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On the Dark Matter Conjecture and the Anomalous Galactic Speeds

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Abstract- Through a physical and mathematical analysis, mainly taking into account that the total mass of a galaxy, unlike the Solar System, is spread, discretised results are obtained. From the analysis of these results, it is concluded that the postulate of the existence of dark matter, which has prevailed for more than 80 years with no means to justify it, not required. In addition to the discretisation of the galactic mass, Gauss's Law is used in this study to calculate the gravitational field within the mass distribution itself. The expression that is obtained for the gravitational field strongly depends on the density of the distribution of the mass, which ultimately determines the dependence of the star velocity with respect to the radial distance. To conclude, without the inclusion of a dark and strange matter, using this physical-mathematical analysis we obtain that the speed of the stars turns out to be a constant for one of the examples proposed in this study. Consequently, we propose that it is evident that the enigma of dark matter never really existed.

Keywords- *Gravitation, Dark Matter, Radial Velocity, Galaxy Clusters, Gauss's Law, Galactic Mass*

I. Introduction

Fritz Zwicky (1898-1974) was an American-Swiss astronomer and physicist of Bulgarian origin, among other facts, he was the first to propose the existence of neutron stars. In the 1933, Zwicky published the results of his work, after observing the spectra of distant nebulae, beyond the Milky Way. He managed to differentiate individual stars within distant galaxies. In an unexpected and contradictory manner, Zwicky discovered that many of those stars were moving at speeds that far exceeded the expected values, according to the Newtonian model he applied, with respect to the traditional gravitational potential to which they were supposedly subjected. The same observation was made for galaxies in clusters, such as the Coma Cluster [1, 2].

Up until 1918, it was believed that the universe solely consisted of the Milky Way, with the Solar System at its centre. Therein, the stars supposedly moved with radial velocities around the Solar System. Astronomers of the early twentieth century tried to obtain values of the speeds of stars in some galaxies of the universe. Those astronomers included Jacobus Kapteyn, James Jeans, Arthur Stanley Eddington, Karl Schwarzschild and, later, Jan Hendrik Oort [3-5]. In order to determine the total mass of the universe at that time, both the visible mass (stars and nebulae) and non-visible mass (other objects that do not shine as do planets and interstellar dust) were considered. Around 1915, Ernst Opik demonstrated that the density of matter in the universe (our local environment within the Milky Way) was dominated by visible matter (stars), and that non-visible matter was negligible [6]. The existence of "non-visible" astrophysical objects has been known for some time, and in fact it is a very old knowledge. In 1783, John Michell (1724-1793) proposed the existence of stars so massive that they did not permit light to escape [7]. These non-visible stars could be detected by their gravitational effects, as proposed by Friederich Bessel (1784-1846) in 1844 [8]. In fact, the clouds of non-visible matter was one of the proposed explanations for the anomaly of the perihelion of the planet Mercurio of French mathematician Urbain Joseph Le Verrier (1811-1877) (the most famous astronomer in the world at the time and director of the Paris Observatory), when the planet Vulcano was not found between the Sun and Mercury. A planet, or a group of smaller planets that would circulate in the vicinity of Mercury's orbit, would be capable of producing the anomalous disturbance felt by this planet, as proposed by Le Verrier in 1859 [9].

Zwicky, from the 1930s, and later Vera Rubin (1928-2016) in the 1960s and 1970s, found no alternative but to postulate the existence of some form of foreign matter causing the speeds that were too large and unexpected for many of the stars of the galaxies [1, 2, 10-12]. They called it Dark Matter. It was something strange, because it only manifested its presence through gravitational force. It cannot be seen, it does not emit light nor does it reflect light, and it cannot be detected by any other means other than through gravitational interaction [1-3, 10-15]. Originally, Zwicky formulated these pioneering ideas related to dark matter. Since then, for more than 80 years the concept of dark matter has prevailed, and is used to justify these excessive speeds of stars in galaxies and of galaxies in galaxy clusters [16-20]. In fact, Dark Matter does not interact with the electromagnetic force, that is, it neither absorbs nor emits heat, light or any radiation. Dark Matter can be totally invisible. On the other hand, it is assumed that its existence was supposedly confirmed from 1974, although until 1980 it was still called "*unseen mass*" or "lost mass" [21, 22].

The concept that was postulated on this strange matter has evolved over time. In the year 2000, dozens of prestigious theoretical physicists were either in favour of (Stephen Hawking (1942-2018) was in favour), or against the supposition that in the next ten years new particles would be found, which would confirm the elegant and favoured theory of supersymmetry to shed light on the composition of the mysterious Dark Matter of Zwicky and Vera Rubin. This happened when the Large Hadron Collider (LHC), the largest and most powerful particle accelerator, was being built. By way of the LHC, in 2012 the so-called Higgs boson was found experimentally, and is considered to be the last piece of the puzzle of the standard model [23]. After 10 years of searching, nothing was found to prove that elegant theory of supersymmetry [13].

During recent years, a group of researchers through different mathematical models and also some exotic models have aimed at explaining the nature of Dark Matter [14-20]. This concept of strange Dark Matter is repeatedly also aimed at being mixed with the concept of a strange energy, such as the postulated Dark Energy, which supposedly accelerates the expansion of the universe [24, 25]. With respect to Dark Matter, there are various experiments around the world that are aimed at detecting that which has been postulated and also the origin of this dark and exotic influence. Some researchers note that, only the size of the mass for the supposed particles of dark matter has been delimited. The adopted motto seems to be “the absence of evidence is not evidence of absence”. Some researchers, who await the results of the experiments, affirm that if there are no positive results in detecting Dark Matter, we will have to look for alternative theories for this effect of the high speeds in the stellar and galactic dynamics [14, 15]. Countries such as the United States, Canada, Italy, Spain, the United Kingdom and China finance large underground facilities that are aimed at detecting the exotic particles of Dark Matter [16, 17, 20, 27-30].

Some researchers assume that the term of Dark Matter was used for the first time in the 1930s by Zwicky or in the 1970s by Rubin. However, the term of Dark Matter (matière obscure in French) was coined by Henri Poincaré (1854-1912) in 1906 in reference to the “dark stars” of the Milky Way as proposed by Lord Kelvin (1824-1907) in 1904. According to Kelvin, the stars of our galaxy (at that time, only a single was known) could be studied as a gas. The kinematic study of the speed of the gas would allow detecting the existence of “dark stars”, whose brightness would have been extinguished, making it impossible to detect them solely with the use of light. The interesting point about Kelvin’s idea in 1906 is that he proposed the method of detection of Dark Matter that is used today. Poincaré himself suggested exploring the idea of Kelvin with some galaxies (which at that time were called nebulae), such as Andromeda (M31), and galactic clusters (then called nebulae clusters), such as the Hercules cluster (M13) and the cluster of Hunting Dogs (M94). The idea of Kelvin was rediscovered around 1915 by Ernst Opik (1893-1985) and in 1922 by Jacobus Kapteyn (1851-1922). One of the students of Kapteyn, Jan Oort (1900-1992), undertook in 1932 the first cinematic analysis of stars close to the Sun to a search for “dark stars”.

Recapitulating:

- Given the impossibility of explaining the flat curves of speed in the dynamics of stars, clusters and galaxies, Zwicky and Rubin postulate the existence of an exotic Dark Matter [1-3, 10-12].
- More than 80 years have passed, and the proper way to explain what this strange Dark Matter is, rather than only from the gravitational effect, has not been found.
- Different methods to explain this Dark Matter have been proposed. Among many other entities, WIMP (weakly interacting massive) particles have been proposed. The Massive Astrophysical Compact Halo Objects (MACHOS), as a modification of both Newton’s law of gravity and Einstein’s theory of relativity, have been suggested [18-20, 27, 28]. Currently, a lack of explanation seems to be sufficient.
- Finally, in this theory of Dark Matter, it must be appreciated that there is something which contradicts part of the scientific methodology: To explain something you can, but should not, propose something inexplicable, for example, Dark Matter. The reason for this is that it generates a regression in the scientific activity: In such circumstances it is now necessary to explain, not only the original fact but, also what was originally proposed.
- On the other hand, in paraphrasing Lord Kelvin, if something cannot be measured, then it does not exist.

Finally, after this recapitulation we add the recent discovery of a galaxy that has been affirmed to contain practically no Dark Matter. Without a central dense region or with no spiral arms or disk, the newly discovered galaxy is called NGC1052-DF2 (DF2) [30]. Effectively, this complicates the panorama that includes this exotic influence. In fact, it takes us away from what was originally thought about what dark matter could be. Using the velocities measured for the stars, calculations were made of the mass of the galaxy and it was determined that the visible stars, gas and dust in DF2 accounted for most of the mass, and that there was only 1/400 of the amount of Dark Matter that there was or we could wait for the results of future research. Unlike elliptical galaxies, DF2 does not have a central black hole. In our conclusions at the end of this paper, we aim to provide an explanation for this phenomenon, which is a galaxy without Dark Matter.

In this work, from a physical point of view, we present a quantitative explanation, with a mathematical analysis, of the almost constant radial velocities of stars in galaxies and of galaxies in clusters. Without recourse to any postulate concerning exotic Dark Matter, we introduce concepts that involve the physical discretisation of the mass of the galaxy, Gauss’s Law, and concepts of electromagnetic theory, and we get a plausible description of why these speeds are apparently outside of the Newtonian model. With this explanation, we aim to put an end to the long speculation, which has been ongoing over a period of more than 80 years that has been held about the existence of the exotic Dark Matter of Zwicky and Rubin, among others [1-3, 10-17].

II. A PROBLEM FROM ELECTROMAGNETIC THEORY

Given the importance of the postulated concept of Dark Matter, and its elevation among other theories of cosmology such as the Big Bang, the theory of the early inflation of the universe and the formation of structures in the cosmos, it is considered necessary to initiate the analysis by providing a basic review of a particular problem [15, 19, 32]. This problem will be the generator of the mere principle that will be used to explain this postulate, longstanding for 80 years as aforementioned, on that strange substance called Dark Matter that supposedly explains the "anomalous" rotation of stars and galaxies.

An example, related to an electric charge distribution in the Electromagnetic Theory, will be very useful to explain the problem of dark matter in cosmology [33]. In most textbooks, the mathematical analysis for the potential and electric field of a spherical charge distribution is treated with insufficiency, and ultimately appears to be inconclusive [33]. It is a fact that in the academic formation for the students of physics, in the study programmes, there is a subject included that is known as Electromagnetic Theory [33]. But, the counterpart that could be called Gravitational Theory is almost never outlined. This is why we propose to start the analysis with a problem that could be more familiar, academically, in order to aim at better understanding the enigma of this strange Dark Matter.

To our knowledge, this is a problem that may have been overlooked [33]. An electric charge distribution in a non-conductive medium, with a density ρ (r) which, in the general case, varies only with the distance to the centre of the distribution, is studied. Due to its importance in the explanation of what has been called Dark Matter, the details are fully explained below. Later, it will be applied to the system of stars that constitutes a galaxy.

Here, we shall see the problem of calculating the electric field within a sphere with volume of radius R of a non-conductive material with a spherical distribution of total charge q, see Figure 1. The description is presented in spherical coordinates (r, θ, φ) that are centred at the origin of the coordinates. By definition:

$$q = \int_0^{\pi}\int_0^{2\pi}\int_0^{R} \rho(r)\, dv \quad (1)$$

and

$$q_r = \int_0^{\pi}\int_0^{2\pi}\int_0^{r} \rho(r)\, dv \quad (2)$$

where q_r is the charge contained within the sphere of radio r.

In this case, Gauss's Law for this problem of electrodynamics is written as [34]:

$$\varepsilon \oint \mathbf{E}_r \cdot \boldsymbol{da} = \int_0^{\pi}\int_0^{2\pi}\int_0^{r} \rho(r)\, dv \quad (3)$$

where vectors are written in bold, $\mathbf{E}_r$ represents the electric field at a distance r from the centre, within the distribution of electric charge. The expression $\boldsymbol{da}$ represents a vector directed outwards from the distribution, perpendicular to the surface $S_r = 4\pi r^2$.

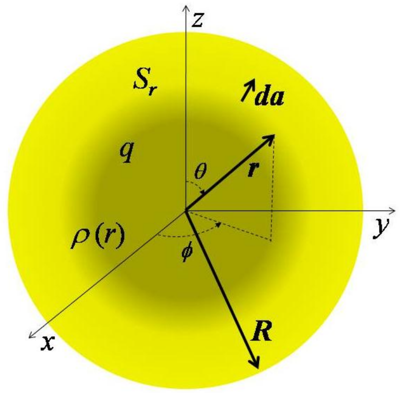

Figure 1. Non-conductive material with a spherical distribution of electric charge with density ρ (r). The electric field is calculated using Gauss's law at the distance r from the centre of the distribution. The vectors are shown in bold.

By integrating on the surface S_r the field $\mathbf{E}_r$ remains constant. Substituting

$$E_r\, 4\pi\, \varepsilon\, r^2 = \int_0^{\pi}\int_0^{2\pi}\int_0^{r} \rho(r)\, dv = q_r \quad (4)$$

from here

$$E_r = \left(\int_0^{r} \rho(r) 4\pi\, r^2\, dr\right) / (4\pi\, \varepsilon\, r^2) \quad (5)$$

In the best-known textbooks on electromagnetic theory, it is proposed that $\rho(r) = cte$. Therefore, the charge q_r inside the sphere of radio r is written as

$$q_r = \rho V_r = \rho 4\pi r^3/3 \quad (6)$$

Finally in those texts with $\rho(r) = cte$ it is found that the electric field of the expression (5), within the charge distribution, varies accordingly with r as:

$$E \propto r \quad (7)$$

It should be noted that this field does not obey the expression that is traditionally known for Coulomb's law. The commonly-known electric field is expressed as

$$E_r = q/(4\pi\varepsilon r^2) \quad (8)$$

This expression is valid, in the previous calculation, for points outside the charge distribution $r > R$.

One can also see, as another example, that if one has a charge density $\rho(r) \propto 1/r$, then the electric field within the charge distribution in expression (5) turns out to be

$$E_r = const. \quad (9)$$

Whether or not there is variation with the coordinate r of the field, equations (7) and (9) will change. They will be different expressions according to the dependency that has $\rho(r)$ of the variable r. In this way, one can treat countless examples for different forms of density $\rho(r)$.

To apply these ideas of the Electromagnetic Theory to the gravitational field, it is required that in equation (8) the substitution $q_r\,(4\pi\varepsilon)\rightarrow GM_r$ is made; where G is the gravitation constant, and M_r represents the mass contained within the sphere of radius r which produces the gravitational field g_r.

III. ABSENCE OF DARK MATTER IN THE SOLAR SYSTEM

Before going directly to the solution of the problem of Dark Matter, we present a brief essay on the solar system. We aim to answer the question: Why do we not have detectable dark matter in the solar system [35]? As will be seen, with respect to Dark Matter, the most important difference between a solar system and a galaxy is that the mass of the sun is concentrated in a relatively small volume, compared to the total volume of the entire solar system. Another important difference that is noteworthy is that, as will be shown, the star rotation speeds depend heavily on the form of discretisation of the mass of the galaxy and, of course, on the clusters.

According to the Newtonian mechanics, the Universal Law of the Gravitation gives the force on each one of the bodies of the solar system, that is to say, for each one of the radii of the orbits of the planets of the Solar System, the force is

$$F_r = GM_s m/r^2 \tag{10}$$

This constitutes Newton's law of universal gravity which represents the force of gravity produced by the mass M_s (mass of the sun) on another mass m (mass of the planet), located at a distance r. This mathematical expression is valid when the main mass is concentrated, in this case in the centre of the distribution. Then, it can be assumed that $M_s = const.$, that is, independent of r. When this is not the case, the expression can be very different. For each planet, equation (10) is equated with the so-called centrifugal force

$$GM_s m/r^2 = mv^2/r \tag{11}$$

From this expression we have that the speed varies as the inverse of the square root of r:

$$M_s G = v^2 r \tag{12}$$

Rubin, in her 2006 article (p. 9), literally notes: In M31 (Andromeda), the same relationship between mass, velocity and distance is valid (expression (12)) [36]. Unfortunately, this same expression (12) is not valid for stars in galaxies, as Rubin states, and this is clarified later in this paper.

As a conclusion to this part, the speed with which a planet moves around the sun only depends on the mass of the sun and the distance between the planet and the sun, see expression (12).

Why is there no detectable Dark Matter in the solar system? [35]. The answer to this question is: "the astronomical measurements on each of the planets agree with the prediction of the velocity curve of equation (12). Therefore, even including the dynamics of the elements of the Solar System in the calculations, the velocities for each of the planets, without important variations, is the expression (12)". The speed of the earth around the sun of $30\ km/s$ is correlative with, using the expression (12), the sun mass of $2x10^{30}kg$ for an approximate radius of Earth's orbit of $1.5x10^{11}m$. And so on, for each of the planets.

Definitely, in the Solar System the Newtonian dynamics are adjusted to the measurements, and it has not been necessary to introduce that postulate regarding the exotic Dark Matter.

As will be seen in later sections, this conclusion is mainly due to the concentration in the sun of the most important mass, in this example, of the Solar System.

In a galaxy, due to the discretisation of the total mass with a determined distribution $\rho(r)$ of the stars, this result that is expressed in equation (12) will be different.

IV. A SPHERICAL GALAXY WITH STAR DENSITY $\rho(r)$

To apply these ideas and to simplify calculations in galaxies, it will be assumed that they are spherical mass distributions, although many galaxies have shapes that tend to form a disk, bulging towards the centre of the distribution. An important point in this analysis is that: A good number of galaxies are spiral galaxies like the Milky Way. In the beginning, the formation of a galaxy has a gigantic mass of mainly gas hydrogen, and in many cases, approximately, a volume of spherical shape. Due to Newtonian dynamics, the initial gravitational potential energy, which tends to become kinetic energy with respect to the gravitational pull, acts in such a way that it is less difficult for it to collapse in the direction parallel to the axis of the total kinetic moment of the original mass of hydrogen gas without changing the value of the kinetic moment. This has consequences. Due to this situation, many galaxies tend to have the shape of a disk, and they are crushed, as is the case with Andromeda and our Milky Way.

In galaxies, unlike the Solar System, the mass is spread and discretised, with a characteristic distribution throughout the galaxy's volume, that is, with a distribution of mass characterised by a discontinued density which, in general, is much more complex than a density function $\rho(r)$ with radial dependence only, see Figure 2. However, in the present study, a continue density with only radial dependence is considered. It will be shown that the spread and the distribution of the mass are of utmost importance for the final result. To begin with, we would need to consider a discretisation of the mass of the galaxy, with a distribution such as that used in the Electromagnetic Theory problem.

Each element of the galaxy, any star, is within the mass distribution. The gravitational field, and in particular the force, within a mass distribution, has a different expression to the expression that appears in equation (10). When trying to answer the question of "How much does a galaxy weigh?", until now, to our knowledge, the astronomers made a mistake in the calculations. Indeed, the calculus made by Rubin, using expression (12), is not the correct calculus [36-38]. In what follows is how a galaxy should be weighed and why this methodology should be used:

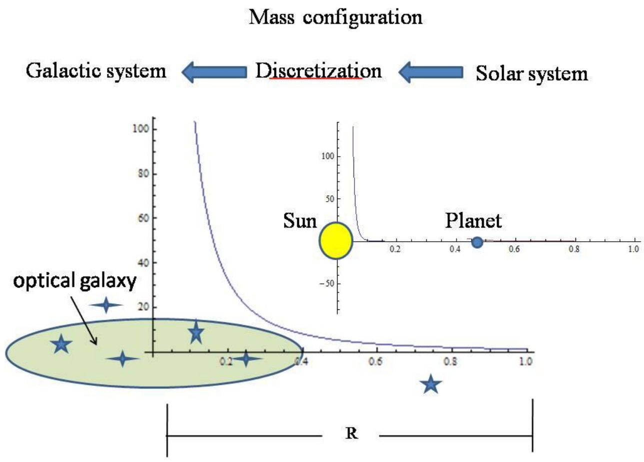

Figure 2. Discretisation of the mass. An extremely important difference between a solar system and a galaxy is that in the galaxy the mass occupies practically all of the volume, unlike in the solar system. In the solar system, if the mass is discretised artificially in a particular way there would also be a constant planet velocity curve.

Considering spherical symmetry, to obtain the expression of the field and the gravitational force within the mass distribution, the analogous equation to equation (2) for any r now is:

$$M_r = \int_0^{\pi}\int_0^{2\pi}\int_0^{r}\rho(r)\,dv = \int_0^{r}\rho(r)\,4\pi\,r^2\,dr \quad (13)$$

Using Gaussian Law again [34], as previously stated, in changing $q_r/(4\pi\,\varepsilon)\rightarrow GM_r$, where M_r represents the mass inside the sphere of radio r, one can get the analogous equation to equation (5), that is now written as

$$g_r = G\left(\int_0^{r}\rho(r)4\pi\,r^2\,dr\right)/r^2 = GM_r/r^2 \quad (14)$$

Therefore, the gravitational field at a distance $r < R$ of the centre of the mass distribution has a strong dependence on how the density function $\rho(r)$ varies.

A. Example 1

It can be see that with a density distribution that has the form

$$\rho(r) = \kappa/r \quad (15)$$

with κ being a constant, from equation (13) it turns out that

$$\left(\int_0^{r}\rho(r)4\pi\,r^2\,dr\right) = M_r = 2\pi\,\kappa r^2 \quad (16)$$

The gravitational field, equation (14) within the distribution, is now

$$g_r = 2\pi\kappa G = \text{const.} \quad (17)$$

With this expression for the gravitational field within the mass distribution for a galaxy, with a density varying as with expression (15), equation (11) is written as:

$$GM_r m/r^2 = 2\pi\,\kappa Gm = mv^2/r \quad (18)$$

From this, the expression for the velocity of the stars in a galaxy, which has the density that has been proposed in equation (15), turns out to be

$$v = \sqrt{2\pi\kappa G\,r} \quad (19)$$

That is, the speed will be greater as we move away from the centre of the galaxy

$$v \propto \sqrt{r} \quad (20)$$

It is very likely that if one searches for this type of galaxy, one can find some galaxy whose speed increases more or less in this way, and whose density will have approximately the variation that is proposed in equation (15).

B. Example 2

Among many other cases, an interesting case that can be treated, is one with a mass distribution that varies as

$$\rho(r) = \kappa/r^2 \quad (21)$$

With this distribution of mass density in a galaxy such as Andromeda, but with more spherical symmetry, equation (16) now indicates that the mass within the sphere of radius r increases with r

$$\left(\int_0^{r}\rho(r)4\pi\,r^2\,dr\right) = M_r = 2\,\pi\,\kappa\,r \quad (22)$$

With this expression, equation (17) is now rewritten as

$$g_r = 2\pi\kappa G\,/r \quad (23)$$

The gravitational field within the mass distribution for a galaxy, with mass density varying as per expression (21), gives us the gravitational force that equates with the centrifugal force, and equation (18) is written as

$$GM_r m/r^2 = 2\pi\,\kappa G\,m\,/r = mv^2/r \quad (24)$$

The speed for each star within the distribution then remains, as in Figure 3

$$v = \sqrt{2\pi\kappa G} = constant \quad (25)$$

In astronomical calculations, the approximations are usually very large. Also, in the velocity measurements for the stars the radial curve is not so constant. This could be a consequence of the incorporation of two factors that are great approximations to reality: a) it is considered to be a spherical galaxy, b) the density of stars within the galaxy does not coincide with the real density, as described here, with the density distribution $\rho(r)$ in equation (21).

With these calculations, and given the proposed approaches, an account of the "anomalous" speeds that have been measured can be given, for the most part.

The mass of the Milky Way can be estimated from equation (22) with $r = R$, taking into account the constant measured velocity for the star rotation equation (25).

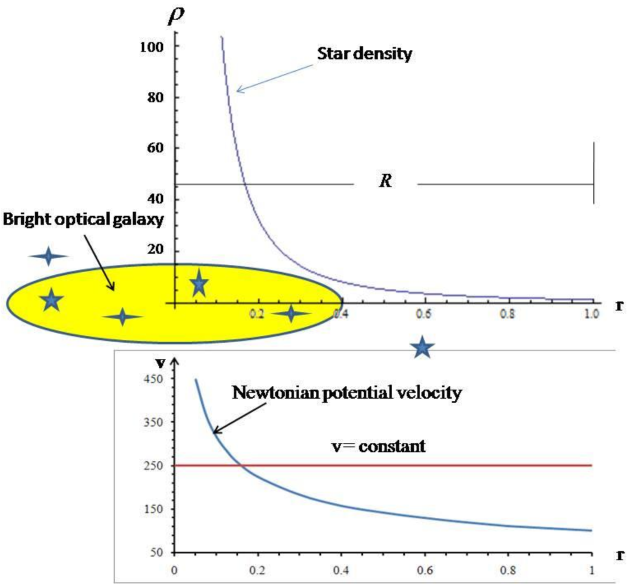

Figure 3. The density of the Milky Way or the Andromeda galaxy can be approximated by the density curve of stars in a galaxy of a spherical type. In the upper part of the figure, this type of $\rho(r) \propto 1/r^2$ is shown. In the lower part of the figure, the constant speed is shown in comparison with the speed resulting from the traditional Newtonian potential.

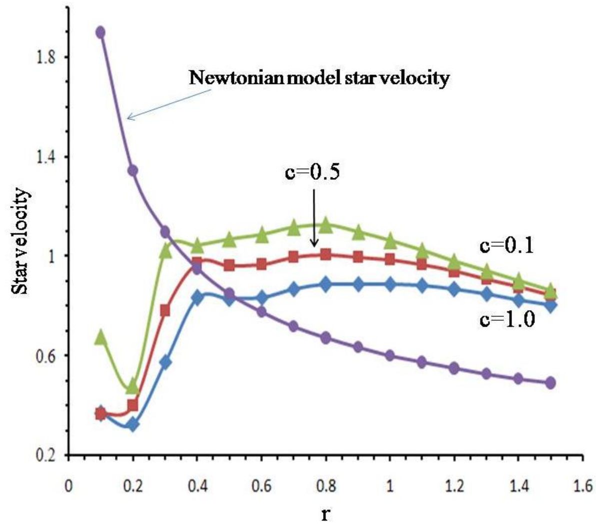

Figure 4. The velocity profiles, numerically obtained along a radius, for a discrete spheroidal distribution of particles, are shown. The spheroids consist of 79 particles located in three layers of radii 1/3, 2/3 and 1.0 on a normalised scale, and whose vertical semi-axis is c = 1.0, c = 0.5 and c = 0.1, respectively. In contrast to the velocity distribution for the Newtonian model, it is observed that the velocity profiles maintain a near-constant profile for r> 0.4, speeds that are similar to those in the work of Rubin.

C. Numerical Calculation

The numerical calculation corroborates, within the proposed approaches, that the analysis performed is correct. Using Newton's expression for the gravitational field for each of the 79 stars (a number that is arbitrarily chosen) that were simulated, the field values being added vectorially, and from there it was obtained that $g_r = GM_r/r^2$, with M_r being the mass contained within the sphere of radius r.

The 79 stars were distributed approximately as a discrete $\rho(r) = \kappa/r^2$ density. In the numerical code, the gravitational and centrifugal forces were equalised:

$$g_r m = GM_r m/r^2 = mv^2/r \qquad (26)$$

where m is the mass of one of the n stars that were simulated.

From equation (26), the velocity curves are obtained, with M_r mass being evaluated at the r distance, which is plotted in Figure 4.

Figure 5 shows two curves for different spheroidal distributions of the stellar mass, and are compared to the curve of a continuous mass distribution that is proportional to $1/r^2$.

Finally, with this second example, we use Gaussian Law [34] and Newtonian dynamics to calculate the field or potential inside a discretised mass distribution. This is unlike the Solar System, where the mass is concentrated in a small volume. Instead, for a galaxy, the mechanics approximately coincides with the measurements of the constant speed of the stars, as obtained by Rubin and others, without the need to propose some hypothesis such as the strange Dark Matter, that to date cannot be found.

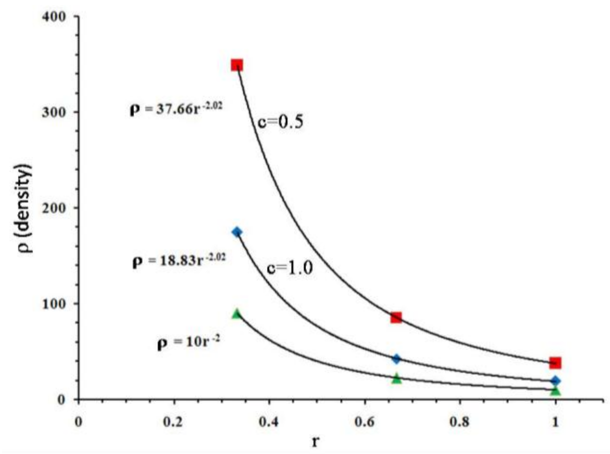

Figure 5. The variation of the particle density $\rho = 3\,n/4\,\pi\,r^3$ along r, is shown for spheroidal distributions with c=1.0 and c=0.5. The curve of a functional relation proportional to $1/r^2$ is also shown. An equivalent functional relationship is observed for each of the distributions shown, with c=1.0 and c=0.5.

V. COMMENTS AND CONCLUSIONS

In the case of Dark Matter in the Solar System, until now no influence, of what was proposed as strange matter, has been found. In this case, one can see that the gravitational field varies as the inverse of the squared radius. This makes the experimentally obtained velocities of the planets fulfil the predictions of Newtonian mechanics for the expression of the gravitational field. The result of the measurement has the predicted effect and it is not necessary to postulate the existence of that exotic substance, Dark Matter.

In a galaxy, on the other hand, the discretisation of the mass in a volume that exceeds the galaxy's brightness, considering a spherical volume occupied by this mass and also a density that varies as the inverse of the radius squared, the calculated values of the speeds along the radius fulfil the measurements in an almost constant manner. With the approximations that have been proposed, particularly in the second example, regarding the spherical shape of the galaxy and the distribution of mass density, the problem of more or less constant speed along the radius can be explained for several galaxies and several stars. The same can be applied to galaxy clusters, in an analogous way.

It is possible that it can be galaxies with the star density given in the first example. There, Newton's mechanics, inside the distribution, predicts that the radial velocity of the stars could increase towards the periphery as $\sqrt{r}$. There are probabilities that in looking for these types of galaxies, one could find some galaxies with these characteristics.

To cite a fact that deviates from the predictions that were made in previous research, recently, astronomers have found a NGC1052-DF2 galaxy that allegedly does not contain as much dark matter as would be expected, according to the Newtonian potential. This fact contradicts what had previously been proposed for this strange matter in the early formation of the universe. More data should be obtained about the behaviour of the stars in this galaxy, in order to achieve an explanation that is consistent with what was analysed in the present work. Also, future research is needed to explain the little presence $\left({}^{1}/_{400}\right)$ of dark matter in NGC1052-DF2. The density of this galaxy is extremely low and almost constant, to the extent that other galaxies can be viewed through it, the extent that the mass M_r could be considered as a constant or as extremely small. The measured velocities comply with the Newtonian prediction, only when the expression used for the gravitational field is valid outside the mass distribution, where M_r remains constant. It seems that this was the mistake that was made, when the value for the galactic mass was calculated. When the totality of the mass is constant, the mathematical expression for the gravitational field is equivalent to the traditional law of universal gravitation.

With this analysis and the calculations that were made, we must reconsider, among other things, the division that is made of the mass in the universe, that is often noted as being Dark Matter making up approximately 25% of the total mass of the universe. Only about 5% is considered to be a common, baryonic mass. After this analysis in this work, we must think about the configuration of the different masses that make up the matter in the universe.

Finally, with the arguments that are presented, and the mathematical analysis that has been undertaken, in this work, it can be said that the introduction of the so-called exotic Dark Matter is no longer necessary. Instead, the pure analysis of Gaussian Law, as applied to the discretisation of the mass of the galaxy with a density of stars, such as described in the second example, is sufficient. This explains, to a large extent, the fact that researchers have tried to find the strange particles that would make up the so-called Dark Matter, but without any success. To our knowledge, the involvement of this strange matter turns out to be an unsuccessful postulate of the scientific method that in some of its sections could prohibit "trying to explain something by introducing something inexplicable".

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