloud E is considerably lower because density of ordinary matter is billions of billions lower than stars. Therefore the total amount of DM get by integration of $\rho(r)_{D.M.}$ all over the space is lower than DM in cluster region.
Therefore this reason could explain the lower amount of DM measured between clusters in comparison with the amount of DM inside the clusters.
This fraction of DM placed between clusters would be the filament of DM.
The picture in the following page shows the density of total matter through the curves.

As we can see there is a lower amount of DM between clusters.
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 stars inside the clusters.

As it has been seen, the DM model can explain easily the two weird evidences about DM in galaxy clusters.

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



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

In previous epigraphs it have been got $\rho(r)_{D.M.HALO} \approx \dfrac{\left|E^2(r)\right|}{4\pi G^2 K}$ It is a simple formula, but the most important thing is that density of DM depends on intensity field , although in the galactic disk or bulge $\rho(r)_{D.M.}$ will be a more complicated function.

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. 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.

It is right from the DM model that the amount of DM depend on the size of the sphere considered since according the model the amount of DM is got by integration of $\rho(\vec{E}(\vec{r}))$, so DM is increasing if the region is increasing.

The dark matter halo is much bigger than the galaxy

In the Milky Way experimentally it has been proof that its halo with a radius for a million light years has a total mass (dark and ordinary) equivalent to 10^{12} solar masses and for a radius below a million light years the total mass enclosed by a sphere is

directly proportional to its radius, (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.

In the annex I it has been shown some calculus to explain that the constant speed in the galactic disk can be explain with the formula $M_{Total} = K \bullet R$, where M is the total mass enclosed by a sphere whose radius is R.

8.2 CLUSTER HALO

In the same sense that there is galactic halo it is possible to define the cluster halo. It is known that cluster interact between them making super cluster.
Therefore according to the DM model the total cluster field will generate a $\rho(\vec{E}(\vec{r}))$ not only inside the cluster but also in their halo, until its border.
According the DM model the cluster halo would have a $\rho(r)_{D.M.\ HALO} \approx \frac{K}{4\pi r^2}$ as happen in galaxies if it is accepted spherical symmetry, which is easy to accept for clusters.

It is known that DM cluster is measured usually by gravitational lensing, which is a perfect method to measure the total mass.
As far I know there is not measured of DM in halo cluster depending on the radius. It is right to understand that this one is a huge challenge because of gigantic distances to galaxy clusters.

A weird experimental evidence is the fact that in galaxy clusters, it has been measured the following proportion: 99% DM over 1 % OM as you can see in the book written by Battaner, E (1999). *Introducción a la astrofísica*.
However, in galaxies is 90% DM over 10% OM.
The DM model could explain qualitatively that weird experimental evidence thanks to cluster halo concept.

Problems come from technologies to measure so far away, distances, speeds and bright light of galaxies. In addition at that huge distance Euclidean geometry may not to be a good model for space.

In the 10 epigraph it will be proposed an experiment to check the DM in cluster halo with experimental evidences.

8.3 TOTAL MASS AS FUNCTION OF DISTANCE TO GALACTIC CENTRE

The formula M_{TOTAL}=K*R would be more precise in the disk and nearby halo, because in the far halo it is more important the field of galactic neighbours. So the density of DM is lower than $\rho(r)_{D.M.\ HALO} \approx \frac{K}{4\pi r^2}$ because of gravitational field of galactic neighbours. So it would be more precise rewrite $M_{DM-\ FAR\ HALO}$=K*f(R) because $\rho(r)_{D.M.\ FAR-HALO} < \frac{K}{4\pi r^2}$

The formula M_{DM}=K*f(R) is limited inside the halo, where the galactic field has his influence. In fact $\rho(r)_{D.M.\ BORDER-HALO} \approx 0$ because gravitational field in halo borders is weak.

Thanks this right reason, it has been shown that formula M_{TOTAL}=K*R is acceptable in the nearby halo and galactic disk and the formula $M_{TOTAL-\ FAR\ HALO}$=K*f(R) may work until the halo border.

8.4 SPIN SPEED CURVES ON FAR HALO

In the annex II there are shown the spin star curves on different galaxies. It is remarkable the fact that the curves in the far halo are lightly leaning down.

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.

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 because of galactic field neighbours. So it is necessary to write $\rho(\vec{E}(\vec{r}))$ instead $\rho(\vec{E}(r))$

8.5 COMPLEXITY OF DM DISTRIBUTION IN GALAXY CLUSTER

It is an experimental evidence that DM in clusters has a complex distribution.

This fact may be explained rightly according the DM model because the total field is got by vector addition of gravitational field of each galaxy, especially in galaxy halo borders.

Moreover gas clouds generate DM through its own field, which add more complexity to DM distribution.

Total DM in a cluster is not exactly the addition of DM of each galaxy plus DM generated by gas. As it has been explained in the 8.2 epigraph, according the DM model, the DM in cluster is bigger than DM galaxies because of cluster halo.

It is known that intergalactic gas cloud has bigger mass than star masses of galaxies. However DM generated by this gas is lower than DM generated by galaxies as it was explained in the epigraph 7. This one add more complexity to DM distribution inside a cluster.

8.6 DM FILAMENTS BETWEEN GALAXY CLUSTERS

The DM filaments between nearby galaxy clusters are generated by ordinary matter placed between both clusters, such as galaxies and gas clouds.

9. EXPERIMENTAL EVIDENCES TO CHECK THE DM MODEL

The model allow to deduce six experimental evidences in order to consider the model 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 we may measure their dark matters and the results 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 for the huge distances.

9.2 - 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.

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 in measures on physical magnitudes because of the huge distances.

9.3 - 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 third experimental evidence 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.

9.4 - DM IN GALAXY CLUSTER

Using similar reason to galaxies it is possible to state $\rho(r)_{D.M.\ HALO\ CLUSTER} \approx \frac{K}{4\pi r^2}$ in the halo cluster. By integration it would be possible to calculate the total DM, which added to total mass inside the cluster give us the total mass for cluster.

Gravitational lensing is the perfect method to measure the total mass for galaxy cluster.

So the forecast of total mass by the DM model could be checked with the experimental evidence of total mass.

9.5- VIRIAL THEOREM AND GRAVITATIONAL LENS IN GALAXY CLUSTERS

It is right that Virial theorem, over a peripheral galaxy that belong a cluster, measure the total mass inside the cluster, therefore It can not measure DM outside the cluster. However gravitational lensing could measure DM from the cluster halo apart from the total mass inside the cluster. The reason is clear. The light which come from a far away object could cross the cluster halo, so the light is deflected by the total mass included DM belonging the halo.

Therefore the model predict that measures of total mass using Virial theorem is lower than using gravitational lens.

This prediction it should be checked with experimental evidences.

9.6 - SPIN SPEED STAR CURVES ON FAR HALO IN GALAXIES

In the annex II are shown the 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 8.4 epigraph. However it can be seen in the annex II diagram that some spin speed star has a light slope up.

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

CONCLUSION

If someone of these experimental evidences contradicted the results that predict the dark matter model then it would have to discard the model. However if all the five tests supported the model, I think we would have plenty of reasons to consider the model as a 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 could be produced by Quantum Gravity as well.

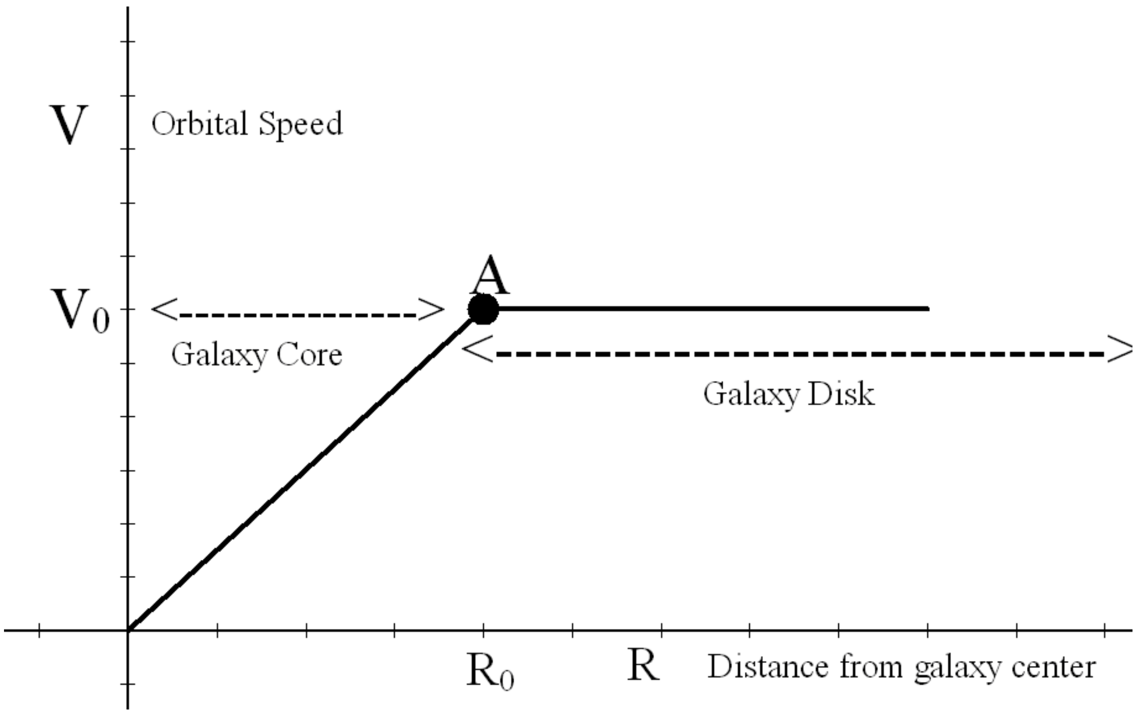
We can remember that in the 19 th century the atom was inexplicable because the electrons should irradiate energy and bringing down with the nucleus. It was Quantum Mechanic which could explain the atom eventually. In my opinion it will be Quantum Gravity which will explain the problem of dark energy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

ANNEX I

Rotational speed curve model of stars around the galaxy centre.



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

In the graphics you can see two regions:
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.

In this paragraph, 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.

In this region, the ordinary mass has a high spherical symmetry and there is experimental evidences that density of ordinary matter is approximately constant, so the constant angular speed can be reasonably explained by the amount of ordinary matter observed.

Galactic Disk

In this region, there is a big negative balance of mass because the rotational speed is too high (from 200 km/s to 300 km/s), in proportion to the ordinary mass measured.
In general galaxies have 90% of dark matter and 10% of ordinary matter.
Now we can obtain the density function that explains the rotational curve in this region.
Given in this region velocity = constant , from the third Keplero´s law written as $v^2 = \frac{GM}{R} =$ constant, it is deduced that the mass contained by the star orbit is directly proportional to the spin of star radius.
From graphic point **A** it is deduced that $\frac{M_0}{R_0} = \frac{M}{R} = K =$ constant, where M_0 represents the total mass contained by the galactic bulge and R_0 represents its radius.

In conclusion in the galactic disk and halo $M_{TOTAL} = K * r$

Thanks to Virial theorem it is possible to relate K with spin speed of stars at the galactic disk. Considering the point **A** in the graphic, a star has spin speed V_0 and its distance to the centre is R_0. Through Virial theorem at this point we have $V_0^2 = \frac{GM_0}{R_0}$ so

$$K = \frac{M_0}{R_0} = \frac{V_0^2}{G}$$

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

Taking into account $\begin{matrix} M = K \bullet R --> dM = Kdr \\ M = \rho \bullet V --> dM = \rho 4\pi r^2 dr \end{matrix}$ it is concluded

$\rho(r)_{TOTAL MASS} = \frac{K}{4\pi r^2}$, where $\rho(r)$ is the density function of total mass (ordinary + dark) in the galactic disk and halo.

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

Therefore, the hypothesis about “the quantum vacuum mass is bigger, the more intense the gravitational field in the vacuum is” can be justified in a qualitative way by the density function of total mass $\rho(r) = \frac{K}{4\pi r^2}$ because the intensity of gravitational field decreases with the distance to the galactic centre.

DISCUSSION OF THE RESULTS

Galactic bulge

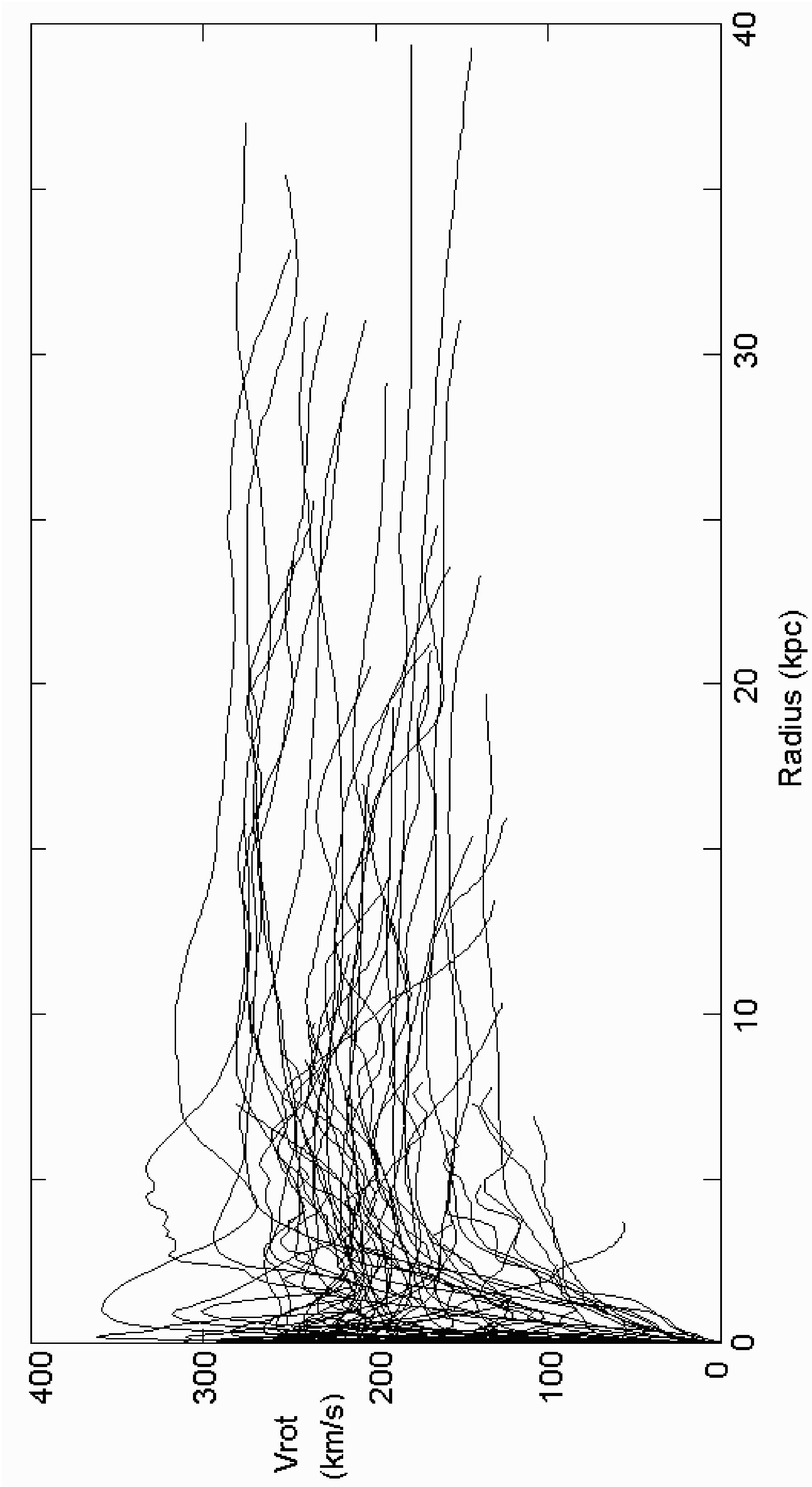
As the galactic bulge is relatively small and DM it depends on volume (by an unknown function) of the space enclosed by the spherical bulge, the amount of DM in the bulge is much smaller than ordinary matter. In addition experimental evidences show that ordinary mass density is constant in this region. Because of this reason, the rotational curve of this region could be well explained with the ordinary matter from the galactic bulge, including the supergiant black hole at the centre.
In conclusion the experimental evidences are consistent with the model of DM.

Galactic disk and halo

The formula $M_{Total} = K \bullet R$ has been deduced through the rotational speed of star in the galactic disk. However, we remember the remarkable experimental evidence that in the Milky Way this formula is true for a radius 20 times the size of our galaxy, as it is wrote in the book Jeremiah Ostriker & Simon Mitton. (2013). *El corazón de las tinieblas. Materia y energía oscuras.* Page 203.

ANNEX II

SPIN SPEED STAR CURVES ON GALAXIES



BIBLIOGRAFÍA

Jermiah P. Ostriker & Simon Mitton. (2013). *El corazón de las tinieblas. Materia y Energía Oscuras*. Barcelona: Ediciones de Pasado y Presente.

Battaner, Eduardo.(1999). *Introducción a la Astrofísica*. Madrid: Alianza Editorial.

Schneider, Peter (2012). Dark matter in clusters and large- scale structure.
Published in XXIV Canary Islands winter school of astrophysics.