Theoretical Justification of the Relationship Between Gravitational and Electric Fields Based on Five-Dimensional Space

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I Introduction

In this paper, we explore a hypothetical model based on five-dimensional space, where we introduce the concept of "space density" $\rho(r)$, which plays a key role in the formation and understanding of the fifth dimension of space. We assume that changes in the fifth dimension, which we interpret as "space density," can lead to effects analogous to gravitational and electric fields. The paper discusses the fundamental postulates, the derivation of formulas for density distribution around one and two spheres, and their interpretation in the context of classical physical theories.

II Formulation of Postulates in Hypothetical Five-Dimensional Space

Let's assume that our space can bend not only along with its metric but also compress and expand in various regions without changing the metric, meaning the space can bend relative to its metric.

Suppose our space has a fifth dimension measured in new abstract units. Paying homage to enthusiasts who unsuccessfully tried to find evidence of ether, we will measure this fifth dimension of space in new physical units called "Etheriums." Do not be alarmed by the experiments conducted by Michelson and Morley on the detection of ether; I fully agree with the results of these experiments, which show that there is no medium that carries electromagnetic waves, including light! Moreover, our space is hypothetical, and we can make any assumptions in it. Our primary task is to study what consequences such an assumption about the existence of a fifth dimension might lead to in abstract space.

We assume that each volume of space can be uniquely associated with a certain number of Etheriums, meaning we can talk about a parameter of space that can be interpreted as density, which is the ratio of the number of Etheriums in a given region of metric space to the volume of that region.

I emphasize that this characteristic of space can be interpreted as density, but it is not density in the sense of material density, such as baryonic density. Unlike material density, space density does not cause curvature of spacetime along with its metric and thus does not form mass in the classical sense. We can only talk about the amount of space density in a given metric volume (curved with metric or not). Compression or stretching of space relative to its metric will be characterized by a change in the number of Etheriums in that region (volume) of space, and thus we can intuitively associate it with changes in density that we observe in ordinary matter. Integrating over an arbitrary volume of space will give us the amount of density contained in that volume, and thus this expression will have the dimension of Etheriums. We will accept the dimension of space density as Etherium/m^3.

This characteristic of space measured in Etheriums cannot be expressed in the known coordinates of our three-dimensional space (with the possibility of curvature along with the metric) and one time coordinate. Thus, mathematically, our characteristic of space—its fifth dimension—will be orthogonal to all other coordinates of our space. On this basis, it can be accepted as the fifth dimension, and space-time can be extended to a hypothetical representation of space-time-density.

Before we proceed to study the properties of this "hypothetical" universe, let us formulate the main laws (Postulates) that will operate in our new five-dimensional space and define its properties. Let's see what results we will obtain by investigating the properties of this five-dimensional space.

Postulates

Here are the postulates:

2.1 Space Density $\rho(r)$

In five-dimensional space, density $\rho(r)$ characterizes the state of space and can change, thus allowing us to talk about the curvature of space without curvature of its metric. Let us call this phenomenon "first-order space curvature," a term used in the Theory of Relativity but with a slightly different context in this theory.

2.2 Spherical Symmetry

The distribution of space density in perturbation is assumed to have spherical symmetry. The space density distribution $\rho(r)$ is assumed to be symmetric about any point that is the center of perturbation.

2.3 Law of Conservation of Space Density Quantity

When perturbing a certain region of space, the surrounding space can change its density such that the total density of all space remains unchanged. In other words, to a certain approximation, it can be said that the total "density" of space over a finite volume must remain constant compared to the volume of perturbation of this space.

2.4 Law of Entropy Minimization of Space Density

Space tends to reach a state of minimal entropy where space density is uniform. We assume that our space before perturbation has some density ρ_0 and under any perturbation, the distribution of space will strive to compensate for this curvature and return to its original state when the entropy of space density is minimal, i.e., density is uniform throughout the volume of space. We can assume that when the density of all space equals ρ_0, the entropy in such a space is zero.

III Distribution of Space Density Around a Compressed Spherical Region of Space

Let us consider two states of our fictional universe. In the first state, the density of space is constant and equals ρ_0 throughout the entire space. In the second state of the system, we have a certain region of space bounded by a sphere $S(R_1)$ that we compress to $S(R_1')$. We need to find the distribution of space density inside the sphere and outside it according to the laws established in our hypothetical universe.

3.1 Density Distribution After Compression

Inside the sphere of radius R_1':

The density after compression inside the sphere is given by:

$$\rho_{\text{inside}} = \rho_0 + \rho_1$$

where ρ_1 is the added density, determined from the volume ratio before and after compression:

$$\rho_0 V(R_1) = \rho_{\text{inside}} V(R_1')$$

Substituting the volumes of the spheres:

$$\rho_0 \frac{4}{3}\pi R_1^3 = (\rho_0 + \rho_1)\frac{4}{3}\pi R_1'^3$$

Simplifying:

$$\rho_0 R_1^3 = (\rho_0 + \rho_1) R_1'^3$$

$$\rho_0 R_1^3 = \rho_0 R_1'^3 + \rho_1 R_1'^3$$

$$\rho_1 = \rho_0 \left(\frac{R_1^3}{R_1'^3} - 1\right)$$

3.2 Density Distribution Outside the Sphere

Outside the sphere, it is assumed that the amount of density removed from the surrounding space should be finite and equal to the amount added inside (i.e., $\rho_1 \cdot V(R_1')$). Thus, the integral of the disturbance from the surface of the compressed region to infinity should yield a finite number, meaning the integrable function must converge. In three-dimensional space, such a function is $\frac{1}{r^4}$. Let us assume that the distribution of reduced density outside the compressed region satisfies this distance dependence. Then the space density decreases as follows:

$$\Delta\rho_{\text{decrease}}(r) = \frac{A}{r^4}$$

3.3 Normalization Coefficient A

To satisfy the conservation of space density, the integral of $\Delta\rho_{\text{decrease}}(r)$ over the volume from R_1' to infinity must equal the added density inside the sphere:

$$\rho_1 V(R_1') = \int_{R_1'}^{\infty} \Delta\rho_{\text{decrease}}(r) \cdot 4\pi r^2 \, dr$$

Substituting:
$$\rho_1 \frac{4}{3}\pi R_1'^3 = 4\pi \int_{R_1'}^{\infty} \frac{A}{r^4} r^2 \, dr$$
Solving the integral:
$$4\pi A \int_{R_1'}^{\infty} \frac{1}{r^2} \, dr = 4\pi A \left[-\frac{1}{r} \right]_{R_1'}^{\infty} = 4\pi A \left(\frac{1}{R_1'} - 0 \right) = \frac{4\pi A}{R_1'}$$
Equality of densities:
$$\rho_1 \frac{4}{3}\pi R_1'^3 = \frac{4\pi A}{R_1'}$$
Finding A:
$$A = \rho_1 \frac{R_1'^4}{3}$$
Final formula for $\Delta\rho_{\text{decrease}}(r)$:
$$\Delta\rho_{\text{decrease}}(r) = \frac{A}{r^4} = \frac{\rho_1 \frac{R_1'^4}{3}}{r^4}$$
Now multiply both the numerator and the denominator by 4π:
$$\Delta\rho_{\text{decrease}}(r) = \frac{4\pi\rho_1 \frac{R_1'^4}{3}}{4\pi r^4} = \frac{\rho_1 \frac{4}{3}\pi R_1'^4}{4\pi r^4} = \frac{\rho_1 \frac{V(R_1')}{R_1'}}{r^4} = \frac{\rho_1 \cdot R_1' \cdot V(R_1')}{4\pi r^4}$$
Thus, the final formula for the decrease in density is:
$$\Delta\rho_{\text{decrease}}(r) = \frac{\rho_1 \cdot R_1' \cdot V(R_1')}{4\pi r^4}$$

3.4 Checking the Conservation of Space Density

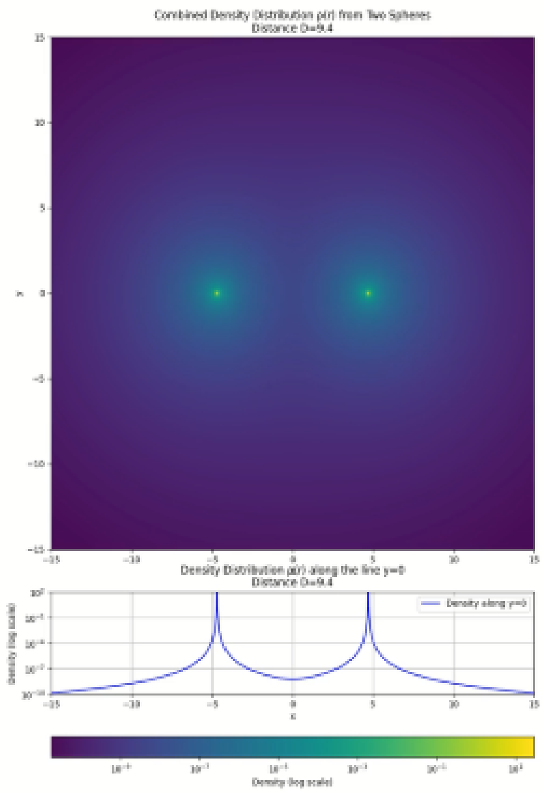
We check that the added density inside the sphere equals the reduced density outside it using the found formula:
$$\rho_1 V(R_1') = \int_{R_1'}^{\infty} \Delta\rho_{\text{decrease}}(r) \cdot 4\pi r^2 \, dr$$
Substituting the expression for $\Delta\rho_{\text{decrease}}(r)$:
$$\rho_1 \frac{4}{3}\pi R_1'^3 = \int_{R_1'}^{\infty} \frac{\rho_1 \cdot R_1' \cdot V(R_1')}{4\pi r^4} \cdot 4\pi r^2 \, dr$$
$$\rho_1 \frac{4}{3}\pi R_1'^3 = \rho_1 \cdot R_1' \cdot V(R_1') \int_{R_1'}^{\infty} \frac{1}{r^2} \, dr$$
Integrating:
$$\rho_1 \cdot R_1' \cdot V(R_1') \left[-\frac{1}{r} \right]_{R_1'}^{\infty} = \rho_1 \cdot R_1' \cdot V(R_1') \left(\frac{1}{R_1'} - 0 \right) = \frac{\rho_1 \cdot R_1' \cdot V(R_1')}{R_1'}$$
Result:
$$\rho_1 \frac{4}{3}\pi R_1'^3 = \rho_1 V(R_1')$$
Thus, we see that the chosen density distribution $\sim \frac{1}{r^4}$ outside the compressed sphere satisfies the law of conservation of space density: the amount of added density inside the sphere

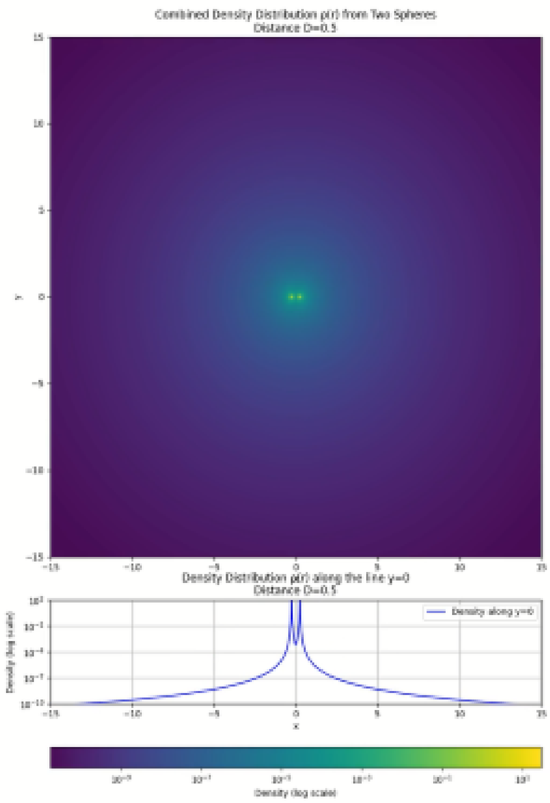
during its compression equals the amount of space density "removed" from the space outside the sphere. The disturbance outside the sphere has finite dimensions and does not cause infinite disturbances in space, unlike its compression or stretching over the entire infinite space. The disturbance in the form of compression of a limited region of space causes a disturbance in the form of stretching in a similarly limited region, with the disturbance (change in space density relative to ρ_0) approaching zero as r approaches infinity.

IV Interaction of Two Compressed Space Spheres

Now let's consider how the density distribution of space outside the compressed region of space, bounded by a sphere, changes in the presence of a second similar sphere with a compressed region of space. Let's add a second compressed spherical region to our space — another such sphere of compressed space from $S(R_2)$ to $S(R_2')$, located at a distance D from the first. Let's examine how the density distribution of space around the first sphere changes due to the second sphere.

Distribution of space density in the area surrounding the spheres:





I built a mathematical model that constructs a three-dimensional array of values $\Delta\rho_{\text{decrease}}(r_1)$ and $\Delta\rho_{\text{decrease}}(r_2)$, representing the density distribution of space outside the first and second spheres, respectively. The code also outputs a graph of the space density along the line connecting the centers of the spheres. By bringing the spheres closer together, one can visually observe (using a logarithmically normalized color scale) the change in the space density distribution in the space surrounding the spheres, as well as a graph of the density distribution along the line connecting the centers of the spheres.

Looking at the images of the space density distribution around the spheres, based on the mathematical model, it can be seen that as the spheres come closer, the density distribution outside these spheres changes. Moreover, it becomes apparent that the amount of non-uniformity in the density distribution around the disturbance caused by one sphere increases as the spheres approach each other and decreases as they move apart.

I pondered how to evaluate this disturbance, which arises in the density distribution of space due to the presence of two spheres, depending on the distance between them. We need such a characteristic of this disturbance that will take into account the change in distribution not only along the line connecting these spheres but also throughout the volume outside the spheres to infinity.

I couldn't think of anything better than to first take the gradient over the entire volume from the density distribution of space, which will be a characteristic of the rate of change in density distribution, and then integrate this result again over the entire volume. Moreover, I need to understand the disturbance caused by the second sphere on the first, so I need to first take the gradient of the space density outside the first sphere, and then integrate the obtained values over the entire space from R_1' to infinity. The obtained solution of this integral will characterize the amount of curvature, or more correctly, the amount of space density disturbance caused by the first sphere alone.

Then let's add the second sphere at a distance D from the first and find the amount of space density disturbance outside the first sphere in the presence of the second sphere. Then, from the obtained total amount of space density disturbance outside the first sphere in the presence of the second sphere at a distance D, subtract the amount of disturbance of the first sphere alone, thus obtaining the difference in the amount of disturbance created by the density distribution of the second sphere on the density distribution of the first sphere. It's convoluted, but I couldn't think of anything smarter. If you know more correct methods for assessing changes in spatial volumetric distribution, please suggest them; I will gladly study them.

Since our space tends to decrease the entropy of the space density distribution, I assume that the amount of disturbance will be proportional to the amount of interaction exerted by the second sphere on the first. Let's do this:

4.1 Integral of the Density Gradient for One Sphere

For one sphere, let the density be given by $\Delta\rho_{\text{decrease}}(r_1)$:

$$\Delta\rho_{\text{decrease}}(r_1) = \frac{R_1'\rho_1 V(R_1')}{4\pi r_1^4}$$

The gradient of the density is:

$$\nabla\Delta\rho_{\text{decrease}}(r_1) = -\frac{4R_1'\rho_1 V(R_1')}{4\pi r_1^5}$$

Integrating over the volume:

$$\int_V \nabla\Delta\rho_{\text{decrease}}(r_1)\, dV = \int_{R_1'}^{\infty} -\frac{R_1'\rho_1 V(R_1')}{\pi r_1^5} \cdot 4\pi r_1^2\, dr = -4R_1'\rho_1 V(R_1') \int_{R_1'}^{\infty} \frac{1}{r_1^3}\, dr$$

Solving the integral:

$$\int_{R_1'}^{\infty} \frac{1}{r_1^3}\, dr = \left[-\frac{1}{2r_1^2}\right]_{R_1'}^{\infty} = \left(0 - \left(-\frac{1}{2R_1'^2}\right)\right) = \frac{1}{2R_1'^2}$$

Thus:

$$\int_V \nabla\Delta\rho_{\text{decrease}}(r_1)\, dV = -4R_1'\rho_1 V(R_1') \cdot \frac{1}{2R_1'^2} = -2\frac{\rho_1 V(R_1')}{R_1'}$$

4.2 Integral of the Density Gradient for Two Spheres

Now for two spheres, located at a distance D:

$$\Delta\rho_{\text{total}}(r) = \Delta\rho_{\text{decrease}}(r_1) + \Delta\rho_{\text{decrease}}(r_2)$$

The density for the second sphere (the center of the second sphere is at a distance D):

$$\Delta\rho_{\text{decrease}}(r_2) = \frac{R_2'\rho_2 V(R_2')}{4\pi(r-D)^4}$$

The gradient:

$$\nabla\Delta\rho_{\text{decrease}}(r_2) = -\frac{4R_2'\rho_2 V(R_2')}{4\pi(r-D)^5}$$

Integrating over the volume:

$$\int_V \nabla\Delta\rho_{\text{decrease}}(r_2)\, dV = \int_{R_2'}^{\infty} -\frac{R_2'\rho_2 V(R_2')}{\pi(r-D)^5} \cdot 4\pi r^2\, dr = -4R_2'\rho_2 V(R_2') \int_{R_2'}^{\infty} \frac{1}{(r-D)^3}\, dr$$

Solving the integral:

$$\int_{R_2'}^{\infty} \frac{1}{(r-D)^3}\, dr = \left[-\frac{1}{2(r-D)^2}\right]_{R_2'}^{\infty} = \left(0 - \left(-\frac{1}{2(R_2'-D)^2}\right)\right) = \frac{1}{2(R_2'-D)^2}$$

Thus:

$$\int_V \nabla\Delta\rho_{\text{decrease}}(r_2)\, dV = -4R_2'\rho_2 V(R_2') \cdot \frac{1}{2(R_2'-D)^2} = -2\frac{\rho_2 V(R_2')}{R_2'-D}$$

4.3 Final Integral for Two Spheres

The total integral for two spheres:

$$\int_V \nabla\Delta\rho_{\text{total}}(r)\, dV = -2\frac{\rho_1 V(R_1')}{R_1'} - 2\frac{\rho_2 V(R_2')}{R_2'-D}$$

Difference ΔW:

$$\Delta W = \left(-2\frac{\rho_1 V(R_1')}{R_1'} - 2\frac{\rho_2 V(R_2')}{R_2'-D}\right) - \left(-2\frac{\rho_1 V(R_1')}{R_1'}\right) = -2\frac{\rho_2 V(R_2')}{R_2'-D}$$

Approximation $R_2' \ll D$

When $R_2' \ll D$:

$$\Delta W \approx -2\frac{R_2'\rho_2 V_{R2'}}{D^2}$$

4.4 Results and Further Discussion

We obtained a very interesting result: the amount of disturbance in the space density distribution caused by the second sphere is similar to the formula for the electric field strength caused by a charge derived from Coulomb's law for the electric field, if we consider $R'_2\rho_2 V_{R2'}$ as the charge of the second sphere. Isn't it a bit mesmerizing when, based on theoretical representations of a hypothetical five-dimensional space endowed with the laws of spherical symmetry, the law of conservation of space density, and the law of minimizing space density entropy, we obtain a formula that very much resembles the formula for electric field strength derived from Coulomb's law based on experimental data?

Upon further analysis of this formula, it becomes clear that what we understand as an electric charge is the amount of space density added to the volume of the sphere $V(R'_1)$, that is, the product of ρ_1 and the volume of the compressed space region.

However, in my opinion, the most interesting result of the study is something else. If you noticed, we have not yet introduced in our hypothetical universe such a concept as energy or the potential of interaction caused by the curvature of the space density distribution, operating exclusively with the concepts of the amount of space density and the amount of its curvature – disturbance. The amount of disturbance in space density exerted by the second sphere on the space density distribution of the first sphere can be interpreted as some amount of interaction between the spheres or, in our usual understanding, as force. By integrating the amount of interaction over d – the distance between the spheres from infinity to D, we obtain what we call the potential of the electric field or the potential energy of the field.

If we look closely at our formula, we will see that at the point $D = R'_1$ we will have division by zero, and the amount of interaction will be infinite, and at $D < R'_1$, the amount of interaction will change sign, and hence the hypothetical potential energy arising from the interaction of two spheres will also change sign. Consequently, this formula implies that the law of conservation of energy has a very limited scope of application and is a special case of the state of the universe when it holds.

This refers us to concepts such as dark energy and matter, when massive objects at great distances begin to repel and move away with acceleration. I assume that this is not related to some hypothetical "invisible" dark energy or matter, but is related to the properties of our space-time-density – with the fact that at large distances the potential energy of gravitational interaction changes sign, as it is easier for space to minimize the entropy of space in this way. Following this logic, our understanding of energy and the potential field is fundamentally incorrect from the perspective of a five-dimensional space-time-density, which strives to reduce its entropy along the path of least resistance, but this is the subject of a completely different study of mine.

The conclusion is that the representation of our space as a five-dimensional object that can curve relative to its metric can shed light on the mechanism of such a phenomenon as the electric field. Let's not assert that Coulomb's law has already been derived theoretically and is a consequence of Maxwell's equations. Coulomb's law and Ampère's law form the basis of Maxwell's equations, and it is not surprising that, under certain simplifications, Maxwell's equations again turn into Coulomb's law. I am not aware of a theoretical derivation not based on empirical knowledge, which forms the basis of Coulomb's law (obtained experimentally);

I have not found it in open sources, which is not surprising as official science does not yet recognize the presence of a fifth dimension in our space. Similar theoretical representations of the nature of the interaction of electric charges are impossible in principle. In my opinion, my hypothesis about the fifth dimension of our space deserves attention and discussion.

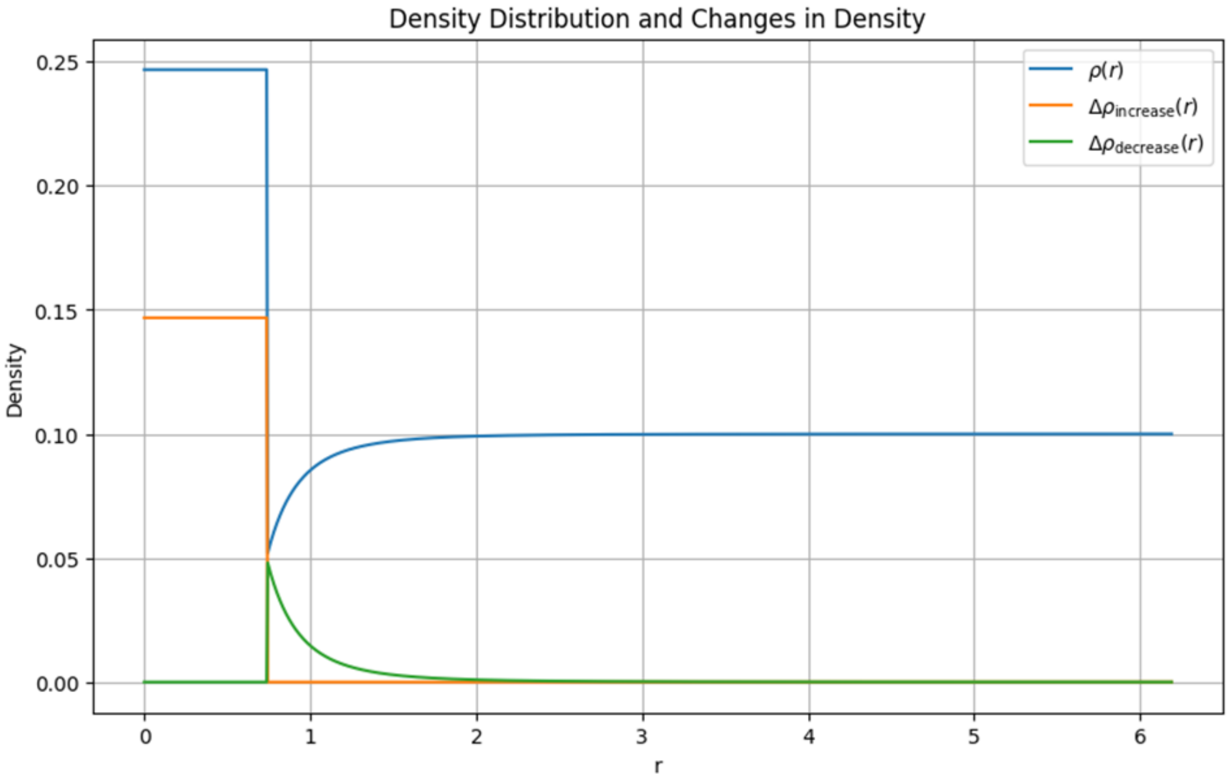
Another interesting conclusion of this theory about five-dimensional space is that what we observe in the interaction of charged particles is not the field of these particles, but the result of their interaction. The real picture of the field created by a point charge represents a dependence of $\sim 1/r^4$, and the dependence we observe in Coulomb's law $\sim 1/r^2$ is a consequence of the effect of the second sphere's field on the distribution of the first sphere's field. In other words, the charge's own field, distorted by the field of the second charge, acts on the charge and causes it to move in space, rather than the field of the second charge directly acting on the first charge as is currently believed.

Accepting this model makes it completely clear what an electromagnetic wave is. If we assume that when a charge is displaced, the change in the density distribution in the surrounding space does not occur instantly but with some delay, and the propagation of the change in the space density distribution occurs at a certain speed, say the speed of light, this will allow us to obtain completely new wave equations for electromagnetic waves created not by a conductor with alternating current, for which Maxwell's equations were written, but for a point charge performing harmonic oscillations relative to the space metric. I will not derive these equations, I think anyone knowing the space density distribution around a point charge $\sim 1/r^4$, can easily derive wave equations for the electromagnetic field knowing the propagation speed of the disturbance equal to the speed of light.

V Solution of the Integral of the Gradient Over the Entire Volume for the Equation of Space Density Distribution of One Sphere

As you may have noticed in the previous sections of my research, we considered the space density distribution outside the compressed spheres, i.e., for $r > R1'$. Now let's write our space density distribution for one sphere from $r = 0$ to infinity, taking into account the boundary conditions of space density distribution at the boundary of the compressed sphere $S(R1')$, and let's find the integral of the gradient of this distribution — the amount of disturbance, to understand whether our space is in a disturbed state or it is in equilibrium in terms of the amount of space disturbance, due to the space density distribution $\sim 1/r^4$ outside the compressed space region in the form of a sphere.

Let's write our distribution under boundary conditions using the Heaviside function and take the integral of the gradient of this space density distribution over the entire volume. The idea is that I assume that mass in the classical understanding of mass is also related to space density. Curvature of space together with its metric (second-order curvature) and curvature of space by Curvature of space relative to its measurement such as space density is inevitably related to boundary conditions! Based on the postulates of our space, inside the compressed sphere, the space density will always be uniform, and thus, to comply with the law of conservation of space, a sharp density transition boundary inevitably arises, which can be described by the Heaviside function, and it is this boundary — as a strong disturbance of space density — that causes the curvature of space relative to its metric. Here is an illustration showing the space density distribution along any radius vector from the center of disturbance to infinity:



These two phenomena are inextricably linked to each other: if there is a curvature of space density relative to ρ_0, there must be a transition boundary that causes the curvature of space relative to it. In my opinion, this is the connection between the electric and gravitational fields, that they are inseparably linked. As I have already mentioned, the change in space density distribution relative to its uniform distribution ρ_0 is first-order curvature, which can manifest itself as an electric field in statics and as a magnetic field when this field moves relative to the space metric, and the second-order curvature arising from boundary conditions — curvature of space together with the metric — manifests itself as a gravitational field. However, the basis of these interactions is the tendency of space to minimize entropy — the tendency to uniform space density distribution and minimization of disturbance.

In this paradigm, the magnetic field is a kind of first-order curvature — dynamic first-order curvature, which changes the nature of interaction: moving like-charged particles begin to attract under the influence of the magnetic field caused by the movement of space density relative to its metric.

As confirmation of this theory about the fifth dimension of our space in the form of space density, there should also be dynamic second-order curvature according to this logic, something like a gravitational magnetic field when moving massive bodies causing curvature of the space metric interact similarly to moving electric charges, but as far as I know, experiments in this direction have not yet been conducted.

5.1 Representation of Space Density Distribution Inside and Outside the Compressed Spherical Region of Space Using the Heaviside Function

To verify the correctness of using the Heaviside function $H(x)$ in this density distribution $\Delta\rho(r)$, we will consider the boundary conditions and ensure that they correctly correspond to the conditions of the problem.

The basic density distribution $\rho(r)$ is defined as follows:

$$\rho(r) = \begin{cases} \rho_0 + \rho_1, & \text{if } r \leq R1' \\ \rho_0 - \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4}, & \text{if } r > R1' \end{cases}$$

Increase in density $\Delta\rho_{\text{increase}}(r)$:

$$\Delta\rho_{\text{increase}}(r) = \begin{cases} \rho_1, & \text{if } r \leq R1' \\ 0, & \text{if } r > R1' \end{cases}$$

Decrease in density $\Delta\rho_{\text{decrease}}(r)$:

$$\Delta\rho_{\text{decrease}}(r) = \begin{cases} 0, & \text{if } r \leq R1' \\ \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4}, & \text{if } r > R1' \end{cases}$$

Now let's express $\Delta\rho(r)$ in terms of the Heaviside function:

1. For the increase in density $\Delta\rho_{\text{increase}}(r)$:

$$\Delta\rho_{\text{increase}}(r) = \rho_1 H(R1' - r)$$

2. For the decrease in density $\Delta\rho_{\text{decrease}}(r)$:

$$\Delta\rho_{\text{decrease}}(r) = \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4} H(r - R1')$$

So, the total change in density:

$$\Delta\rho(r) = \Delta\rho_{\text{increase}}(r) - \Delta\rho_{\text{decrease}}(r)$$

$$\Delta\rho(r) = \rho_1 H(R1' - r) - \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4} H(r - R1')$$

Now let's check the fulfillment of the boundary conditions:

1. For $r \leq R1'$:

$$\Delta\rho(r) = \rho_1 H(R1' - r) - \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4} H(r - R1')$$

Since $H(R1' - r) = 1$ and $H(r - R1') = 0$:

$$\Delta\rho(r) = \rho_1 - 0 = \rho_1$$

2. For $r > R1'$:

$$\Delta\rho(r) = \rho_1 H(R1' - r) - \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4} H(r - R1')$$

Since $H(R1' - r) = 0$ and $H(r - R1') = 1$:

$$\Delta\rho(r) = 0 - \frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4} = -\frac{R1' \cdot \rho_1 \cdot V_{R1'}}{4\pi r^4}$$

Now, substituting $V_{R1'} = \frac{4}{3}\pi(R1')^3$:

$$\Delta\rho(r) = -\frac{R1' \cdot \rho_1 \cdot \frac{4}{3}\pi(R1')^3}{4\pi r^4} = -\frac{\rho_1 \cdot R1'^4}{3r^4}$$

Thus, we arrive at the following expression for $\Delta\rho(r)$:

$$\Delta\rho(r) = \rho_1 H(R1' - r) - \frac{\rho_1 \cdot R1'^4}{3r^4} H(r - R1')$$

Therefore, the density distribution using the Heaviside function correctly reflects the change in density:

$$\Delta\rho(r) = \rho_1 \left[H(R1' - r) - \frac{R1'^4}{3r^4} H(r - R1') \right]$$

5.2 Verification of Density Conservation Condition Using Heaviside Function

To verify whether our equation, written using the Heaviside function, satisfies the condition of density conservation, we take the integral of $\Delta\rho(r)$ over the entire volume. Recall that $\Delta\rho(r)$ is given by:

$$\Delta\rho(r) = \rho_1 \left[H(R1' - r) - \frac{R1'^4}{3r^4} H(r - R1') \right]$$

We will compute the integral:

$$\int_0^\infty \Delta\rho(r) \cdot 4\pi r^2 \, dr$$

We split the integral into two parts corresponding to $\Delta\rho_{\text{increase}}(r)$ and $\Delta\rho_{\text{decrease}}(r)$:

$$\int_0^\infty \Delta\rho(r) \cdot 4\pi r^2 \, dr = \int_0^\infty \left[\rho_1 H(R1' - r) - \frac{\rho_1 \cdot R1'^4}{3r^4} H(r - R1') \right] \cdot 4\pi r^2 \, dr$$

We split this into two separate integrals:

$$\int_0^\infty \rho_1 H(R1' - r) \cdot 4\pi r^2 \, dr - \int_0^\infty \frac{\rho_1 \cdot R1'^4}{3r^4} H(r - R1') \cdot 4\pi r^2 \, dr$$

First, consider the integral:

$$\int_0^{R1'} \rho_1 \cdot 4\pi r^2 \, dr = 4\pi\rho_1 \int_0^{R1'} r^2 \, dr = 4\pi\rho_1 \left[\frac{r^3}{3} \right]_0^{R1'} = 4\pi\rho_1 \cdot \frac{(R1')^3}{3} = \frac{4\pi\rho_1 (R1')^3}{3}$$

Now consider the second integral:

$$\int_{R1'}^\infty \frac{\rho_1 \cdot R1'^4}{3r^4} \cdot 4\pi r^2 \, dr = \frac{4\pi\rho_1 R1'^4}{3} \int_{R1'}^\infty \frac{1}{r^2} \, dr = \frac{4\pi\rho_1 R1'^4}{3} \left[-\frac{1}{r} \right]_{R1'}^\infty$$

Evaluating the limits:

$$\frac{4\pi\rho_1 R1'^4}{3} \left(-\frac{1}{\infty} + \frac{1}{R1'} \right) = \frac{4\pi\rho_1 R1'^4}{3} \cdot \frac{1}{R1'} = \frac{4\pi\rho_1 R1'^3}{3}$$

Adding both results:

$$\int_0^\infty \Delta\rho(r) \cdot 4\pi r^2 \, dr = \frac{4\pi\rho_1 (R1')^3}{3} - \frac{4\pi\rho_1 (R1')^3}{3} = 0$$

Thus, the integral of $\Delta\rho(r)$ over the entire volume is zero:

$$\int_0^\infty \Delta\rho(r) \cdot 4\pi r^2 \, dr = 0$$

This result is expected, as we set up the problem such that the increase in density in one volume is compensated by a decrease in density by the same amount outside this volume across the entire space. This is a consequence of the density conservation law of our universe. However, we have verified the correctness of boundary conditions using the Heaviside function for our density distribution for a sphere from 0 to infinity.

5.3 Gradient Integral Calculation and Equilibrium Check

Now let's compute the integral of the gradient to determine whether the space is in equilibrium or perturbed.

5.3.1 Main Density Distribution

To define the density $\Delta\rho(r)$:

$$\Delta\rho(r) = \rho_1 \left[H(R_1' - r) - \frac{\rho_1 \cdot R_1'^4}{3r^4} H(r - R_1') \right]$$

5.3.2 Density Gradient

We need to find the gradient $\nabla\Delta\rho(r)$: 1. **Derivative of $H(R_1' - r)$**:

$$\frac{\partial}{\partial r} H(R_1' - r) = -\delta(r - R_1')$$

2. **Derivative of $\frac{R_1'^4}{3r^4} H(r - R_1')$**:

$$\frac{\partial}{\partial r} \left(\frac{R_1'^4}{3r^4} H(r - R_1') \right) = -\frac{4R_1'^4}{3r^5} H(r - R_1') + \frac{R_1'^4}{3r^4} \delta(r - R_1')$$

Thus, the partial derivative is:

$$\frac{\partial(\Delta\rho)}{\partial r} = \rho_1 \left[-\delta(r - R_1') + \frac{4R_1'^4}{3r^5} H(r - R_1') - \frac{R_1'^4}{3r^4} \delta(r - R_1') \right]$$

5.3.3 Integration Over the Entire Volume

Integrate over the entire volume:

$$\int_0^\infty \nabla\Delta\rho(r) \cdot dV = \int_0^\infty \frac{\partial(\Delta\rho)}{\partial r} \cdot 4\pi r^2 \, dr$$

We split the integral into three parts: 1. **Integral of $-\rho_1 \delta(r - R_1')$**:

$$\int_0^\infty -\rho_1 \delta(r - R_1') \cdot 4\pi r^2 \, dr = -\rho_1 \cdot 4\pi (R_1')^2$$

2. **Integral of $\rho_1 \frac{4R_1'^4}{3r^5} H(r - R_1')$**:

$$\int_{R_1'}^\infty \rho_1 \frac{4R_1'^4}{3r^5} \cdot 4\pi r^2 \, dr = \rho_1 \cdot \frac{16\pi R_1'^4}{3} \int_{R_1'}^\infty \frac{1}{r^3} \, dr$$

Compute the integral:

$$\int_{R_1'}^{\infty} \frac{1}{r^3}\,dr = \left[-\frac{1}{2r^2}\right]_{R_1'}^{\infty} = \frac{1}{2(R_1')^2}$$

Thus:

$$\rho_1 \cdot \frac{16\pi R_1'^4}{3} \cdot \frac{1}{2(R_1')^2} = \rho_1 \cdot \frac{8\pi R_1'^2}{3}$$

3. **Integral of $-\rho_1 \frac{R_1'^4}{3r^4}\delta(r - R_1')$**:

$$\int_0^{\infty} -\rho_1 \frac{R_1'^4}{3r^4}\delta(r-R_1')\cdot 4\pi r^2\,dr = -\rho_1 \frac{R_1'^4}{3}\int_0^{\infty} \frac{\delta(r-R_1')}{r^4}\cdot 4\pi r^2\,dr = -\rho_1 \frac{R_1'^4}{3}\cdot\frac{4\pi}{(R_1')^2} = -\rho_1 \frac{4\pi R_1'^2}{3}$$

5.3.4 Final Integral

Combine all parts:

$$\int_0^{\infty} \nabla\Delta\rho(r)\cdot dV = -\rho_1 \cdot 4\pi(R_1')^2 + \rho_1 \cdot \frac{8\pi R_1'^2}{3} - \rho_1 \cdot \frac{4\pi R_1'^2}{3}$$

Bring to a common denominator and simplify:

$$\begin{aligned} &= -\rho_1 \cdot 4\pi(R_1')^2 + \rho_1 \cdot \frac{8\pi R_1'^2}{3} - \rho_1 \cdot \frac{4\pi R_1'^2}{3} \\ &= -\rho_1 \cdot \left(4\pi(R_1')^2 - \frac{4\pi(R_1')^2}{3}\right) \\ &= -\rho_1 \cdot \left(\frac{12\pi(R_1')^2}{3} - \frac{4\pi(R_1')^2}{3}\right) \\ &= -\rho_1 \cdot \frac{8\pi(R_1')^2}{3} \end{aligned}$$

Express in terms of the sphere's surface area $S(R_1')$:

$$S(R_1') = 4\pi(R_1')^2 \implies (R_1')^2 = \frac{S(R_1')}{4\pi}$$

Substitute into the integral:

$$\begin{aligned} \int_0^{\infty} \nabla\Delta\rho(r)\cdot dV &= -\frac{8\pi\rho_1\left(\frac{S(R_1')}{4\pi}\right)}{3} \\ &= -\frac{8\rho_1 S(R_1')}{12} \\ &= -\frac{2\rho_1 S(R_1')}{3} \end{aligned}$$

Thus, the integral of the density gradient over the entire volume, in terms of the sphere's surface area $S(R_1')$, is:

$$\int_0^{\infty} \nabla\Delta\rho(r)\cdot dV = -\frac{2\rho_1 S(R_1')}{3}$$

5.4 Conclusions

The result obtained presents an interesting observation: we see that the product of three-dimensional density and the surface area of a three-dimensional sphere expresses the magnitude of the spatial density perturbation. This confirms that, despite adherence to the conservation of spatial density, the system remains perturbed. Thus, to fulfill the fourth law of our universe— the tendency to minimize entropy of the spatial density distribution— it is necessary that the amount of perturbation in the spatial density also tends toward zero. However, if we make additional changes to the density distribution beyond the sphere and somehow redistribute the spatial density outside the sphere, this will, in turn, lead to a violation of the third law related to the conservation of spatial density.

In this context, it can be hypothesized that to compensate for this perturbation, space will curve, thus altering its metric. This way, both the third and fourth postulates of our hypothetical universe will be satisfied. It is now necessary to find a density distribution that will result in zero spatial density perturbation caused by the boundary conditions on the compressed sphere.

5.5 Integral of the Density Gradient for One Sphere

First, we will transform our formula for the spatial density perturbation into one representing the perturbation caused by the compression of a spherical region of space. For this purpose, we will multiply both the numerator and the denominator of the obtained formula for the spatial density perturbation by R_1'. Given that the volume of the sphere contains a certain amount of spatial density equal to the integral over the entire volume of the sphere from ρ_1, and that ρ_1 is uniformly distributed over the sphere's volume, the amount of added spatial density inside the sphere (Q_1) can be expressed as:

$$Q = (V(R_1) - V(R_1')) \cdot \rho_0$$

Thus:

$$\rho_1 = \frac{Q}{V(R_1')}$$

Considering the formula for ρ_1 and the formula for the amount of spatial density perturbation created by one compressed sphere from $S(R_1)$ to $S(R_1')$:

$$\int_0^\infty \nabla \Delta\rho(r) \cdot dV = -\frac{2\rho_1 S(R_1')}{3}$$

By multiplying the numerator and the denominator by R_1', we get:

$$\frac{\text{Numerator} \cdot R_1'}{\text{Denominator} \cdot R_1'} = \frac{Q \cdot V(R_1')}{V(R_1') \cdot R_1'}$$

Expanding the formula for the volume of the sphere:

$$V(R_1') = \frac{4}{3}\pi(R_1')^3$$

Substituting:

$$\frac{Q}{\frac{4}{3}\pi(R_1')^3}$$

Using the formula for the volume of a four-dimensional sphere:

$$V_4(R'_1) = \frac{\pi^2 (R'_1)^4}{2}$$

We can write:

$$\frac{Q}{V_4(R'_1)} = \frac{Q}{\frac{\pi^2 (R'_1)^4}{2}} = \frac{2Q}{\pi^2 (R'_1)^4}$$

Thus, our formula for the spatial density perturbation takes the form:

$$\frac{(3\pi Q) \cdot V_3(R'_1)}{4 \cdot V_4(R'_1)}$$

If we take $\rho'_1 = \frac{Q}{V_4(R'_1)}$ as the four-dimensional density, then the formula for the spatial density perturbation becomes:

$$\frac{3\pi \rho'_1 V_3(R'_1)}{4}$$

where $V_3(R'_1)$ is the three-dimensional volume of a sphere with radius R'_1, and $\rho'_1 = \frac{Q}{V_4(R'_1)}$ is the four-dimensional density.

This formula:

$$\frac{3\pi \rho'_1 V_3(R'_1)}{4}$$

can be interpreted as a form of gravitational charge. Next, it is straightforward to express the curvature coefficient $K(r)$ of the spatial metric, which, similar to the density distribution outside the compressed sphere, will be proportional to $1/r^4$ with some normalization factor. We will obtain an equation for the distribution of the coefficient $K(r)$—the curvature of the spacetime metric due to density—and then through the amount of perturbation that a second gravitational charge will create on the distribution of the coefficient $K(r)$—the curvature of the spacetime metric due to the first charge—derive something akin to gravitational equations.

However, as you may have noticed, the obtained formula, analogous to electric charges, will describe the repulsion of gravitational charges, while we know that massive bodies, which we associate with the curvature of spacetime along with their metric, attract each other. Here, we must consider that the curvature of the spatial density, both for electric and gravitational charges created by the second object, will interact directly with the "density lump," which represents both gravitational and electric charges. Remember that a gravitational charge is the surface area of a sphere multiplied by the three-dimensional density, which we simply approximated as a volume gravitational charge to find $K(r)$, analogous to electric charge. Thus, the surface area of a sphere multiplied by the three-dimensional density is essentially a four-dimensional bubble, and to minimize its entropy, space will tend to push out from less curved regions (where $K(r)$ is smaller) to areas with more curvature (where $K(r)$ is larger), i.e., towards a second sphere creating perturbation on the distribution of the curvature of the first. Hence, there will be a region where the forces of attraction and repulsion are equal, and beyond this region, objects that cause spacetime curvature will begin to repel, which is what we observe in cosmology as cosmic objects accelerate away from each other.

5.6 Evaluation of the Gravitational Charge and Its Physical Meaning

5.6.1 Application of the Analogy Between Gravitational and Electric Charges

Justification of the Analogy

- The application of the analogy between gravitational charge and electric charge is based on the mathematical similarity of the formulas for the spatial density perturbation. The article presents that the perturbation of space caused by one compressed sphere can be interpreted as a density distribution analogous to the distribution of the electric field.
- The interaction formula of two compressed spheres resembles Coulomb's law, which allows the use of the analogy between gravitational charge and electric charge. This similarity suggests that gravitational charge can play a role similar to that of electric charge in the generated spatial perturbations.

5.6.2 Physical Meaning of the Gravitational Charge

- The gravitational charge can be interpreted as the force that holds space in a compressed state. This implies that the gravitational charge is a measure of the energy required to create and maintain the compression of space.
- The article suggests that the amount of interaction created by the second sphere on the first can be interpreted as a force. This leads to the conclusion that the gravitational charge is the source of this force that holds the compressed region of space.

5.7 Analysis of the Gravitational Charge in the Context of the Standard Model of Elementary Particles

5.7.1 Analogy with the Higgs Boson

- In the standard model of elementary particles, the Higgs boson is responsible for the mechanism by which particles acquire mass. In this context, the gravitational charge can be considered as an analogue of the Higgs field, but in a spatial-energy interpretation.
- If the gravitational charge is interpreted as the force holding space in a compressed state, this resembles the mechanism of the Higgs field, which creates a potential through which particles interact and acquire mass.

5.7.2 Role in the Structure of Space-Time

- The gravitational charge can be considered as a quantum of space curvature, analogous to how the Higgs boson acts in the context of particle mass. This suggests that the gravitational charge could be a link between classical gravity theory and quantum mechanics.
- In the hypothesis presented in the article, the gravitational charge is responsible for creating and maintaining space curvature, which may indicate the existence of a fundamental particle or field that governs this process.

VI Results of the Study

The obtained result regarding the perturbation of spatial density, which refers to four-dimensional density, represents an interesting and potentially profound discovery in the context of theoretical physics and cosmology.

6.1 4D Density Interpretation

The transition to four-dimensional density $\rho_1' = \frac{2Q}{\pi^2 (R_1')^4}$ may suggest that spatial density perturbations are not merely a three-dimensional phenomenon. This could hint at deeper properties of spacetime where four-dimensional aspects play a crucial role. In some theories, such as string theory or general relativity in extended models, spaces may have additional dimensions.

6.2 Impact on Conservation Laws

The result indicates that changes in three-dimensional density might be related to additional dimensions or properties of spacetime. This could imply that conservation laws (in this case, density) might manifest differently depending on the number of dimensions. In four-dimensional space, density may be more complex, and changes in three-dimensional coordinates might affect properties in four-dimensional dimensions.

6.3 Gravitational Field and Metric Curvature

If we consider the result in the context of a gravitational field, it might suggest that the perturbation in density is associated with changes in the spacetime metric. Gravity in general relativity is related to the curvature of spacetime, and if density perturbations occur, this might mean that the metric is curved according to changes in density.

6.4 Physical Interpretation

Examining the formula for density perturbation:

$$\frac{3\pi \rho_1' V_3(R_1')}{4}$$

where ρ_1' is the four-dimensional density, and $V_3(R_1')$ is the three-dimensional volume of the sphere, can be interpreted as a form of gravitational charge or energy distributed in space that influences its geometry. This might suggest that spacetime is not strictly three-dimensional in terms of its physical properties, and has "influential" components in an additional dimension or in the form of more complex structures. In other words, we do not know what holds charges in the compressed state of spatial density; perhaps the four-dimensional charge somehow determines the amount of energy spent compressing the spatial density from $S(r_1)$ to $S(R_1')$, and this is the energy that holds the electric charge in a compressed state. In other words, gravitational charge, or as interpreted by the Standard Model, the Higgs boson, is the amount of multidimensional energy spent on forming an elementary particle.

6.5 Theoretical and Practical Implications

If such results are indeed present in real physics, they could impact our understanding of fundamental physical laws. For example:

- **Exploration of Additional Dimensions:** If density is related to four dimensions, this could lead to new research and theories about the structure of spacetime.
- **Development of New Models:** A new theory or model might be needed to explain how density and gravity interact in higher dimensions.
- **Observations and Experiments:** If such theoretical results can be experimentally verified, it could open new avenues for observations and testing fundamental theories.

VII Conclusion

The result linking three-dimensional density perturbation with four-dimensional density may indicate the need to reconsider current theories about the nature of spacetime and density. This opens interesting possibilities for theoretical physics and may offer new avenues for exploring and understanding the fundamental structures and properties of the microcosm and the Universe. This theory highlights several important aspects of the theory of the fifth dimension, which, if correct, could significantly expand our understanding of fundamental physics. Let us consider some of them in more detail:

7.1 Gravitational Charge and New Understanding of Fields

The assumption of the existence of a gravitational charge and a new interpretation of interactions between charges through the curvature of spacetime density indeed opens up interesting perspectives. This may offer an alternative explanation for some phenomena traditionally associated with gravity and electromagnetism and may potentially provide a unified view of matter and energy.

7.2 Role of Dark Matter and Dark Energy

If the theory of the fifth dimension can explain the nature of dark matter and dark energy, it would be a significant achievement. These phenomena remain one of the greatest mysteries of modern astrophysics and cosmology. Theories that provide explanations for these phenomena without introducing new "invisible" entities could indeed be considered more economical in terms of ontology.

7.3 Gaps in Maxwell's Equations

Maxwell's equations, while fundamental for understanding electromagnetic phenomena, are based on empirical laws such as Coulomb's law and Ampère's law. They do not provide a deep explanation of the nature of the electromagnetic field at the microscopic structural or origin level. The theory of the fifth dimension, if it can offer a more fundamental explanation, could represent a significant advance in understanding electromagnetism.

7.4 Analysis of Observed and Theoretical Fields

The assumption that the field we observe is the result of interactions of fields in five-dimensional space may also be intriguing. It could explain anomalies or features in field distribution that cannot be accounted for by current theories.

VIII To contact me, you can use my email khoruzhenkova@gmail.com I need a reviewer who, if he finds the article justified and the topic of the article interesting for other researchers, will make a recommendation for publishing the article in more authoritative journals that require confirmation and review of the article. Thank you in advance for your questions about the article and the discussion on the chosen topic for study