Original Research Article

Gravitational displacement: Time dilation rooted in vacuum energy

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Abstract

Astronomical findings, particularly from the last decades of research,have confirmedthat our universe either must contain large amounts of an unknown form of matter, called dark matter, or the laws of gravity must be influenced by undiscovered variables. Although both of the two approachescontain many candidates with their respective matches and fails, no theories have so far been able to finally solve the fullpicture of missing mass at different structural levels with the relation to several associated problems. In this study, gravity is considered with a new approach,more specifically not tobe a property fundamentally incorporated to space, but something that arise from the presence of background energy and its responsibility for making time flow at different local rates. The study suggests that the gravitational constant, G, is only locally constant, and that gravity itself causes a displacement that decreases the gravitational strength, only to a noticeable degree for massive astronomical structures like galaxies and more heavyparent structures.

Keywords

Gravity, gravitational displacement, time dilation, general relativity, gravitational constant, vacuum energy, dark matter, black holes

Introduction

Newton's laws of gravity and Einstein's theory of relativity respectively stands for some of the most influential breakthroughs in science, that is crucial for our understanding of physics and the universe. It is in the same time known that they, as classical theories, might be influenced by still undiscovered physics deeply hidden in the space itself, possibly with roots in the background energy so far conceptually known as the vacuum energy.

According to current acknowledged models, the observable universe consists of around 25 % dark matter, 5 % normal matter, and 70 % dark energy. The exact numbers have varied for different estimates.

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Dark matter[1,2,3,4,5] is typically predicted to be responsible formore than80 % of the attractive gravitational force, and normal matterless than 20 %. It is still unknown what kind of physical phenomenon that causes the percentage of normal matter, according to classical theory, to become that low.

Since dark matter has not yet been identified as a possible form of matter, it isas a topic of researchconsidered to include both the research of potentiallyundiscovered matter types and the research of modification of gravitational laws, where both types of researches aim to solve the same common problems.

Different theoriesand models have attempted to solve the problems associated with dark matter through the modification of gravitational laws, known as Modified Gravity (MOG)[6]. Among them is Modified Newtonian dynamics (MOND)[7,8,9,10,11,12], where a range of different models have been researched. Although MOND has made successful matches at one structural level, it commonly breaks down when including two structural levels. Using the same modifications for a galactic cluster as for individual galaxies still shows a missing mass at the galactic-cluster level. Therefore, the prediction theorized by MOND, that gravity becomes stronger at large distances, does not match the full nature of the universe. An offset of apparent mass distribution in galactic-cluster collisions is another important finding[13] that conflicts with MOND.

Due to the inability for present suggested modifications of gravitational laws to solve the problems of dark matter, a new approach to gravity could be crucial to the future research. The deep nature of time dilationis in this study particularly considered in order to establish a new approach.

Time dilation

According to the theories of relativity, there are two types of time dilations:

1) The speed-induced time dilation defined by Special Relativity and Lorentz-transformations, and;
2) Gravitational time dilation[14] defined by General Relativity

The gravitational time dilation is considered to be fully consistent with the gravitational strength, meaning that they are two aspects of the same. The gravitational strength depends on the amount of gravitational time dilation. Therefore, some theories also consider time itself, as a property incorporated to space, to be the mediator of gravity. Gravity differs in that way from the other 3 fundamental forces, which are mediated by particles known as the force carriers.

Gravitational displacement

In the assessment of gravity as something that is mediated by the background energy of space, which reflectively is responsible for making time flow at different local rates, aneffectwhere gravity itself can displace the local strength of gravitation is possible. This possible form of displacement is hereinafter named “gravitational displacement”.

From intergalactic conditions, the background energy makes space gravitationally repulsive, as known from the cosmic expansion and the subjects associated with dark energy. When mass is put into the repulsive space, in the form of astronomical structures like galaxies and galactic groups,space starts to become locally attractive instead. This implies that when time flows at one rate, intergalactically, space is repulsive, and when it is slowed just a tiny bit, it becomes attractive.

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Earth is known to dilate time by around $7*10^{-10}$ second per second, and the sun by around $2,12*10^{-6}$ second per second. This tiny bit of time dilation is what causes the respectively great strengths of gravitation associated with Earth and the sun. It implies that just a small bit of time dilation causes energy to be conserved through a great gravitational force.

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As the boundary between arepulsive and a strong attractive gravitation is rooted in just slight difference in elapsed time rates, a possible gravitational displacement may also form within equivalently slight time dilations.

Although the time dilation near massive black holes can reach extreme levels, such extreme levels does only apply to local regions which border to limited amounts of space. Larger astronomical volumes ofspace can only reach a relatively small time dilation.In the centre of galaxies, the time dilation might typically be on the order of 10^{-4} to 10^{-6} second per second, depending on the radius and mass density of the galactic centre.

A possible cause for gravitational displacement might be that the background energy of empty space has the property that time only can be dilated to a certain degree before energy is conserved through different gravitational strengths.

Gravity is caused by the way space conserves energy. Since energy is measured by time, and time itself is a part of the picture, it is possible that the energy-conservation regime responsible for gravity changes when the time is dilated just to a slight degree.

Our own solar system is located in a region where the gravitational displacement ofits parent galaxy is expected to be significant, and therefore the gravitational constant, G, is also affected equivalently. In regions farther away from the galactic centre, the local G is expected to be higher, and in intergalactic space, even higher.The orbital velocities in these regions arethereby expected to be equivalently higher, in accordance with observations.

Contrary to MOND, a gravitational displacement does not make gravity stronger for long distances, but it implies that gravityby nature is stronger from the surroundingdeep space, as illustrated in figure 1.

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Figure 1

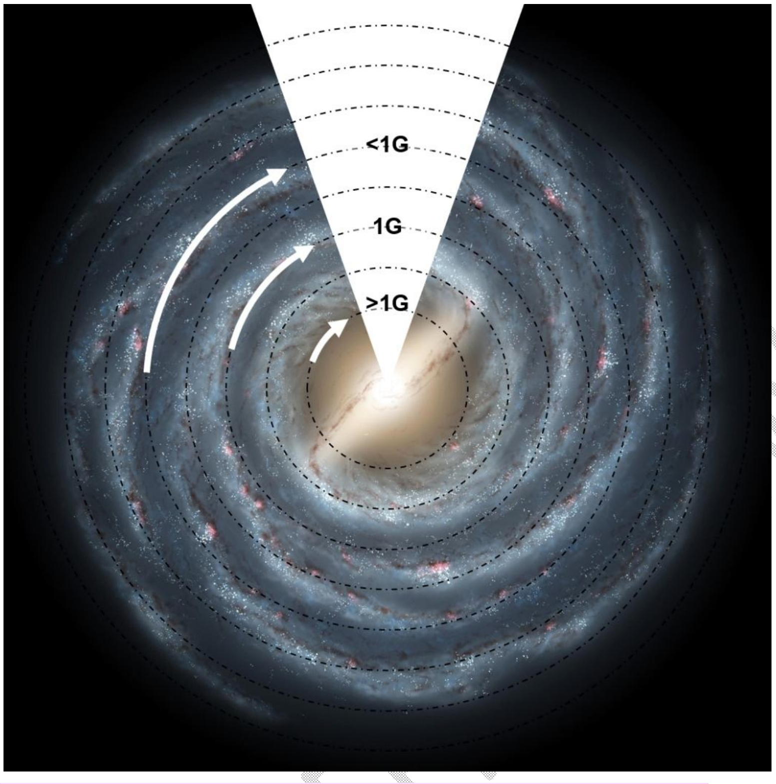

Figure 1: Principal illustration of gravitational displacement

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if so, indicate the process that led to this photograph

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The velocity curves

According to observations, astronomical objects in the outer regions of galaxies orbits significantly faster than the gravitational strength of visible matter are supposed to allow them to do. This is known as the velocity curves of galaxies, more specifically the observed and the calculated velocity curves.

Seen in view of gravitational displacement, this effect can be divided into two subcomponents:

1) The gravitational strength between the inner and outer regions of an astronomical structure becomes higher, not impacted by distance in itself, but because gravity by nature is stronger from intergalactic space whereof the inner regions due to gravitational displacement contains more mass than calculated with present models
2) The local gravitational strength between objects in the outer regions of an astronomical structure is higher relative to the inner regions

The velocity curves can, based on the mentioned two components, be described as an effect of gravitational displacement. It does not exclude the possibility that there might exist unidentified matter additionally, in the form of objects or gas that is hard to identify or in the form of dark matter, but it does also open the possibility that dark matter does not need to exist.

The bottom-level constant

From an objective viewpoint, the gravitational strength of a massive object is not determined by the object itself, but the space surrounding it. Although the time in black holes can be slowed to a large degree relative to its surrounding space, the gravitational strength of the surrounding space may not be displaceable more than to a certain degree.A rate at which time will re-enter a volume occupied by mass, if it ceased to exist,may form a lower limit to how much gravitational displacement that is possible.

A bottom-level constant can be described as the background energy's capability to accelerate time. Where space is occupied by a massive object, the background energy is forced to deceleration of time that can only be locally maintained.

A bottom-level constant must have a value of >1. Based on present research, a bottom-level constant cannot be identified to an exact value. Such identification requires new research. The lack of a known value makes it difficult to study gravitational displacement with accuracy. The use ofnotional values does however enable gravitational displacement to be studied conceptually.

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Methods

The local gravitational constant: The Local G-formula

In order to calculate the local gravitational constant G based on gravitational displacement, two respective reference volumes are required:

1) The reference volume of the known G
2) The reference volume of the relative G

The total mass occupying the space of both reference volumes are required for the identification of the gravitational displacement.

The local G for the relative reference volume may be expressed as:

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$$G_l = G\frac{b + d^{(mt_2{}^2 v_2)} \times (1-b)}{b + d^{(mt_1{}^2 v_1)} \times (1-b)} = G\frac{d_2}{d_1}$$

whereG_l is the local gravitational constant, b (= >1) is the unknown bottom-level constant, d (= >1) is the displacement factor number, mt_1 and mt_2 are the total masses occupying the respective reference volumes, and v_1 and v_2 are the volumes of the respective reference volumes.

By the identification of the respective displacement factors, G_l is given by:

$$G_l = G\frac{d_2}{d_1}$$

where d_1 and d_2 is the respective displacement factors.

General Relativity and Newton's law of gravitation

Gravitational displacement may be accounted for by the existing laws of gravity by replacing the gravitational constant G with the local gravitational constant G_l, derived from the local G-formula.

Newton's law of universal gravitation can be expressed as:

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$$F = G_l \frac{m_1 m_2}{r^2}$$

where F is the gravitational force, m_1 and m_2 are the respective masses, r the distance between their centres, and G_l is the local gravitational constant.

It can also be expressed, together with the local G-formula, as:

$$F = G \frac{b + d^{(m{t_2}^2 v_2)} \times (1 - b)}{b + d^{(m{t_1}^2 v_1)} \times (1 - b)} \times \frac{m_1 m_2}{r^2}$$

The Einstein field equations may be written in the form:

$$G_{\mu v} \equiv R_{\mu v} - \frac{1}{2} R g_{\mu v} = \frac{8\pi G_l}{c^4} T_{\mu v}$$

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where$G_{\mu v}$ is the Einstein tensor, $R_{\mu v}$ is the Ricci tensor, R is the scalar curvature, $g_{\mu v}$ is the metric tensor, $T_{\mu v}$ is the energy-momentum tensor, G_l is the local gravitational constant, and c is the speed of light in vacuum.

Results

The study of astronomical mass distribution profiles

The exact mass density of known galaxies in the universe is in general hard to identify, and therefore, such numbers does only exist in the form of estimates. Additionally, with gravitational displacement, those numbers will change.

In this study, gravitational displacement is only demonstrated conceptually, and therefore, it does not intend to match the mass distribution of specific known structures.

In the following table, an astronomical structure with a certain radius and mass distribution profile is used as a base for studying the gravitational displacement. The bottom-level constant and the displacement factor number areassumed to have certain values. The gravitational constant G is finally calculated out from the displacement factors, with a reference volume located between the inner and outer regions of the astronomical structure.

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d	Radius (kpc)	Mass total (GM⊙)	Volume (kpc^3)	Displacement factor	G (m3 kg-1 s-2)
0,99995	291,9292603	1184,331885	13020008,81	0,999997307	7,20655E-11
0,99995	194,6195068	1166,861041	3857780,388	0,999991176	7,2065E-11
0,99995	129,7463379	1146,307107	1143046,041	0,999971261	7,20636E-11
0,99995	86,49755859	1122,126009	338680,3084	0,999907060	7,2059E-11
0,99995	57,66503906	1093,677657	100349,721	0,999702091	7,20442E-11
0,99995	38,44335938	1060,209008	29733,25067	0,999055763	7,19976E-11
0,99995	25,62890625	1020,834128	8809,852049	0,997051447	7,18532E-11
0,99995	17,0859375	974,5107383	2610,326533	0,990986673	7,14161E-11
0,99995	11,390625	920,0126333	773,4300839	0,973375023	7,01469E-11
0,99995	7,59375	855,8972156	229,1644693	0,926141430	6,6743E-11
0,99995	5,0625	780,4673125	67,9005835	0,819274735	5,90416E-11
0,99995	3,375	691,72625	20,11869141	0,652234559	4,70037E-11
0,99995	2,25	587,325	5,96109375	0,527693158	3,80286E-11
0,99995	1,5	464,5	1,76625	0,501112481	3,6113E-11
0,99995	1	320	0,523333333	0,500028182	3,60349E-11

Table 1:Astronomical mass distribution profiles

G is the gravitational constant, d is the displacement factor number, the radius is the distance from the centre of the structure, the volume is the volume derived from the radius, and mass total is the overall mass occupying that volume. Distances are given by kiloparsec (kpc), volume by cubic-kiloparsec (kpc^3), and mass by billion solar masses (GM⊙).

The table illustrates an astronomical structure with a certain mass distribution profile from a radius of 1 kpc to 291,93kpc. The bottom-level constant is set to 0,5, and the displacement factor number d to 0,99995. The value of 1 intends to correspond with the deepest space of the parent structure.

The local gravitational constants are derived from the local G-formula, $G_l = G\frac{d_2}{d_1}$, using the radius of 7,59kpc as the reference volume d$_1$.

The results demonstrates that the displacement factor decreases the gravitational constant G to a significant degree. At a radius of 3,38kpc and 11,39kpc, the displacement factor is appr. 0,652 and 0,973, respectively. The gravitational strength is therefore about 49,2 % higher at 11,39kpc than 3,38kpc, which may be expressed as the displacement factor as illustrated in figure 2.

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Figure 2

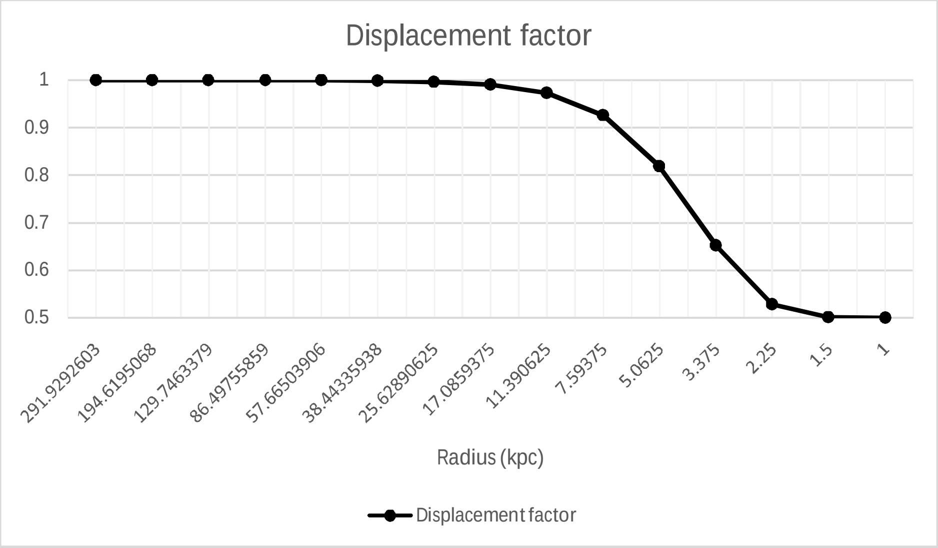

Figure 2: Graph of displacement factor

In view of the total mass numbers, given by GM⊙, the results also demonstrates that a high mass density alone is not enough to obtain a gravitational displacement that comes near to the bottom-level constant. Thereby, no other astronomical objects than black holes are heavy enough to locally come near to the bottomlevel on its own. Even the largest stars in the universe do only impact the gravitational constant to a barely measurable degree near its core based on these demonstrated values.

Figure 3

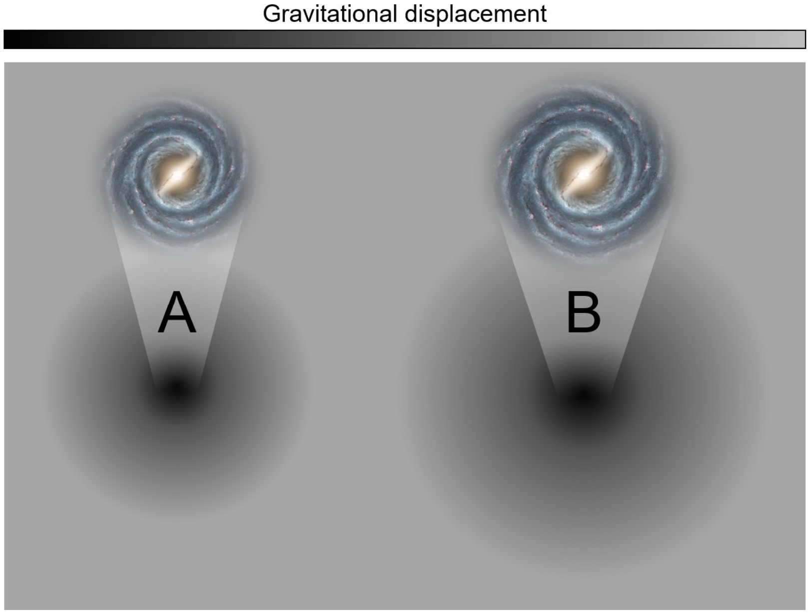

Figure 3: Principal illustration of the spatial extension of gravitational displacement

The figure 3 shows an astronomical structure A and B, where B is larger than A, both in form of total mass and volume. The gravitational displacement is therefore extending to a larger volume of space for B than A.

For a flat rotating astronomical structure, the gravitational displacement is expected to extend similarly in the radial direction as theaxial direction, which may form a spherical halo of displacement surrounding the flat structure. Thus, it creates a gravitational lensing effect that surrounds the visible matter to a significantly greater radius.

Figure 4

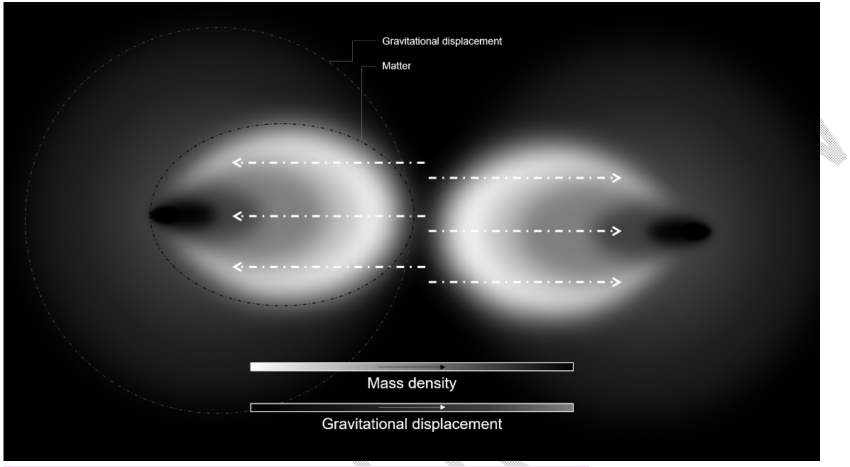

Figure 4: Principal illustration of a collision offset

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The kinetic energy of dense regions is, relative to their resistance through a collision, significantly higher than for less dense regions. Therefore, the magnitude of gravitational displacement is moved offset compared to the distribution of low-density matter, which are more significantly slowed in the interaction with each other. The figure 4 illustrates how this effect could appear for a certain type of collision, similar to the effects observed through gravitational lensing.

Only one structural level is demonstrated by this study. Two or several structural levels implies a higher degree of complexity, and requires further research.

Gravitational displacement profile (GDP)

The use of gravitational displacement to redefine the local gravitational strength in structures implies that every massive astronomical structure has its unique gravitational displacement profile (GDP). The velocity curves are determined by the GDP, and therefore, astronomical structures with different mass distribution profiles are also expected to have different velocity curves.

Since different astronomical structures are observed to have different velocity curves, among other in conflict with MOND, gravitational displacement demonstrates that this phenomenon may be an effect of GDP.

Figure 5

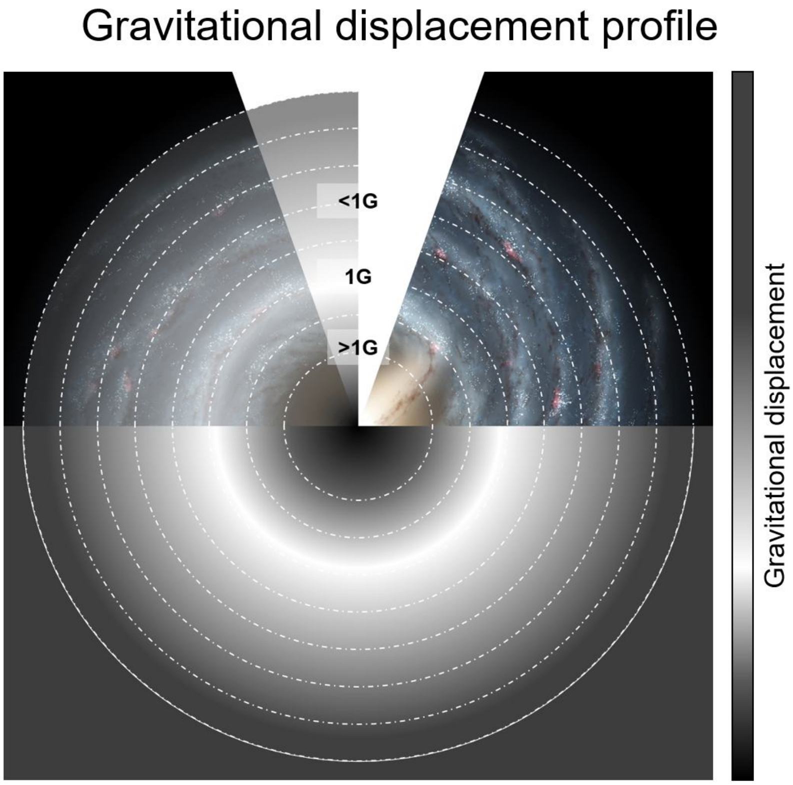

Figure 5: Principal illustration of gravitational displacement profile (GDP)

The figure5 illustrates an astronomical structure with a reference volume located between its inner and outer regions.

If the mass distribution profile of a structure were changed, for example by adding more mass to its outer regions than inner regions at a given total mass, the local gravitational displacement in the inner regions would decrease significantly. The GDP and the velocity curveswould change equivalently. This provides an interesting new type of dynamics that is not accounted for by present astronomical models.

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Figure 6

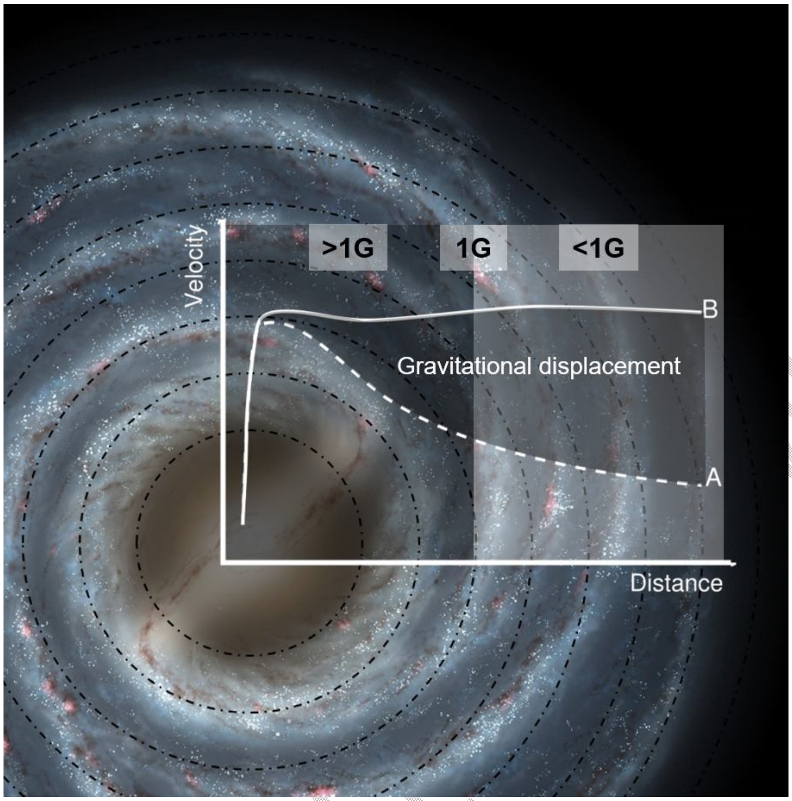

Figure 6:Principal illustration of the typical velocity curves

The gap between velocity curves

The figure6 illustrates the effect of gravitational displacement, where the line A is the calculated velocity curve without accounting for gravitational displacement, and the line B is the typical observed velocity curve.

The typical scenario for known galaxies in the universe is that the gap between the two velocity curves starts to enlarge after a certain radius, and then the further enlargement typically takes off after passing a radius farther away.

Close to the centre of a galaxy, the gap between the two velocity curvesis typically small. As demonstrated in this study, this might be an effect of the gravitational displacement nearing the bottom levelof gravitational displacement, which implies that the effect of gravitational displacement takes off when the total mass and mass density becomes high, like in the centre of galaxies.

Discussion

The demonstration of gravitational displacement as a possible solution to the problems associated with dark matter, may provide the following 7 consequences:

1) Massive and dense regions in the universe, like the centre of galaxies, contain more mass than they appear to with current laws of gravity;

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2) The gravitational strength is higher in peripheral regions of astronomical structures than near their centres;

3) The velocity curves of galaxiesare governed by the following two consequences of gravitational displacement;

  a) an increase of mass in galactic centres

  b) a decrease of gravitational strength relative to intergalactic space

4) The apparent missing mass at galactic-cluster level, among other in conflict with MOND-models, is caused by the increased gravitational strength of intergalactic space;

5) The variation of velocity curves for different types of astronomical structures, among other in conflict with MOND, is caused by the variation of the gravitational displacement profile (GDP);

6) The apparent mass-containing halos surrounding galaxies, among other observed through gravitational lensing, is caused by the extension of gravitational displacement into the space surrounding the structure;

7) The apparent offset of matter distribution in galactic-cluster collisions is caused by the spatial extension of gravitational displacement

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Conclusion

This study demonstrates that the problems associated with dark matter may be solvable with a new approach to gravity, with the accompanying possibility that dark matter as a form of matter does not need to exist. Contrary to present suggested modifications of gravitational laws, the new approach implies that the apparent missing mass in astronomical structures, also at respectively different structural levels, may be an effect of gravitational displacement. The spatial extension of gravitational displacement does also imply an offset in collisions between astronomical structures, in accordance with theoffset observed through gravitational lensing. Moreover, it does imply that each astronomical structure has its unique gravitational displacement profile, which leads to different velocity curves for different types of structures. The clear conclusion is therefore that the study strongly recommends gravitational displacement to be further researched as a possible solution to the problems associated with dark matter.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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