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Newtonian Field Interaction Hypothesis and Equilibrium Potential Theory

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Abstract

Despite all the theories on gravity of the last few decades, in this article, we start from those of which we are certain because, as far as we know, celestial bodies, with the presence of negligible relativistic phenomena at small speeds and large distances, essentially obey Newtonian gravity; therefore, the gravitational phenomena we observe in the space around us should be able to be explained by Newtonian physics, even if viewed differently in this article. It all starts from a consideration: since Newtonian gravity is given by a very small perturbation of the temporal component of the Minkowski metric, from the gravitational superposition principle, where independent forces are added, it would mean having independent time metric perturbations simultaneously at the same point of spacetime where a test mass is located, which seems inconceivable. On the other hand, assuming the formation of a single perturbation with interaction between Newtonian fields, through the interpretation of an experiment carried out with a rudimentary gravitational torsion balance (static deflection method) between 2 masses under the influence of another mass (the simplest case), a different value of the active gravitational mass of the same object is generated if not all the masses involved are known, perceived by such an observer as a change in force. If we then imagine measuring the Newtonian gravitational constant G without taking this into account, we can mistakenly arrive at a variation of it, therefore presupposing that its value can be influenced by the Earth itself via the same mechanism proposed in the experiment. Here we chose to use the "old" Newtonian forces to better describe the concept of gravitational mass and gravitational potential, understanding that the gravitational superposition effect may not be a sum of independent forces but rather their sum in a single force, which is different in every point of the created superposition that we exclusively attribute to the observed object. By transferring this interaction effect to the potential of the stars in our galaxy, we obtain a strange result: a net zero potential of the galactic plane, which could help explain some phenomena around us. This theory cannot be considered a new theory of gravitation but rather a different vision of the Newtonian one only that its manifestation is hidden from us by the constant superposition we undergo on Earth.

Keywords

Dark Matter

1. Introduction

In a very small, suitably sealed environment, a rudimentary torsion balance is placed on a firm, suitably oiled surface, isolated from vibrations by spongy material.

Space is left underneath for larger masses also isolated to avoid vibrations as much as possible.

The balance has a 60 cm bar with two small 14 g steel balls (m) of 14 mm in diameter hanging with a 1 mm polyester thread and is balanced with two 260 g iron balls (M) of 4 cm in diameter resting on two movable metal bars which allow their approach toward m until reaching, after a few hours, a desired equilibrium that keeps M and m separated by 3 - 4 millimeters.

Once equilibrium has been reached, 2 other iron masses ($M1$) of 7 kg with diameter of 12 cm are placed very carefully approximately 0.5 cm below the 2 masses M, and after a few minutes, a new equilibrium is reached with M and m touching each other (to view it, see the bottom of the article).

We can approach this experiment, represented in **Figure 1**, sowing to the gravitational superposition principle, in which the forces FMm and $FM1m$ act independently and can be divided into a horizontal component Fx and a vertical component Fy.

$Fx = FMm + FM1m\cos\theta$; instead, $Fy = 0$ because the vertical FMm is 0 ($\sin 0^\circ = 0$), whereas that of $FM1m$ is neutralized by the balance.

By directly measuring distances and angles, we have 3 cm between the center of M and m, and 9 cm between $M1$ and m with an angle between m, $M1$ and the horizontal plane of 70˚ (whose cos is 0.34), thus obtaining a total force (Ft) acting on m (G is considered $6.67 \times 10^{-11}\ \text{m}^3\cdot\text{kg}^{-1}\cdot\text{s}^{-2}$):

$$\begin{aligned} Ft &= FMm + FM1m\cos\theta \\ &= G\times 0.26\ \text{kg}\times 0.014\ \text{kg}/9\times10^{-4}\ \text{m}^2 + G\times 7\ \text{kg}\times 0.014\ \text{kg}/8.1\times10^{-3}\ \text{m}^2\times 0.34 \\ &= 2.69\times10^{-10}\ \text{N} + 2.74\times10^{-10}\ \text{N} \\ &= 5.43\times10^{-10}\ \text{N}. \end{aligned}$$

We can also approach this issue another way, through the sum of potentials (V) to which m is subjected, hypothesizing the sum of VM and $VM1$ with a certain angle (therefore proportional to $\cos\varphi$), to which adds the effect of the balance that shows us this only "horizontally" (therefore proportional to the $\cos\theta$). This gives an effect that we observe as a greater gravitational force existing between M and m, calculable at any distance from M as deriving from a new VM, which can be called VM' therefore equivalent to:

$VM' = VM + VM1\cos\varphi \times \cos\theta$, and since the angles φ and θ are congruent with each other, we can rewrite it as: $VM' = VM + VM1\cos^2\theta$.

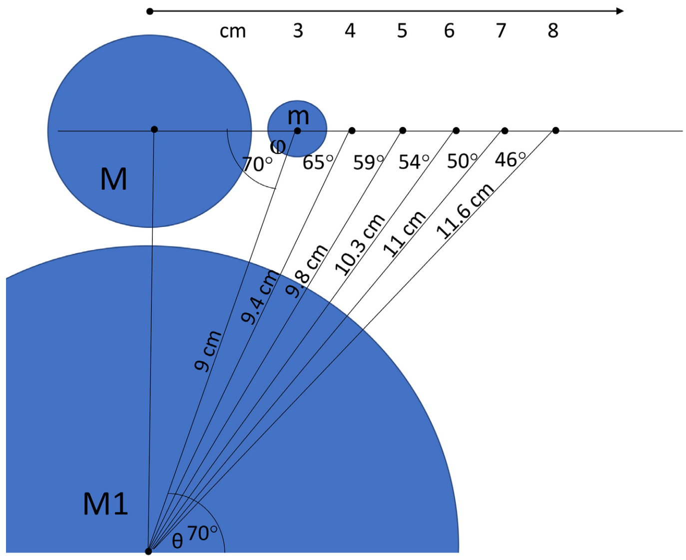


Figure 1. Representation of the various conditions assumed by varying the distance of m with $M1$ below.

We can explain it even better by seeing it in reverse, that is, considering the presence of $M1$ and m first and M added later. In fact, if we bring $M1$ close to m, the balance forces us to see only the "horizontal" $VM1$ generating $FM1m$ with m, which depends on the angle θ. If we then place M above $M1$ assuming that their Vs are added, according to the angle φ that they form in the position where m is located, a new V is created such that its value is equal to that found in the Newtonian field at distance R from M', which we all know is characterized by the V/R gradient, which makes the $FM'm$ force appear as the only force, as we apparently see in the experiment.

In real dimensions, it is possible to calculate the force acting on m through the sum of single forces or through the aforementioned formula both for the situation of the experiment and for successive ones with m assumed, for example, at 1 cm distance intervals.

We already knew the total force acting on m in the experimental situation: **5.43 × 10^{-10} N**.

Knowing that VM at 3 cm is -5.78×10^{-10} m^2·s^{-2} and $VM1$ at 9 cm is -5.19×10^{-9} m^2·s^{-2} with $\cos^2 70^\circ = 0.115$, we have:

$$\begin{aligned} VM' &= VM + VM1\cos^2\theta \\ &= -5.78\times10^{-10}\ \mathrm{m}^2\cdot\mathrm{s}^{-2} - 5.19\times10^{-9}\ \mathrm{m}^2\cdot\mathrm{s}^{-2}\times0.115 \\ &= -1.17\times10^{-9}\ \mathrm{m}^2\cdot\mathrm{s}^{-2} \end{aligned}$$

By attributing this V to a radius (R) of the M' field and Knowing that the acceleration (Ac) in this field is the gradient of its V (V/R), at that point (3 cm from M') we obtain the same total force acting on m that we observe:

$-1.17\times10^{-9}\ \text{m}^2\cdot\text{s}^{-2}/0.03\ \text{m} = -3.90\times10^{-8}\ \text{m}\cdot\text{s}^{-2}$; this acceleration gives a force with m:

$3.90\times10^{-8}\ \text{m}\cdot\text{s}^{-2}\times0.014\ \text{kg} = 5.46\times10^{-10}\ \text{N}$ (the same value obtained with the classic method).

Similarly, for the other situations described in **Figure 1**, the forces obtained in the two ways continue to coincide; therefore, the superposition principle can be seen not only as the sum of independent forces derived from independent Vs but also as the result of their additive interaction, which locally gives rise to a new V that can be attributed to the observed object if the contributions of the other objects are ignored.

Let us now look at other situations of the experiment with m assumed, for example, at 4 and 5 cm from M, remembering that M here stands for active gravitational mass (Ma), to analyze them more thoroughly.

EXAMPLE WITH m 4 CM FROM M

Distances (meters): M-m: 0.04 m $M1$-m: 0.094 m

Angle ($\theta=\varphi$): 65

Masses: $M1$: 7 kg M: 0.26 kg m: 0.014 kg

TOTAL FORCE EXPERIENCED BY m FOUND WITH THE CLASSIC METHOD.

$$FMm = (G\times0.26\times0.014)/(0.04)^2 = 1.51\times10^{-10}\ \text{N}$$

$$FM1m = (G\times7\times0.014)/(0.094)^2 = 7.40\times10^{-10}\ \text{N}$$

The balance shows us only the "horizontal" component of $FM1m$ so:

$$7.40\times10^{-10}\times\cos65^\circ = 3.12\times10^{-10}\ \text{N}$$

$$Ftot = FMm + FM1m\cos\theta = 1.51\times10^{-10}\ \text{N} + 3.12\times10^{-10}\ \text{N} = 4.63\times10^{-10}\ \text{N}$$

ALTERNATIVE METHOD.

$$V \text{ of } M1 \text{ at } 9.4\ \text{cm} = -GM1/r = -G\times7/0.094 = -4.96\times10^{-9}\ \text{m}^2\cdot\text{s}^{-2}$$

The balance shows us only the "horizontal" component of this V that creates the force with m:

$$-4.96\times10^{-9}\times\cos65^\circ = -2.09\times10^{-9}\ \text{m}^2\cdot\text{s}^{-2}$$

This V will be added to the potential of M (VM) according to the angle φ that it forms with it in that point:

$$-2.09\times10^{-9}\ \text{m}^2\cdot\text{s}^{-2}\times\cos65^\circ = -8.85\times10^{-10}\ \text{m}^2\cdot\text{s}^{-2}$$

$$\text{Instead, } VM \text{ at } 4\ \text{cm} = -GM/R = -G\times0.26/0.04 = -4.33\times10^{-10}\ \text{m}^2\cdot\text{s}^{-2}$$

So what we see, due to the balance and the V interaction effect, is a new V that we apparently can only attribute to M, or better to M', and which we can rewrite as:

$$VM' = VM + VM1\cos^2\theta = -4.33\times10^{-10} - 8.85\times10^{-10} = -1.32\times10^{-9}\ \text{m}^2\cdot\text{s}^{-2}$$

Assuming, as mentioned before, that the Ac we see derives from the M' field having a V/R gradient, this means that at that distance from M (4 cm) we have:

$$-1.32\times10^{-9}\ \mathrm{m}^2\cdot\mathrm{s}^{-2}/0.04\ \mathrm{m}=-3.30\times10^{-8}\ \mathrm{m}\cdot\mathrm{s}^{-2}$$

Therefore the force exerted on m that we see is:

$$3.30\times10^{-8}\ \mathrm{m}\cdot\mathrm{s}^{-2}\times0.014\ \mathrm{kg}=4.62\times10^{-10}\ \mathrm{N}$$

EXAMPLE WITH m 5 CM FROM M

Distances (meters): M-m: 0.05 m $M1$-m: 0.098 m

Angle ($\theta=\varphi$): 59˚

Masses: $M1$: 7 kg M: 0.26 kg m: 0.014 kg

TOTAL FORCE WITH THE CLASSIC METHOD

$$FMm=(G\times0.26\times0.014)/(0.05)^2=9.71\times10^{-11}\ \mathrm{N}$$

$$FM1m=(G\times7\times0.014)/(0.098)^2=7.40\times10^{-10}\ \mathrm{N}$$

$$FM1m\cos\theta=7.40\times10^{-10}\times\cos59^\circ=3.50\times10^{-10}\ \mathrm{N}$$

$$Ftot=FMm+FM1m\cos\theta=9.71\times10^{-11}+3.50\times10^{-10}=4.47\times10^{-10}\ \mathrm{N}$$

ALTERNATIVE METHOD

$$VM\ \text{at 5 cm}=-G\times0.26/0.05=-3.46\times10^{-10}\ \mathrm{m}^2\cdot\mathrm{s}^{-2}$$

$$VM1\ \text{at 9.8 cm}=-G\times7/0.098=-4.76\times10^{-9}\ \mathrm{m}^2\cdot\mathrm{s}^{-2}$$

$$\begin{aligned}VM'&=VM+VM1\cos^2\theta=-3.46\times10^{-10}-4.76\times10^{-9}\cos^2 59^\circ\\&=-1.60\times10^{-9}\ \mathrm{m}^2\cdot\mathrm{s}^{-2}\end{aligned}$$

$$1.60\times10^{-9}/0.05\times0.014=4.48\times10^{-10}\ \mathrm{N}$$

Examples of Active Gravitational Mass Changes

Let us take the same examples and observe the same force experienced by m from another point of view.

Let us imagine that observer A is in front of a sheet that covers $M1$, which therefore allows only M and m to be seen, whereas observer B is behind it and can see all the masses involved.

Let us now consider the situation in which M and m are 4 cm apart.

For B:

$Ftot=FMm+FM1m\cos\theta=4.63\times10^{-10}\ \mathrm{N}$ and $M=0.26\ \mathrm{kg}$.

For A, who ignores the presence of $M1$, m will experience the same force but that he has judged generated only by M, which becomes M' for him: $F=GM'm/R^2$ with M' becoming:

$$M'=FR^2/Gm=4.63\times10^{-10}\times(0.04)^2/G\times0.014=0.79\ \mathrm{kg}$$

Equally let us consider the situation in which M and m are 5 cm apart.

For B:

$$Ftot=FMm+FM1m\cos\theta=4.47\times10^{-10}\ \mathrm{N}$$

with M always 0.26 kg.

For A:

$$M' = FR^2/Gm = 4.47 \times 10^{-10} \times (0.05)^2/G \times 0.014 = 1.2 \text{ kg}$$

M (or rather Ma) has changed because, in the points where m was located, the superposition between the gravitational fields of $M1$ and M has changed and therefore the resulting field that we can attribute to M'. To avoid any misunderstanding, it is important to point out that the mass obviously remains the same but the gravitational effect around it changes due to the interaction with the other field. In fact, the Ma of an object depends on the gravitational Ac that it creates at a certain distance ($Ac = GMa/R^2$ therefore $Ma = AcR^2/G$), whereby attributing different accelerations to the same object at a fixed R we can attribute a different Ma to it. We do not experience this phenomenon on Earth because we undergo the same terrestrial superposition, which makes us perceive only one value of Ma.

However, let us now move on to what observer A would actually see in the experiment:

We must remember that the distance at which m is from M is determined by the Ac it experiences, and if we attribute the Ac resulting from the $M1$-M interaction solely to M', we can justify it by the presence of a different force between M and m, because the new distance they acquire does not allow us to conceive a variation of M. In the experiment, always different superpositions are created at each radius of the M field, but in nature, as with celestial bodies at large distances, this should not exist (M would orbit around $M1$), allowing M to have a constant gravitational superposition of its field which allows to respect the gradient that characterizes it as we usually know it (V/R). But a variation of V over its entire field would still cause the position of an object m to vary, which we cannot conceive as a variation of M but as a variation of force due to the position that m acquires.

For example: suppose we have m (0.014 kg) 5 cm from M (0.26 kg) where it experiences an Ac of 6.93×10^{-9} m·s^{-2} in a field where it presents a gravitational superposition of 1×10^{-9} m·s^{-2}.

The resulting Ac that m would undergo would be 7.93×10^{-9} m·s^{-2} and this means that for an observer A that Ac would be developed exclusively by M', acquiring for him the value of 0.297 kg (considering this Ac created 5 cm from its center), which develops a force with m at that distance of 1.10×10^{-10} N.

But if we consider the first equilibrium achieved, what he would actually observe when moving to the second equilibrium with the superposition created, would be a shift of m still considering M 0.26 kg and not a variation in Ma. We can calculate at what distance we will obtain the same force with M still 0.26 kg: $R^2 = G \times 0.26 \text{ kg} \times 0.014 \text{ kg}/1.10 \times 10^{-10} \text{ N}$, obtaining 4.69 cm.

If we calculate the Ac that M of 0.26 kg develops at 4.69 cm from its center, we obtain the previous value of 7.93×10^{-9} m·s^{-2}, created with the superposition 5 cm from it, which means that 4.69 cm would be the new distance from M that m would acquire in the second equilibrium with the same force.

Therefore, if we attribute the existing *Ac* created with the superposition to the same *M* with *m* changing its distance, there is no need to hypothesize a variation of *Ma*, since seeing a force between M' and *m* at a fixed distance or between *M* with a variable distance of *m* is a different way of looking at the same force. This could create a problem (as we will see later) when we measure the Newtonian gravitational constant *G*, since it is influenced by the *Ac* created by *Ma* at a fixed distance and not by the position of the objects that they acquire because of it, *i.e.* by a force.

So what we can see around us, considering only two observed objects *M* and *m*, exactly like the observer A, is a change in force between them but in reality due to a variation of the *M* field caused by the interaction with other fields not considered. Among celestial bodies, this would mean that every external contribution in *Ac* can be evaluated as belonging to the observed system without perceiving a variation of *Ma* (or rather of *GMa*) but rather of force between them (note that this happens to *FMm* as well as to -*FmM*).

For example: if the Moon was farther away and slower or faster and closer, Earth's *GMa* would always be the same. It is like deciding whether to consider a different *Ac* at a changing *R* with the same *Ma* or a different Ac at a fixed *R* with a changing *Ma*, and among celestial bodies, we observe only the first of these two possibilities. With this mechanism between masses, an increase in *V* would be created between them which we will not be able to observe directly unless judging a greater force; in this case, it is like seeing multiple Earth-Moon systems with the Moon moving faster and closer to the Earth in each system, but for us, who do not have such a reference, it is impossible to notice it.

We know that the first reaction to all this is: impossible, we know by principle and experimentally verified that Newtonian fields do not interact. In fact, if in the experiment we bring *M* close to *m* horizontally, and after *M*1 is located vertically below *M*, we can experimentally judge that the force *FMm* is not influenced by *M*1, which adds an independent force giving the expected result, *i.e.*, *FMm* will be independent of *FM*1*m*. However, if experimentally one deduces from the results that the forces do not interact, then here too we can provocatively say that they interact on the basis of the results. The force obtained is the same, its attribution is what changes. Who can say, on the basis of calculations alone, what is the true mechanism?

We know that Newtonian gravitation represents that given by General Relativity in certain conditions more common to us, and starting from the geodesic equation, applying the limits that we experience as speeds much lower than that of light ($v \ll c$), with gravitational fields stable over time ($\partial g/\partial t = 0$) and weak, *i.e.* considered as a small perturbation of the flat Minkowski spacetime ($g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu}$), it allows us to make many simplifications in the calculations and then considering the time coordinate separately we obtain: $\mathrm{d}^2x^0/\mathrm{d}s^2 = 0$; whereas from the spatial ones a gradient is obtained: $\mathrm{d}^2x/\mathrm{d}s^2 + 1/2(\nabla h_{00})(\mathrm{d}ct/\mathrm{d}s)^2 = 0$; thus arriving through new calculations and substitutions at the equation:

$\mathrm{d}^2x/\mathrm{d}t^2 = -\nabla c^2 h_{00} 1/2$ which is very similar to the Newtonian one we know:

$\mathrm{d}^2x/\mathrm{d}t^2 = -\nabla\phi$ where therefore $-\phi = -c^2 h_{00} 1/2$ and being $\phi = -GM/R$;

$h_{00} = -2GM/c^2R$.

It will therefore be this dimensionless perturbation that creates the V existing in the flat spacetime around a non-relativistic mass.

We can test it for example with the mass M (0.26 kg) of the experiment that we have seen to develop a V of -5.78×10^{-10} m²·s⁻² at an R of 3 cm from its center, therefore:

$$h_{00} = -2GM/c^2R = -3.46\times10^{-11}\ \mathrm{m}^3\cdot\mathrm{s}^{-2}/2.7\times10^{15}\ \mathrm{m}^3\cdot\mathrm{s}^{-2} = -1.28\times10^{-26}$$

$$-GM/R = h_{00}\,1/2\,c^2 = -1.28\times10^{-26}\times4.5\times10^{16}\ \mathrm{m}^2\cdot\mathrm{s}^{-2} = -5.76\times10^{-10}\ \mathrm{m}^2\cdot\mathrm{s}^{-2}$$

This is what we expected. Up to here nothing new, but according to the gravitational superposition principle, m of the experiment, or rather η_{00} where m is located, instead of a sum of the two h_{00} in a larger one, it should simultaneously undergo two independent h_{00}, which remaining independent would represent the independent Vs that m experiences, but since these h_{00} are also very small perturbations of the "1" of the flat metric (in particular the temporal component), it would mean having two independent time metric perturbations simultaneously at the same point of the spacetime where the test mass is located, which seems inconceivable. It seems that the gravitational superposition principle is a way that allows us to calculate the total force exerted on a test mass, but in reality it does not correspond to the phenomenon that the spacetime in which it is located undergoes. All this would suggest that the mechanism described here could be more correct than the commonly known one, with the formation of a single h_{00} - V that generates a single force with m, that appears to us to be derived from independent forces.

2. Implications for Measuring G

If it is true that $M1$ adds its V with that of M forming VM' as in the experiment, then each object M on Earth will also experience the sum of Earth's V, but in this case, each object's V (Vo) would experience the same increase in terrestrial V (Vt), generating its own new V. This means that each object would have a $Vt + Vo$ and next to another, such as M and m, attract each other much more than they would in the absence of the Earth but between them would bring out only the forces deriving from Vo (VM and Vm) since the same Vt would add to both. Vt is always the same but the Earth is not a perfect sphere and presents small variations in Vt due to its oblate spheroidal shape and local anomalies (which together we will simply call anomalies), such that the total Ac arising from $Vt + Vo$ swings beyond what is expected. In fact, if we used a torsion balance with M and m to measure G and did so again with the mass $M1$ below M, it would be larger, but we must think that in reality G does not change, rather the Ac from which we calculate it, making G appear more correct with small Vt anomalies and wrong with larger Vt anomalies (note that if there is a Vt that interferes, this cannot be modulated in the measurements as it is ubiquitous).

For example from Cavendish's experiment (remembering that M stands for Ma) we know that: $G = \left(2\pi^2 d\theta R^2\right)/\left(T^2 M\right)$ where $2\pi^2 d\theta/T^2$ expresses the acceleration Ac created by M, which with R^2/M allows G to be calculated, so that: $G = Ac \times R^2/M$. Owing to the small variation in Ac created by the superposition of the Vt anomalies and being the R^2/M ratio considered fixed, an error equal to this variation in the measurement of G would be created. The error, being a measure of a variation of Ac at a fixed R, which we have seen presupposes a variation of M, would be to consider M fixed. As in the experiment, with the Earth standing for $M1$, Vt anomalies would give a very little variation of Ma of the object M, and at a fixed distance this variation would translate into a variation of Ac, then recorded, but not accompanied by a variation of the value of Ma that created it. It is as if during the measurement of G we were the observer A with a mass $M1$ that we ignore which always changes very little allowing us to experience only a small variation of Ac rather than a variation of M.

The gravitational Ac that we distinguish between the interaction of two objects would be that given by the V of the objects alone ($Vo1$ and $Vo2$), but in reality, between them, it would be:

$(Vt + Vo1) = -(Vt + Vo2)$ which would be equivalent to $(c + Vo1) = -(c + Vo2)$ where c for us is a constant equal to 0; therefore $Vo1 = -Vo2$.

In terms of acceleration Ac at a certain distance between them:

$Ac1 = -Ac2$; $GMa1/R^2 = -GMa2/R^2$ thus developing between them, with the reciprocal role of active and passive gravitational mass Ma and Mp, the forces that we all know.

Note how this, starting from the third principle of dynamics, continues to guarantee the equality of the Ma/Mp ratio in every system.

The situation is different when we want to measure G because we measure the acceleration at a fixed distance generated by a source mass (or group of masses), and since this derives from $Vt +Vo$, in this case, any variation of Vt would emerge. In fact, even starting from a force, we know that $F = GMm/R^2$ and $G = FR^2/Mm$, but being $F = ma$; $G = maR^2/Mm$ so $G = aR^2/M$ and we return to the previous relation $G = Ac \times R^2/M$.

The same can also be said for other methods used to measure G, for example in the time of swing method with the gravitational attracting torque acted by external masses on a pendulum, or in the angular acceleration method which is dependent on "Qlm", which are the multipole fields of the external mass distribution [1], and so on for the other methods.

All this is to say that the purpose is always the same: to measure the acceleration at a fixed distance created by some source mass, bringing out Vt of the $Vt + Vo$ interaction, even if the measurement is the result of forces involved with other masses, where instead Vt in that case, would acquire the value of a constant acting equally on all forces despite its small local variation.

We could therefore, as mentioned before, record a variation in g (resulting from the variation in Vt), which we could erroneously attribute to a variation in G, stressing that we judge $Vt + Vo$ as Vo (as VM' of the experiment composed by $VM1$ and VM).

Let us take a practical example: suppose that we measure G with M and m of our experiment exploiting the oscillation to achieve the first equilibrium (very difficult but it is just an example) in an environment where g is 9.8072620 m·s^{-2}. The Ac developed by M derived from the VM at 3 cm from its center is 1.92×10^{-8} m·s^{-2}, but we must remember that this Ac is obtained from the measurement of a force experienced with another object in which the value of g is ubiquitous and would be added to all the forces, however as explained, this Ac would be 9.8072620192 m·s^{-2} when we measure G (the acceleration derived from $Vt + VM$), and 1.92×10^{-8} m·s^{-2} is what we distinguish in that environment between the masses. In the measurement of G we record the entire value given by $Vt + VM$ at a fixed distance and if we then intend to perform the same measurement in an environment in which g is, for example, 9.8077334 m·s^{-2}, the resulting variation of ≈50 ppm in the G value will be recorded, emphasizing again that in this case we would judge $Vt + Vo$ as Vo recording a change in Vt, which instead between forces would acquire the value of a constant.

It is difficult on Earth to measure such a small variation, but it would be possible to verify with the same torsion balance and same masses in some gravitationally very different places on the Earth with the same nearby gravitometer and notice if there is an increase in G as g increases and vice versa, someone has already noticed this strange correlation even though attributed to the changing G [2].

We take up this article from 2016 [2] in which there are the best measurements of G by that time but where, unfortunately, only in one case the real value of g was taken even if 10 years earlier (measurement Zurich 2006) [3], and this was 9.8072335 m·s^{-2} instead of the theorized 9.8052360 m·s^{-2} which we insert together with the other values, which we are instead forced to use only as theoretical data as they were not actually detected during the measurements, and let us determine if a relation can exist by calculating the variations in G and g taken into consideration (for convenience units of measurement are not used).

	G	g
University of Colorado, Bolder	6.672340	9.796034
Δ	$\Delta G = 0.0011$	$\Delta g = 0.0024$
HUST Wuhan, China	6.673490	9.793537
Δ	$\Delta G = 0.00038$	$\Delta g = 0.0092$
St.LabMeas.St.Lab, New Zealand	6.673870	9.802807
Δ	$\Delta G = 0.00034$	$\Delta g = 0.0044$
University of Washington	6.674215	9.807262
Δ	$\Delta G = 3.7 \times 10^{-5}$	$\Delta g = 2.9 \times 10^{-5}$
University of Zurich	6.674252	9.807233
Δ	$\Delta G = 0.0012$	$\Delta g = 0.0021$
BIPM France	6.675540	9.809357

It is repeated, unfortunately the g values are only theoretical in which there are certainly errors, just think of HUST laboratory in China located underground or the difference from the real measurement found in Zurich, but it would be worth trying to measure G with the same equipment and gravitometer at different locations with very different g values (or at very different heights) to determine if such a relation truly exists.

A test that could be done is the Cavendish experiment (but other types of gravitational balances would work) in a lunar mission looking for the value of G, always with the same torsion balance and the same masses, here on Earth and on the Moon, where it will be possible to evaluate Ma at fixed R and understand whether the lunar superposition (approximately 1/6 of that of the Earth) plays a role, because considering Ma as on Earth we should find a distorted value of G dependent on the new superposition. In reality, due to the variation of Ma, the small masses m would oscillate more slowly, creating a smaller angle θ for a longer time (the $2\pi^2 d\theta/T^2$ ratio, which represents Ac, decreases) and the R^2/Ma ratio would increase as Ma decreases due to the smaller lunar superposition contribution of its field, leaving G unchanged. To our eyes, Ma would acquire a lower value because it would generate a smaller Ac equal to the smaller lunar superposition attributed to it. According to the discussed relationship, $G = Ac \times R^2/M$ it would be like multiplying and dividing R^2 by the same superposition contribution. If instead, we considered Ma with the value it acquires with the terrestrial superposition, G would be distorted.

3. Methods

This interaction would give rise to a single acceleration belonging to the observed object, practically a new field, which then, with another object, would give rise to a new force as seen in the experiment.

The terrestrial superposition that we have hypothesized above would be total, without the cosine of any angle, in which the Earth would play the role of $M1$, however, when an angle is created as in the experiment, this single force is unmasked in the forces that compose it, in fact the V/R gradient of the field of M, which in the experiment changes by varying the angle of superposition with $M1$, is the one we all know with the constant superposition we experience, which then generates a force with m that we all know.

Therefore, the force experienced by m would be the one with M' and not with $M + M1$, we usually consider $FMm + FM1m$ as independent forces rather than consider just $FM'm$ in which $FM1m$ participates.

This raises the hypothesis that the missing mass among celestial bodies could be the passage of V between one mass and another, in which the field of one mass creates variation in the field of the other, creating a new field adding linearly (given the context in which they are found), which is why we can hypothesize the formation of a single V among the stars discussed below, in which systems become increasingly stronger with the ever-increasing number of masses involved without us realizing it.

We start from two conditions: 1) the described gravitational interaction exerted between the masses $M1$ and M of the experiment is valid, even between celestial bodies. 2) There is so much space between masses in our galaxy that relativistic effects are irrelevant; therefore, the gravitational phenomena that characterize it must be able to be explained through Newtonian physics, even if seen here in an alternative way with mutual linear interaction.

We have seen that we can hypothesize the formation of stronger gravitational systems between masses by assuming an additive interaction of their Vs. This should also occur among stars, and we can try to understand what the average Newtonian gravitational potential created by a set of stars could be undergone by the galactic plane considering their additive effect.

If their Vs are interacting, they can be seen together as a single V, in which each star provides its contribution, like the field of $M1$ which contributed with that of M to create that of M', acting on the galactic plane as a whole, considering that the galactic field is the one on which the stars "weigh", managing to make the local Newtonian V of the supermassive black hole (SMBH), on which they orbit, more negative, like the earth for example, which creates a V around itself that is more negative than the local solar one. To do this we do not use any model but exploit the knowledge of the stellar spatial density.

Considering the average distance between stars, the V created by each of them that the SMBH's field experiences are the maximum where the star is located and the minimum between one and another; therefore, on average, it undergoes a potential present at 1/4 of their average distance.

Be careful, this does not mean that at that distance there is an average V created by each star, but that the SMBH's field on average experiences a V present at 1/4 of that distance due to their average distance.

Now, let us look for the average stellar mass by analyzing the most common stars:

Star class	Main-sequence mass	% of all main sequence stars	Average $M_\circ$ mass	Weighted mass for class	% mass of class overall
O	≥16 $M_\circ$	0.00003	20	0.0006	0.001
B	2.1 - 16 $M_\circ$	0.13	9.05	1.1765	2.891
A	1.4 - 2.1 $M_\circ$	0.6	1.75	1.05	2.580
F	1.04 - 1.4 $M_\circ$	3	1.22	3.66	8.992
G	0.8 - 1.04 $M_\circ$	7.6	0.92	6.992	17.179
K	0.45 - 0.8 $M_\circ$	12.1	0.625	7.5625	18.581
M	0.08 - 0.45 $M_\circ$	76.45	0.265	20.2592	49.776
TOT				40.7008	100

We obtain an average value of approximately $40.7/100 \approx 0.4\ M_\circ$.

Starting from the analysis of the disk, the density of the stars contained in it is represented by a double exponential characterized by an exponentially decaying density of star counts, both radially (R) and in height (Z) above and below the disk, where ρ is the exponentially falling off parameter (in this case, density in the number of stars) starting from its initial value $\rho_\circ$ and β is the scale length or scale height.

$$\rho(R) = \rho_\circ e^{-r/\beta} \qquad \rho(Z) = \rho_\circ e^{-z/\beta}$$

We first attempt to determine the stellar density in the galactic plane where the sun is located.

We know that in the vicinity of the Sun the stellar density is 0.004 per cubic light year (8.46×10^{47} m^3) [4].

To make this in cubic parsec (2.92×10^{49} m^3), we obtain 0.13 stars pc^{-3}.

The disk is characterized by two main populations of stars, which give rise to a thick disk (T) and a thin disk (t), which differ in some characteristics and each with its own scale height. Recently, the scale height of the thick disk (≈800 pc) and that of the thin disk (≈280 pc) were evaluated, with their star number density ratio being 0.75 ($\rho T/\rho t$) [5].

This means that starting from a concentration of 0.13 stars pc^{-3}, 0.056 are from the thick disk and 0.074 from the thin disk.

We can add the two stellar populations by taking into account this decay every 100 pc by calculating their average distance, which locally will be not only in Z but also in all directions, thus being able to calculate the V at 1/4 of their average distance and verify what it is the total one "weighing" on the disk plane.

Z (pc)	Density of t stars (pc^{-3})	Density of T stars (pc^{-3})	Total density of stars (pc^3)	Total density of stars (pc^{-1})	Average distance between stars (pc)	1/4 distance between stars (10^{16} meters)	Potential at 1/4 distance between stars (m^2·s^{-2})	Stars in 100 pc (Z)	Stellar potential in 100 pc (Z) (m^2·s^{-2})
0	0.074	0.056	0.13	0.50	2.00	1.54		−3461 × 50 = −173,050	
100	0.051	0.049	0.10	0.46	2.17	1.67		−3191 × 46 = −146,786	
200	0.036	0.043	0.079	0.42	2.38	1.83		−2912 × 42 = −122,304	
300	0.025	0.038	0.063	0.39	2.56	1.97		−2705 × 39 = −105,495	
400	0.017	0.034	0.051	0.37	2.70	2.08		−2562 × 37 = −94,794	
500	0.012	0.030	0.042	0.34	2.94	2.26		−2358 × 34 = −80,172	
600	8×10^{-3}	0.026	0.034	0.32	3.12	2.40		−2220 × 32 = −71,040	
700		0.023	0.023	0.28	3.57	2.74		−1945 × 28 = −54,460	
800		0.020	0.020	0.27	3.70	2.84		−1876 × 27 = −50,652	
900		0.018	0.018	0.26	3.84	2.95		−1806 × 26 = −46,956	
1000		0.016	0.016	0.25	4.00	3.08		−1730 × 25 = −43,250	
1100		0.014	0.014	0.24	4.16	3.20		−1665 × 24 = −39,960	
1200		0.012	0.012	0.22	4.54	3.49		−1527 × 22 = −33,594	
1300		0.011	0.011	0.22	4.54	3.49		−1527 × 22 = −33,594	
1400		9.7×10^{-3}	0.010	0.21	4.76	3.66		−1456 × 21 = −30,576	
TOT								−1,126,683	

What we can notice initially is that the density of t after ≈600 pc has little influence while that of T remains appreciable up to ≈1400 pc. In fact, as appears from the analysis of the sum of the densities of the two disks, that height contains almost all the stellar mass (in a galactic solar R of ≈ 8 kpc, **Figure 2**) [5], thus making the V of the highest stars little influential (an ever smaller number of stars multiplied by an ever smaller V owing to their density in space), to which must be added the effect of the decrease in the average stellar mass in Z not considered here; in fact, we know for a long time that the distribution of stars perpendicular to the plane has a spectral variation, with the oldest and least massive stars that are the most common ones at high Z [6], which would allow us to ignore further heights.

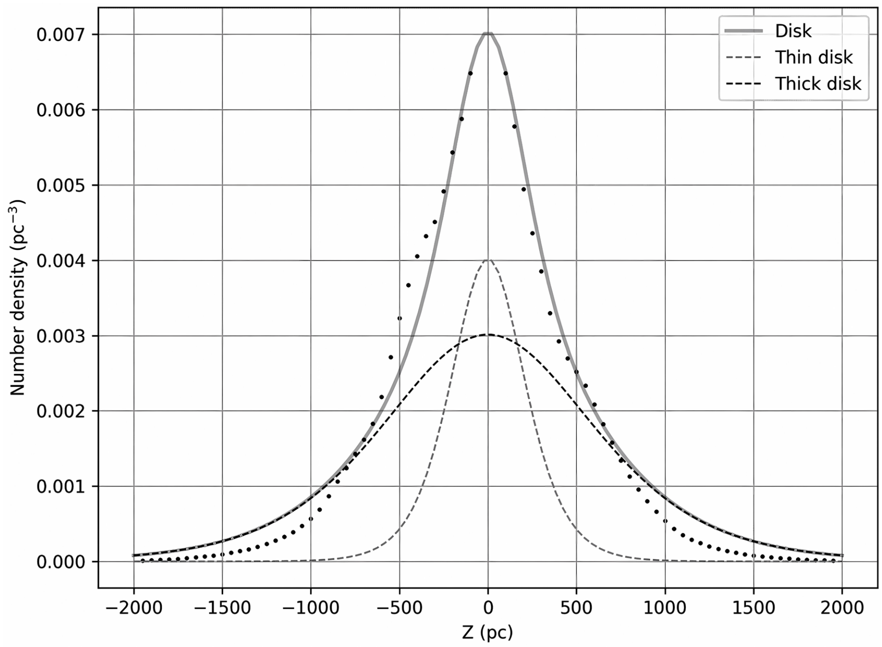


Figure 2. Vertical density of simultaneous thin and thick disks at the galactocentric solar R [5].

If we consider the potential created in both galactic planes, we obtain the potential that on average "weighs" on that radius of the disk; therefore −1,126,683 $m^2 \cdot s^{-2} \times 2 \approx -2.25 \times 10^6\ m^2 \cdot s^{-2}$.

Notably, the Newtonian potential of the SMBH ($4.29 \times 10^6 M_\circ$) [7] developed at ≈8 kpc is $-2.32 \times 10^6\ m^2 \cdot s^{-2}$.

Obviously, there may be inaccuracies in the average mass considered, in the density of stars, in the scale height chosen, in the value of the SMBH mass etc., but it is strange that considering the enormous numbers with which we are dealing, the results correspond.

We can try to do the same thing for other internal and external areas of the galaxy, and in doing so, we take into account the scale length of the stellar density. In recent years we have realized that considering the scale length of a single stellar population we obtain values from 1.8 kpc to 5 kpc because they are the result of different radial scale lengths of different stellar disk components, which can vary strongly.

In particular, the scale length of the old components of the thick disk is only 1.8 - 2.2 kpc whereas that of the younger thin disk components is 3.5 - 4.5 kpc [8]. The effective scale length of the stellar disk is determined by the sum of all the components, whose combined density profile defines the effective disk scale length density at every radius [9], as shown in **Figure 3**.

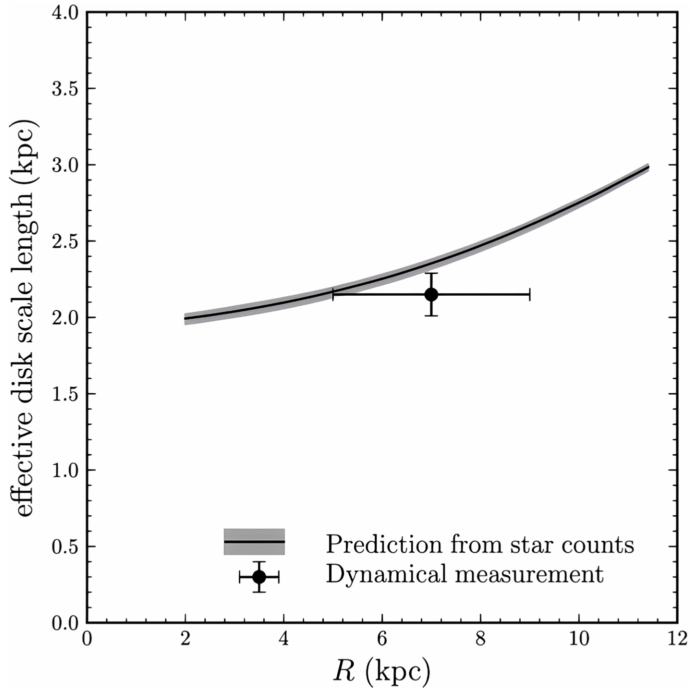


Figure 3. Effective scale length of the Milky Way disk determined by star counting [9]. Although in this work, in light of more recent observations, a slightly steeper slope is used (Reproduced by permission of the AAS).

Several authors have reported scale length values of the thick disk of 1.8 kpc [10], whereas others have reported a scale length toward the periphery (≈12 kpc) of 3.8 kpc essentially due only to the thin disk [8]. Therefore, we can consider in the most internal and external areas a scale length of 1.8 kpc at $R \approx 4$ kpc caused by a short scale length of the thick disk and one of 4 kpc at $R \approx 14$ kpc caused by the thin disk.

At the galactocentric distance R of the sun (≈8 kpc) there should be an effective scale length (β) of ≈2.5 kpc (**Figure 3**); therefore, if ρ existing near the sun is 0.13 stars pc^{-3} we can go back to the initial $\rho_\circ$ of the disk origin.

In this way: $\rho(R) = \rho_\circ e^{-r/\beta}$, we obtain $\rho_\circ$ = 3.1 stars pc^{-3}, a value consistent with that found around ≤3 kpc from the center of the Milky Way (**Table 1**), where the disk originates.

If we therefore want to find the stellar density in the galactic midplane at R 4 kpc, which we say can correspond to a scale length of 1.8 kpc, we find that: $\rho = 3.1e^{-4/1.8} = 0.33$ stars pc^{-3}.

Table 1. Stellar densities in the Milky Way, with particular attention to the galactic nucleus [11]. (Reproduced by permission of the author)

Table of Star Densities at the Galactic Core					
Radius from Center, *R*	**Star Density**	**Stars within Radius *R***	**Average Distance Between Stars**		**Irradiation by Surrounding Stars**
(parsecs)	(stars/pc^3)	(M_{sun})	(parsecs)	(A.U.*)	(Earth/Sol = 1.0)
0.1	5.2×10^7	6.0×10^5	0.0034	700	6×10^{-4}
1.0	8.4×10^5	8.8×10^6	0.013	2700	9×10^{-5}
10.	1.3×10^4	1.4×10^8	0.053	11,000	6×10^{-6}
20.	3.8×10^3	3.2×10^8	0.081	17,000	4×10^{-6}
100	2.2×10^2	5.0×10^9	0.21	43,000	1×10^{-6}
(Nucleus) 800	20.0	2.0×10^{10}	0.46	94,000	3×10^{-7}
(Core) 3000	3.0	-- -	0.87	180,000	9×10^{-8}
(Disk/Sol) 10^4	0.15	-- -	1.88	380,000	5×10^{-9}

This means that considering the ratio between the t and T disks with their scale heights, we obtain:

Z (parsec)	Density of t stars (pc^{-3})	Density of T stars (pc^{-3})	Total density of stars (pc^3)	Total density of stars (pc^{-1})	Average distance between stars (pc)	1/4 distance between stars (10^{16} meters)	Potential at 1/4 distance between stars (m^2·s^{-2})	Stars in 100 pc (Z)	Stellar potential in 100 pc (Z) (m^2·s^{-2})
0	0.19	0.14	0.33	0.69	1.44	1.10	−4845 × 69 = −334,305		
100	0.13	0.12	0.25	0.62	1.61	1.23	−4333 × 62 = −268,646		
200	0.093	0.10	0.19	0.57	1.75	1.34	−3977 × 57 = −226,689		
300	0.065	0.096	0.16	0.54	1.85	1.42	−3753 × 54 = −202,662		
400	0.046	0.085	0.13	0.50	2.00	1.54	−3461 × 50 = −173,050		
500	0.032	0.075	0.10	0.46	2.17	1.64	−3250 × 46 = −149,500		
600	0.022	0.066	0.088	0.44	2.27	1.74	−3063 × 44 = −134,772		
700	0.015	0.058	0.073	0.41	2.43	1.87	−2850 × 41 = −116,850		
800	0.011	0.051	0.062	0.39	2.56	1.97	−2705 × 39 = −105,495		
900	7×10^{-3}	0.045	0.052	0.37	2.70	2.07	−2574 × 37 = −95,238		
1000		0.040	0.040	0.34	2.94	2.26	−2358 × 34 = −80,172		
1100		0.035	0.035	0.32	3.12	2.40	−2220 × 32 = −71,040		
1200		0.031	0.031	0.31	3.22	2.47	−2157 × 31 = −66,867		
1300		0.027	0.027	0.30	3.33	2.56	−2082 × 30 = −62,460		
1400		0.024	0.024	0.28	3.57	2.74	−1945 × 28 = −54,460		
1500		0.021	0.021	0.27	3.70	2.84	−1876 × 27 = −50,652		
1600		0.019	0.019	0.26	3.84	2.95	−1806 × 26 = −46,956		
1700		0.016	0.016	0.25	4.00	3.08	−1730 × 25 = −43,250		
1800		0.014	0.014	0.24	4.16	3.20	−1665 × 24 = −39,960		
1900		0.013	0.013	0.23	4.34	3.34	−1595 × 23 = −36,685		
2000		0.011	0.011	0.22	4.54	3.49	−1527 × 22 = −33,594		
2100		0.010	0.010	0.21	4.76	3.66	−1456 × 21 = −30,576		
2200		9×10^{-3}	9×10^{-3}	0.20	5.00	3.85	−1384 × 20 = −27,680		
TOT								−2,451,559	

Here, we notice that the density of t after ≈900 pc has little influence, whereas that of T remains appreciable up to ≈2200 pc, and if we consider the V created in both galactic planes, we obtain:

$-2{,}451{,}559\ \text{m}^2\cdot\text{s}^{-2} \times 2 \approx -4.90 \times 10^6\ \text{m}^2\cdot\text{s}^{-2}$.

The potential of the SMBH ($4.29 \times 10^6 M_\circ$) developed at R 4 kpc is $-4.65 \times 10^6\ \text{m}^2\cdot\text{s}^{-2}$, demonstrating a correlation in this case, too.

If we consider the periphery $R \approx 14$ kpc, as mentioned, we can consider an effective scale length (β) of 4 kpc therefore: $\rho = 3.1\text{e}^{-14/4} = 0.094$ stars pc^{-3}.

However, as mentioned, according to various observations, this area seems to be populated only by stars of the thin disk, therefore the scale height to use is that of the thin disk.

Z (parsec)	Density of t stars (pc^{-3})	Density of t stars (pc^{-1})	Average distance between stars (pc)	1/4 distance between stars (10^{16} meters)	Potential at 1/4 distance between stars ($\text{m}^2\cdot\text{s}^{-2}$)	Stars in 100 pc (Z)	Stellar potential in 100 pc (Z) ($\text{m}^2\cdot\text{s}^{-2}$)
0	0.094	0.45	2.22	1.70	−3135 × 45 = −141,075		
100	0.066	0.40	2.50	1.92	−2776 × 40 = −111,040		
200	0.046	0.35	2.85	2.19	−2433 × 35 = −85,155		
300	0.032	0.31	3.22	2.47	−2157 × 31 = −66,867		
400	0.022	0.28	3.57	2.74	−1945 × 28 = −54,460		
500	0.015	0.24	4.16	3.20	−1665 × 24 = −39,960		
600	0.011	0.22	4.54	3.49	−1527 × 22 = −33,594		
700	7×10^{-3}	0.19	5.26	4.05	−1316 × 19 = −25,004		
TOT						−557,155	

Here, we also note a correlation since $-557{,}155\ \text{m}^2\cdot\text{s}^{-2} \times 2 \approx -1.11 \times 10^6\ \text{m}^2\cdot\text{s}^{-2}$ and the potential of the SMBH developed at R 14 kpc is $-1.32 \times 10^6\ \text{m}^2\cdot\text{s}^{-2}$.

If we go deeper, into the bulge, or rather into the pseudobulge, it appears connected to the disk by bar-shaped structures. In particular, the long bar is present in the entire pseudobulge, finding a thin and a superthin component with two scale heights of ~180 pc and ~45 pc respectively [12], interpreting it as the counterpart of the thin disk and the young thin disk near the sun.

If we consider the proportions between these components similar to those used in the solar neighborhood ($\rho T/\rho t \approx 0.75$), as suggested by the estimated masses (the mass of the thin component $3.3 \times 10^9\ M_\circ$ and the mass of the superthin component $4.0 \times 10^9\ M_\circ$) [12], considering a galactocentric R of 800 pc where these conditions exist and where we know the local $\rho_\circ$ (≈20 stars pc^{-3}, **Table 1**), from their scale heights (180 pc and 45 pc) we can trace the total number of stars gravitating in the disk in that area given by this double exponential.

In this way, we can consider a superthin component up to $Z \approx 100$ pc and the thin one up to ≈500 pc, giving a total V of $-3.8 \times 10^6\ \text{m}^2\cdot\text{s}^{-2}$ and $-1.5 \times 10^7\ \text{m}^2\cdot\text{s}^{-2}$

respectively.

The V developed by the SMBH at R 800 pc is -2.32×10^7 m^2·s^{-2} but it is right to expect that the remaining part is to be attributed to the stars of the true bulge: those older and sparser [13].

For example, the previously obtained total V at R 4 kpc starting from the height of ≈600 pc up to an assumed height of ≈2500 pc of the bulge seems likely to fill this gap.

In fact, we know that the pseudobulge can be seen as a bulge that encloses an internal disk [14], but both have to be orbited by the potential of the same SMBH, and the fact that these stars have a different kinematics and metallicity from the younger and more massive ones that move in a more rotary manner [14], suggests that this star formation in the galactic plane is subsequent to the formation of the bulge that was already orbiting the SMBH (which therefore starts its $\rho_\circ$ from a pre-existing value similar to that of the thick disk).

This makes us understand that, taking into account the effect discussed here, the stars could have a non-random concentration but be arranged in such a way as to give the annihilation of the Newtonian V of the SMBH caused by the sum of their average Vs undergone by it, but starting from where?

The further we go into the center of the galaxy, the more complicated the kinematics become due to the concentric structures that are created such as the nuclear stellar disk and the nuclear stellar cluster. Furthermore, we must consider the increase in the average stellar mass that we encounter as we delve into the galaxy which unfortunately, due to the lack of certain data, makes the work too speculative.

However, even if not proposed here, confirmation is found with the average mass of $1.5M_\circ$ at R 100 pc, $2M_\circ$ at R 20 pc, $4M_\circ$ at R 10 pc and $10M_\circ$ at $R < 1$ pc, which in the light of the observations seem plausible [13] [15]-[17] with an ever-increasing presence of massive stars towards the center of the galaxy and with a participation of supermassive stars increasingly present in the first pc [18].

In fact, we can do better towards the most extreme center to understand what would be the maximum V reachable by the masses with this effect. We know that in the first pc^3 there is included a stellar mass of $\approx 8.8 \times 10^6\ M_\circ$ with a star density of 8.4×10^5 pc^{-3} (**Table 1**), so each object has an average mass of $8.8 \times 10^6 M_\circ / 8.4 \times 10^5 = 10.4 M_\circ$ which, as mentioned, is made plausible by the presence of numerous massive and supermassive stars (notice how even at R 0.1 pc with 5.2×10^7 stars pc^{-3} in 0.1 pc^3 with $6 \times 10^5 M_\circ$ we get about the same thing).

Therefore we know that inside this first pc there is a density that reaches 5.2×10^7 stars pc^{-3} (**Table 1**), corresponding to 373 pc^{-1}; and from both sides on this area of the galactic plane they constitute a total of $373 \times 2 = 746$ stars.

These are separated by 0.0034 pc (**Table 1**), and at 1/4 of that distance they would develop a V of -5.31×10^7 m^2·s^{-2} for a total V of $746 \times -5.31 \times 10^7$ m^2·s^{-2} ≈ -4×10^{10} m^2·s^{-2}.

At this point we must also add the V obtained from the other masses above and below the SMBH, which would be given by the average masses considered of $4M_{\circ}$ (present at R 10 pc) for a considered Z of 10 pc, $2M_{\circ}$ (present at R 20 pc) for a considered Z of 20 pc and of $1.5M_{\circ}$ (present at R 100 pc) for a considered Z of 100 pc, making the V contributions from higher Z negligible based on local spatial densities (**Table 1**), and thus obtaining from both sides a value in V respectively of $-6.24 \times 10^8\ m^2 \cdot s^{-2}$, $-2.54 \times 10^8\ m^2 \cdot s^{-2}$ and $-1.49 \times 10^8\ m^2 \cdot s^{-2}$, for an overall value of $\approx -1 \times 10^9\ m^2 \cdot s^{-2}$.

Therefore, the maximum average V that the SMBH would experience from the stars, taking into account this additive effect of their Vs, would be $\approx -4.1 \times 10^{10}\ m^2 \cdot s^{-2}$. But starting from where more precisely?

If we are guided by the idea that the stellar V equals that of the SMBH as in the rest of the galaxy, knowing its mass ($4.29 \times 10^6 M_{\circ}$), we can find the R in which this occurs.

In fact if $V = GM/R$; $R = GM/V$ where M is the mass of the SMBH and V is the total stellar V, obtaining a value of 1.39×10^{16} m, which is between 0.4 and 0.5 pc.

Those who study the center of our galaxy know this galactocentric R because it corresponds to the R in which the expected cusp does not appear. According to the Bahcall-Wolf cusp distribution, there should be a cusp with γ of ≈ 1.7, but from the observations, we find a slope ≈ 0.34 or almost flat [19] (especially for the red giants) so much that the theory has been changed to "the shallow cusp theory" accompanied by explanations of shorter relaxation times, plausible contamination of young stars in the observation of older ones, collisions between the innermost stars, etc. However, late-type stars have recently been suspected to show a core-like rather than cusp-like distribution [20].

The stellar population at $R < 0.3$ pc appears to belong to the SMBH with a Keplerian fall-off radius [21], whereas at $R > 0.5$ pc it seems influenced by the surrounding masses [22], considering therefore $R \approx 0.4$ pc a distinctive zone that will play a crucial role in the subsequent discussion.

4. Results and Discussion

As discussed above, by the transfer of potential, systems of increasing force would be created between the masses, which if considered among the stars of our galaxy would give it fundamental stability acting as a "gravitational glue".

In the Z direction, this could also explain the thickening of the thick disk over time, driven by a higher gravitational gradient towards the outside of the disk favoring an "inside-out" formation, thus also explaining the vertical motions of the stars inside it.

At the central level, the sum of the stars' average V undergone by the V of the SMBH's field, would reduce (or rather neutralize) the local tidal forces near it, increasing the gradient uniformity of its field and allowing greater star formation "*in situ*", explaining the large star formation where we would not expect.

However, the most important consideration of this effect concerns the SMBH, which with a V resulting from all the stars together would experience a V far greater than that created by itself, which is therefore not able to make them orbit in Keplerian way as we would expect.

The result is its "flattened" potential totally occupied by a spatial density of stars generating two self-gravitating halves made up of the maximum number of them it can make orbit, while it could make orbit in Keplerian way the innermost stars (S cluster), the stellar halo and the bulge in a transition zone: the pseudobulge, characterized by the coexistence of the pre-existing three-dimensional potential zones (the bulge) with the more recent flattened ones (the internal disk) which over time have greater star formation, mass and luminosity, therefore becoming increasingly larger and the bulge increasingly smaller.

With this effect, the local V of the SMBH is made more negative for a value equal to its value at every R, which therefore remains the same from the point where it is generated, so that in the disk exists only the Keplerian potential of local objects such as stars, clusters, etc. that compose it but there is no proper potential of the disk, its potential is decided by the Keplerian potential of the SMBH around which the central masses orbit at $R \approx 0.4$ pc.

This would also explain why the stars of the disk in their disordered motion are ordered, as they would be in equilibrium between a local V determined by the nearby masses and that of the disk determined by the Keplerian V of the SMBH. Where there is less or more local mass, there will be a lower or higher speed respectively, dictated by the resulting V and therefore depending on the mass-to-light ratio, which would also explain the great success in predicting galactic velocity curves according to MOND theory and the Universal Rotation Curve (URC) which use the mass-to-light ratio of the visible component of each galaxy (*) as the only free parameter [23] [24].

Stellar motions are dictated both by the rotational attraction of the center (the point masses attract each other and begin to follow one another following the internal rotation) with consequent radial velocity, and by the local gravitational attraction caused by nearby objects with consequent velocity dispersion which, for the effect discussed here, increases in the thickness of the disk as the force of the star fields increases.

Therefore, the disk, even if it orbits around the SMBH, cannot be considered under its direct control in the way we usually think, even if it decides its potential and therefore its speed.

Consequently, if we imagine these central masses in a closed and relaxed Keplerian motion around a central mass where energy conservation applies, from the Virial theorem we know that $K = -1/2U$ where each of these masses will be gravitationally linked to M and so: $1/2\,mv^2 = 1/2\,GMm/R$ so that each of them will have speed: $v = \sqrt{GM}/R$, and considering M the mass of the SMBH of 4.29 $\times 10^6 M_\circ$ and R the distance at which these masses are located (≈0.4 pc), we obtain a speed of 215 km·s^{-1} with which they orbit around it and will therefore be maintained throughout the galaxy. This velocity manifests itself outside the strong influence of the surrounding masses that create dispersion, although as mentioned, it always remains influenced by local dispersion, as in the disk (even if there it becomes less strong, having a less concentrated mass distribution and no presence of the bulge).

This is not exactly the speed we know, which is about 220 km·s^{-1}, but it is very close.

Therefore, from ≈0.4 parsec, one can think that an area begins in which the masses are distributed to cancel the galactic potential by self-gravitating in equilibrium with it, since, due to this effect, it is the maximum number of stars that can be orbited with the SMBH's potential, allowing a constant velocity of objects to be maintained as a result of a necessary balance.

Theoretically, this speed could be maintained indefinitely since the mass density of the galaxy seems to be distributed to cancel out the V of the SMBH, in fact, the maximum size of the galactic stellar disk is not yet known [25], only the matter not being infinite gradually decreases, allowing its V to rise again, reducing the speed of the orbiting objects at great galactocentric R [26] [27].

We can also interpret this as a restoration of its spacetime curvature around the area of the flattened disk, where the net zero disk potential would be equivalent to a net zero spacetime perturbation, thus creating an unexpected peripheral lensing effect around it. This is because, being able to assume the sum of the stellar Vs in a single one and knowing, as we have seen, that these are determined by the small spacetime perturbations h_{00}, this would give rise to a single h_{00} equal to that created by the SMBH in the disk area, thus allowing us to make this consideration around it and creating in fact a potential well. Note that if other large masses, such as other galaxies, manage to lower this V again, they will gain speed, thus creating clusters of galaxies with unexpected speeds with an even larger lensing effect around them. Consider for example the arrangement of our Local Group [28].

This equilibrium V that is created between the galactic mass and the SMBH, due to the effect we are talking about, is right to be expected at a lower value with the secularization of the galaxy and its mass gain, thus giving greater velocity to the objects orbiting this increasingly lower V; a velocity then transferred to the entire galaxy, thus explaining the Tully-Fisher relation in disk galaxies (*).

We are used to measure the mass of SMBHs from their surrounding kinematics, but we have to think that the central masses, which are located where the equilibrium V is generated, can have different speeds around the same SMBH dependent on the potential they orbit, and it may be that some SMBH, which for some reason does not have many of these masses around compared to its mass, may appear too small or absent; others, which have many masses around them compared to their mass, may appear too large; as if all this were caused by a different central mass.

In the pseudobulge, the more the flattened V is present, the brighter it will appear, but this would also create a bigger disturbance of the coexisting three-dimensional V (the bulge), causing greater velocity dispersion (σ) of the objects in it, but also, as seen above, proportional to the greater kinematics created by these masses around the SMBH; thus, luminosity and σ become $\propto$ to the kinematics around the SMBH, which could explain the M-σ relation (but which in reality would not give information on the real mass of the SMBH).

We know that the anisotropies of the Cosmic Microwave Background (CMB) represent inhomogeneities at the dawn of the universe that we can interpret as an obstacle to the homogeneous expansion of this radiation owing, among other things, to the attractive gravitational effect, which we always identify with mass, but could also be given by the effect of which we are talking about here.

Even if the baryonic mass in that period was much more uniform, this effect must have already existed, and this radiation therefore must have spread not only through the gravitational effect of the masses but also through the effect of a new V between them resulting from their interaction, creating other anisotropies.

In fact, in the primordial universe, ordinary matter interacted strongly with this radiation whereas dark matter did not, it would have influenced the CMB only with its gravitational potential.

This effect would also lead to greater Gravitational Instability than previously imagined and could help us explain why matter organized itself so quickly to form galactic nuclei at unexpected primordial times.

It would also be possible to explain the behavior of the "Bullet Cluster", in which the baryonic gas seen in X-rays interacts whereas the dark matter would remain undisturbed along with the galaxies, continuing to give the lensing effect of the objects behind them. In reality, the dark matter would follow the galaxies because it would be an effect of the V rising around the disks as mentioned above, and the disks are flattened mainly due to the stars inside them, which however do not collide, allowing this effect to be maintained.

All of these findings suggest that if the dark matter does not interact with anything except gravitationally, it could be a gravitational effect of "ordinary" mass.

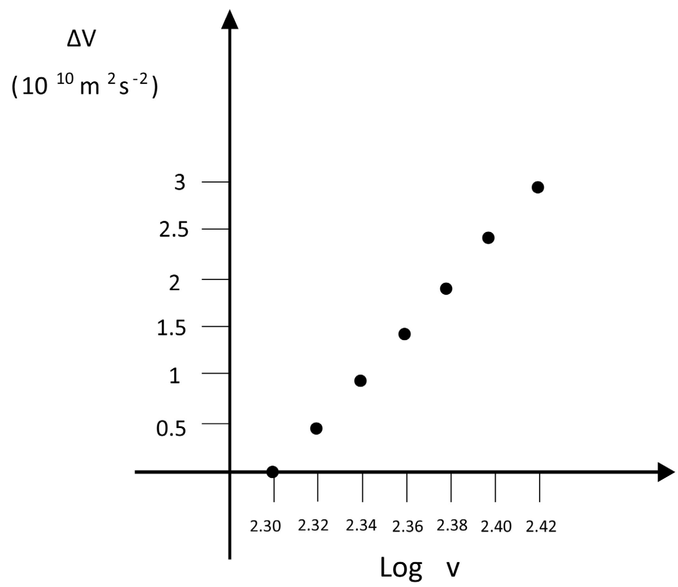
(*) In this theory, the stellar mass seems to be in equilibrium with the V of the SMBH because, owing to the effect described here, the stars would otherwise develop a V greater than the existing one needed to make them orbit. This would be enabled by the continuous star formation that occurs at the median height of the galactic plane, which means that we can hypothesize a relation between the stellar mass (which we can estimate from the M/L ratio) and the Keplerian V of the SMBH on which these masses orbit since the galactic mass would be on the same V. Therefore, the relation between the galactic mass and the rotation speed of the galaxy, such as that of Tully-Fisher (not surprisingly, closer when talking exclusively about mass), is equivalent to the relation between the V created by the stars of the galaxy and its rotation speed.

Performing the calculations as previously described, for example with a V of $4 \times 10^{10}\ \text{m}^2\cdot\text{s}^{-2}$ created by these masses around a SMBH of $4.29 \times 10^6 M_\odot$, they would result at an R of 1.43×10^{16} m with a speed of 200 km/s. Looking for the velocity that would exist at regular increments of stars' V, for example, every $5 \times 10^9\ \text{m}^2\cdot\text{s}^{-2}$, we would have:

4.5×10^{10} m^2·s^{-2} ≈ 212 km/s, 5×10^{10} m^2·s^{-2} ≈ 223 km/s, 5.5×10^{10} m^2·s^{-2} ≈ 234 km/s, 6×10^{10} m^2·s^{-2} ≈ 245 km/s, 6.5×10^{10} m^2·s^{-2} ≈ 255 km/s, 7×10^{10} m^2·s^{-2} ≈ 265 km/s, and so on.

Thus, every equal variation in the potential (5×10^9 m^2·s^{-2} in this case) corresponds to an equal variation in v (≈10 km/s in this case).

By graphing this variation in potential with respect to the rotation speed, we obtain something very similar to a Tully-Fisher relation:



In particular, the mass growth of the SMBH is considered negligible and proportional over time compared to the stellar mass growth of the galaxy that hosts it, and therefore compared to the total V acquired by the stars. In fact, even assuming a large growth of the SMBH, the growth of the stellar mass would be much greater, and taking into account the effect described here, the equilibrium potential between them would still be at an increasingly lower value over time. This relation is not related to the actual mass of the SMBH (like the kinematics surrounding it as described above) but is only evidence of the gravitational relation existing between it and the galactic mass.

(*) MOND theory assumes that light traces mass, that is, the mass-light ratio (M/L) in any individual galaxy is constant. After the surface brightness distribution (preferably in the near infrared) is converted into a surface density distribution, the Newtonian gravitational force is subsequently calculated via the Poisson equation and the "true" gravitational force is calculated from the MOND formula with a fixed acceleration a_0 (which would mark the entry into the MOND area if $a \ll a_0$), and the mass of the stellar disk is adjusted until the best match to the observed rotation curve is achieved.

The "fixed" value of a_0 used can be interpreted as the establishment of the equilibrium V between the SMBH and the stellar mass of each galaxy in which the velocity becomes no longer dependent on R because on the same V. The use of the M/L ratio of the disk (baryonic matter only) as the only free parameter of the fit is a feature shared with the URC, and it could be due to the fact that stars crossing an area of high stellar density, in which the local V of the SMBH is further lowered, would acquire greater speeds, whereas those crossing a less dense area, in which the V of the SMBH increases, would acquire lower speeds. This would explain the great success of MOND e URC in predicting velocity of spiral galaxies, which is confirmed on hundreds of them and therefore must have a physical meaning that is perhaps too overlooked.

5. Conclusions

This method cannot provide exact numbers but rather provides an alternative way to explain some phenomena through a different vision of Newtonian gravitation. Perhaps the reasoning is too simplified and the method used is not the most correct, but if the interpretation of the performed experiment is correct and the masses are able to provide the effect described, then the SMBH cannot make all the stars of the galaxy orbit in Keplerian way as we should expect, with the coincidence that the maximum concentration of the mass of the galaxy should be found to orbit the Keplerian potential of the SMBH corresponding to a speed very similar to that of the objects in the disk (not taking into account the local dispersion).

There may be doubts about the stellar densities and data used in various areas of our galaxy (**Table 1**), but we know the densities and measurements near us, and it is another coincidence that considering this effect, there is an average V undergone by the SMBH's field created by the masses above and below our sun almost equal to that of the SMBH 8 kpc from it, furthermore, using the same criteria, analogies can be found in various points of the Galaxy.

Although simple, the theory apparently remains valid and can be falsified by experiments such as the search for a correlation between G and g never carried out before or, better yet, such as the lunar experiment hypothesized here.

Beyond the validity of the theory, it remains to be clarified why a physical phenomenon such as that of gravitational superposition among masses can be assumed to occur in two different ways because physically it can only occur in one.

Do the Vs that give rise to the forces add up independently, or do they add up into a single one that appears to us to come from independent Vs? It may seem like a useless question, but if we consider it between the objects that we commonly test on Earth and the Earth itself or between the stars, we obtain particular results.

For the more curious, the "home" test is here: https://youtu.be/wZ49W7JQRiw.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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