The Geometric Concept of Matter

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A B S T R A C T

The geometric concept of matter defines the fundamental structure of the elementary material particle as a rotating-vibrating sphere. All the essential properties of matter, such as energy content, gravitation and relativistic effects, are comprised in the new concept. In that respect, gravitational interaction between two elementary particles will be calculated, and compatibility with Einstein's Special Theory of Relativity will be demonstrated.

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1. Hypothesis

We are going to hypothesize a single elementary material particle creation. In order to do that, we shall define the required work for a particle creation, which is equivalent to the energy contained in that particle.

$$W = \mathbf{F} \cdot \mathbf{d} = mc^2 = E_o \qquad (1)$$

Artificial constructs, the concepts of mass and force, have the common geometric origin, acceleration. Therefore we shall reduce equation (1) to a pure geometric form $\mathbf{a} \cdot \mathbf{d} = c^2$, ignoring relativistic effects, since the geometric construct [5] does not comprise mass, and $\mathbf{d}$ is the size of a hypothesized particle at rest. We shall discuss the consequences of relativistic effects later in chapter 3. It is convenient to write a reduced equation in the following form:

$$\mathbf{a} = \frac{c^2}{d}\hat{\mathbf{d}} \qquad (2)$$

Equation (2) definitely tells us that geometric underlying structure is a particular form of acceleration, in our case, centripetal acceleration. For that reason, we shall write equation (2) using suitable notations

$$\mathbf{a}_c = -K\frac{c^2}{r}\hat{\mathbf{r}} \qquad (3)$$

Coefficient K is temporarily introduced because it represents the ratio between centripetal acceleration of point motion along a circle, and centripetal acceleration of point motion along a sphere (see chapter 4). For reasons of simplicity, we shall exclude the coefficient K in further analysis, as it can be easily recalled if needed.

Now we shall summarize our hypothesis as follows:

a) The pure geometric construct defined by equation (3) is what represents the elementary material particle. From now on, we shall use symbol $\mathbf{a}_m$ as a substitute for $\mathbf{a}_c$. (index m symbolizes matter)

b) On the basis of the equation (3) , we shall assume that the shape of the material particle is a sphere with radius $\mathbf{r}_m$. (see chapter 4)

c) Equation (3) also tells us that velocity associated to circular motion is the speed of light c meaning, the property of free space is part of the geometric construct.

Equation (3) now has the form $$\mathbf{a}_m = -\frac{c^2}{r_m}\hat{\mathbf{r}}_m \qquad (4)$$

These hypotheses are the basis of our theory, *The Geometric Concept of Matter* .
On the following pages, we shall use this new geometric concept of matter to calculate gravitational interaction. Then we shall show one compatibility example, the relation to Einstein's Special Theory of Relativity.

2. Interaction

The existence of gravitational interaction can easily be verified in an experiment and it undoubtedly proves to us that free space is capable of some sort of communication (transfer of information $\Leftrightarrow$ interaction) that makes the aforementioned interaction possible.
Whether it is a property of free space or some sort of "medium or substance", whether it is called "curved space" or "action at a distance", communication undoubtedly exists!
Such an experiment involves distance and interaction, which means that three-dimensional Euclidean space with an embedded Cartesian coordinate system with a reference frame in its origin, and the notion of acceleration, are minimum and sufficient requirements to define the physical and mathematical environment for our theory.
Further, we shall consider the energy content of our rotating-vibrating sphere to be invariant in time. Proportionally, its size that is represented by radius r_m is invariant too. Therefore, the embedded centripetal acceleration and its flow through the sphere's surface must be invariant as well. We can write all that in the following form:

$$\Phi_{am} = a_m 4\pi r_m^2 \qquad (5)$$

where Φ_{am} is the flow of centripetal acceleration a_m associated with the material particle, through the surface of the sphere with radius r_m .
It is evident that any scientific experiment that involves gravitation tells us that interaction on distance exists through any medium including a nonmaterial medium, or free space if you prefer, giving it an all pervading quality.

Consequently, the all pervading feature enables us to define Φ_{ad} as the flow of centripetal acceleration a_d at any distance d from the centre of the material sphere – the elementary particle. The law of conservation of energy enables us to write

$$\Phi_{am} = a_m 4\pi r_m^2 = a_d 4\pi d^2 = \Phi_{ad} \tag{6}$$

Now it is easy to calculate acceleration at a distance $$a_d = a_m \frac{r_m^2}{d^2} \tag{7}$$

We can also write equation (7) in the following form $$\mathbf{a}_d = -c^2 \frac{\mathbf{r}_m}{d^2} \hat{\mathbf{d}} \tag{8}$$

It is possible to perform a virtual or real physical experiment (see chapter 5) that will show us that $\mathbf{a}_d$ has the same magnitude and direction as gravitational acceleration as we know it, proving that the hypothesized geometrical construct correctly describes the elementary material particle and its properties, according to observation. In comparison with the classic formula for gravitational acceleration

$$\mathbf{a}_2 = -G \frac{m_1}{d^2} \hat{\mathbf{d}} \tag{9}$$

it can easily be seen that there is no concept of mass and Newtonian constant of gravitation [2][3] in the new equation (8).

3. Relation to Einstein's Special Theory of Relativity

Here is one example of compatibility between the new geometric concept of matter and existing physics. Einstein's "SR" states that the mass of an observed object appears differently to an observer moving with respect to it, than to a stationary one. To be exact, this means that the stationary observer seeing no movement with respect to the observed object "measures" $E_o = mc^2$ [1] , while at the same time the moving one "measures" $E = \gamma mc^2$, where $\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$. For further analysis, it is convenient to write this in the following form $$M = \gamma m \tag{10}$$

In the new concept of matter, we measure its quantity not by its mass or energy content but by the size of the corresponding sphere or, precisely, its radius r_m. Therefore, if compatibility to "SR" is to be met, we must obtain the equation (10) in the following form

$$R_m = \gamma r_m \tag{11}$$

Now we shall analyze the dimensions of our material particle for $0 < v < c$ relative to the observer. According to "SR", due to the Lorentz contraction, our sphere will become an ellipsoid or more precisely a spheroid, which means that r_m will appear changed, a good start toward compatibility with Einstein's "SR" !

As the radius of curvature is not constant for a spheroid, we must calculate the particular one that has the same direction as the relative speed between the observer and the material particle in order to meet the requirements of "SR". We can conclude then, that the maximum radius of curvature is of interest to us. The following formula is needed to calculate the radius of curvature R for any function

$$R = \frac{(x'^2 + y'^2)^{3/2}}{|x'y'' - y'x''|} \tag{12}$$

The maximum radius of curvature for the spheroid (ellipse) can now be calculated. The result is as follows $$R_{\max} = \frac{a^2}{b} \tag{13}$$

where the semi-major axis length of ellipse a is equal to r_m, and the semi-minor axis length b is equal to the contracted length of r_m which is $r_{mc} = r_m / \gamma$, and the maximum radius of curvature $R_{\max}$ then becomes R_m, the observed one.

Finally, we can calculate the particular radius of spheroid R_m which is seen by an observer in the direction of relative motion to our material particle:

$$R_m = \frac{a^2}{b} = \frac{r_m^2}{r_m / \gamma} = \gamma r_m \tag{14}$$

The result is equivalent to equation (11), exactly as we wanted, showing compatibility with Einstein's Special Theory of Relativity.

4. Centripetal Acceleration

In this chapter, we shall calculate the magnitude of centripetal acceleration as a second time-derivative of the function that describes point motion along a sphere in parameterized form.

The points on the static sphere with radius r can be parameterized as follows:

$$r_x = r\sin\theta\cos\varphi$$
$$r_y = r\sin\theta\sin\varphi$$
$$r_z = r\cos\theta$$

Our sphere is not static but is rotating at angular speed ω whose components are:

$$\omega_1 = \frac{d\theta}{dt} \quad \text{and} \quad \omega_2 = \frac{d\varphi}{dt}$$

Now we can write parameterized equations for the dynamic sphere as functions of time, and set $r = 1$ for reasons of simplicity.

$$r_x(t) = \sin(\omega_1 t)\cos(\omega_2 t)$$
$$r_y(t) = \sin(\omega_1 t)\sin(\omega_2 t)$$
$$r_z(t) = \cos(\omega_1 t)$$

In order to calculate centripetal acceleration a_c we must find a second time derivative of all the three components, and then sum up the corresponding vectors:

$$a_c = \sqrt{\ddot{r}_x^2(t) + \ddot{r}_y^2(t) + \ddot{r}_z^2(t)}$$

Second time-derivatives are as follows :

$$a_x = \ddot{r}_x(t) = -(\omega_1^2 + \omega_2^2)\sin(\omega_1 t)\cos(\omega_2 t) - 2\omega_1\omega_2\cos(\omega_1 t)\sin(\omega_2 t)$$
$$a_y = \ddot{r}_y(t) = -(\omega_1^2 + \omega_2^2)\sin(\omega_1 t)\sin(\omega_2 t) + 2\omega_1\omega_2\cos(\omega_1 t)\cos(\omega_2 t)$$
$$a_z = \ddot{r}_z(t) = -\omega_1^2\cos(\omega_1 t)$$

The sum of the squared values is

$$a_c^2 = a_x^2 + a_y^2 + a_z^2 = (\omega_1^2 + \omega_2^2) + (2\omega_1^2\omega_2^2 - \omega_2^4)\cos^2(\omega_1 t)$$

To simplify the equations, we shall set $\omega_2 = k\omega_1$ (15)
and then calculate the mean value

$$\bar{a}_c = \omega_1^2\sqrt{1 + 3k^2 + k^4/2} \qquad (16)$$

To get equation (3) in scalar form $a_c = K\dfrac{c^2}{r}$, we must express the angular speed with associated velocity. For that, first time-derivatives are needed:

$$v_x = \dot{r}_x(t) = \omega_1\cos(\omega_1 t)\cos(\omega_2 t) - \omega_2\sin(\omega_1 t)\sin(\omega_2 t)$$
$$v_y = \dot{r}_y(t) = \omega_1\cos(\omega_1 t)\sin(\omega_2 t) + \omega_2\sin(\omega_1 t)\cos(\omega_2 t)$$
$$v_z = \dot{r}_z(t) = -\omega_1\sin(\omega_1 t)$$

The sum of the squared values is

$$v^2 = v_x^2 + v_y^2 + v_z^2 = \omega_1^2 + \omega_2^2\sin^2(\omega_1 t)$$

Substituting ω_2 with $k\omega_1$ and then calculating the mean value we get:

$$\bar{v} = \omega_1\sqrt{1 + k^2/2} \qquad (17)$$

After recalling the previously omitted radius of our sphere r, using equations (16) and (17), we can calculate the formula for centripetal acceleration along the sphere in the required form as follows:

$$\bar{a}_c = \frac{\bar{v}^2}{r}\sqrt{\frac{1+3k^2+k^4/2}{1+k^2+k^4/4}} \tag{18}$$

Let us write equation (18) in the following form $\bar{a}_c = \frac{\bar{v}^2}{r}K$ and analyze the coefficient $K = \sqrt{\frac{1+3k^2+k^4/2}{1+k^2+k^4/4}}$ as a function of k to see what the range of variable K and the corresponding magnitude of centripetal acceleration $\bar{a}_c$ are.

We can simplify coefficient K by analyzing the square of the function K and substitute k^2 with x , so that we have

$$f(x) = K^2 = \frac{1+3x+x^2/2}{1+x+x^2/4} \tag{19}$$

We have to find the first and second derivative of function $f(x)$ to find its maximum or minimum points:

$$\frac{d}{dx}f(x) = -\frac{1}{4}x^2 + \frac{1}{2}x + 2 \quad \text{and} \quad \frac{d^2}{dx^2}f(x) = -\frac{1}{2}x + \frac{1}{2} \quad .$$

Equating the first derivative with zero gives us only one real root at $k = 2$ and the second derivative is negative, meaning that it is the function's maximum point.

Now we can find the values of K as follows:

a) $\omega_1 \neq 0$, $\omega_2 = 0$, $k = 0$, $K = 1$ - minimum value of K

b) $\omega_2 = 2\omega_1$, $k = 2$, $K = \sqrt{7/3} \approx 1.53$ - maximum value of K

c) $\omega_1 \neq 0$, $\omega_2 \to \infty$, $K \to \sqrt{2} \approx 1.41$ - hypothetical value

Note that the minimum value represents the familiar formula for $a_{cp} = \frac{v^2}{r}$ along a circle, which is true for $\omega_2 = 0$.

At the end of this chapter, we can conclude that the formula for centripetal acceleration along a sphere $a_c = K\frac{v^2}{r}$ is similar to the formula for acceleration along a circle $a_{cp} = \frac{v^2}{r}$ except for coefficient K, which has the value of $1 \le K \le \sqrt{7/3}$.

For $v = c$ we obtain the equation (3) $a_c = K\frac{c^2}{r}$.

The range and specific value of coefficient K are not critical for this work and we shall not analyze and discuss the implications here.

5. Virtual experiment

Here we shall make a virtual experiment in which gravitational interaction will be "measured" between the two elementary particles. The "measured" value will be used to determine r_m of the observed particle in order to calculate the magnitude of gravitational acceleration using the alternative formula (8) $a_d = c^2\frac{r_m}{d^2}$ derived from the geometric concept of matter. Then we shall calculate the magnitude of gravitational acceleration using Newton's classic formula (9) $a_2 = G\frac{m_1}{d^2}$ and compare results. (Please note that we expect $a_d = a_2$)

Instead of performing actual measurement, we shall calculate the gravitational attraction using the classical Newton equation that will give us the same results as a real experiment.

Let us assume two electrons with an arbitrary distance between them set at $d = 1\times10^{-3}m$. The mass of an electron is $m_e = 9.109382\times10^{-31}kg$.
Because classical equations involve the concept of mass, we shall use equation (1) to define the relation between the classical concept of mass and the new geometric concept of matter.
Now we shall write equation (1) with updated notations as follows:

$$W = F_{m1} r_{m1} = m_1 c^2 = E_o \tag{20}$$

We have changed the notation of force F to F_{m1} to remind us that it is the force that contributed in the creation of the first material particle-electron. For now, its value is unknown, but it will soon be revealed.

Using equation (8) we can calculate

$$F_{12} = m_2 a_d = m_2 c^2 \frac{r_{m1}}{d^2} \tag{21}$$

From equation (21) follows
$$r_{m1} = \frac{F_{12} d^2}{m_2 c^2} \tag{22}$$

and from (20) we have
$$F_{m1} = \frac{m_1 c^2}{r_{m1}} \tag{23}$$

Substituting r_{m1} in (23) with (22) we get
$$F_{m1} = \frac{m_1 m_2 c^4}{F_{12} d^2} \tag{24}$$

Calculating the numerical values for the equations (22) and (23) using the stated set-up conditions; the mass of an electron is $m_e = 9.109382\times10^{-31}kg$, the distance between two electrons $d = 1\times10^{-3}m$, $c = 2.997924\times10^{8}ms^{-1}$, $G = 6.67428\times10^{-11}Nm^2kg^{-2}$, we get the following values:

$F_d = F_{12} = 5.53837\times10^{-65}N$ ["measured" value]
$r_{m1} = 6.76475\times10^{-58}m$ [equation (22)]
$F_{m1} = 1.21026\times10^{44}N$ [equation (23) or (24)]

Finally, we can use the estimated value for r_m to calculate and compare results between Newton's formula (9) and our new one (8), which was the initial purpose of this virtual experiment.

Newton (9) $$a = a_2 = G\frac{m_1}{d^2} = 6.07985\times 10^{-35}\, ms^{-2}$$

Our alternative (8) $$a = a_d = c^2\frac{r_{m1}}{d^2} = 6.07985\times 10^{-35}\, ms^{-2}$$

We can conclude that the results are identical. Therefore, this is the proof that the hypothesized geometric structure's embedded centripetal acceleration has the same magnitude as gravitational acceleration.

Before proceeding to further analysis of the obtained results, let us briefly repeat the numerical procedure, this time with round numbers like:
$d = 1m$, $m_1 = m_2 = 1kg$.

The new results will be as follows:

$$F_d = F_{12} = 6.67428\times 10^{-11} N$$
$$r_{m1} = 7.42614\times 10^{-28} m$$
$$F_{m1} = 1.21026\times 10^{44} N$$

Newton (9) $$a = a_2 = G\frac{m_1}{d^2} = 6.67428\times 10^{-11} ms^{-2}$$

Our alternative (8) $$a = a_d = c^2\frac{r_{m1}}{d^2} = 6.67428\times 10^{-11} ms^{-2}$$

The entire "experiment" can also be made analytically, leading to the same results and conclusions.
A closer look at the previous results reveals their very intuitive and natural characteristics. It is perfectly logical that a larger particle, that is, a larger sphere and r_m respectively, represents a larger mass in the classical concept and that also implies stronger gravitational interaction.

$F_m = 1.21026 \times 10^{44}\,N$ force that assisted in the hypothetical creation of our material particle remains constant and looks very natural indeed, because it is very obvious that its value is identical to the well-known Planck force, a member of Planck units, part of the system of natural units often referred to by physicists as "God's units".

Perhaps now it is a good time to explain the negative sign in equation (3). It is very important to recognize cause-effect, action-reaction principles regarding causal force $\mathbf{F}_m$ assisting in hypothesized particle creation, and opposing complementary "gravitational force" as a corresponding reaction. In that respect, the opposing pair of forces justifies a negative sign in equation (3).

Furthermore, please note that the new definition of gravitation is compatible with nuclear forces (strong interaction) since, in an ideal case, maximum forces in the order of Planck force are possible, and at close distances, vectors representing the flow of centripetal acceleration can no longer be considered parallel, thus, forces no longer obey the inverse-square law.
Therefore, at very close distances, attractive forces weaken and can drop even to zero at hypothetical zero distance, thus resembling quarks inside protons and neutrons. Unification of strong force with gravitation looks like a very promising prospect for this new theory.

At the end of this chapter, I would also like to mention that the new geometric concept of matter makes the definition of energy very simple, since it can be "measured" by the radius of the material sphere using the *meter* as unit, with the conversion factor $1m = 1.21027 \times 10^{44}\,J$.

Conclusion

Although the new geometric concept of matter deals with gravitational interaction, description of the source of gravitation is its primary objective. It is well known that energy contained in mass is the source of gravitation. However, the question is, what do we know about the form of involved energy? The new theory presented in this paper gives us some "geometric" insights abut the answer to that question, meaning, a rotating sphere is a dynamic geometric form assigned to every energy packet that represents the elementary material particle. This should present two new intuitive facts in physics. First, exactly defined spatial dimension-extension is assigned to any elementary material particle, thus eliminating singularities associated with the point particle approach. Second, gravity and electromagnetism share the same fundamental physical constant, a first step toward unifying those two phenomena. In addition, please note that the new geometric concept describes gravitation correctly without Newton's constant of gravitation G .
Furthermore, from the defined geometric construct, it is easy to calculate the associated frequency f_m and wavelength λ_m .

$$f_m = \frac{c}{2\pi\, r_m} \quad \Rightarrow \quad \lambda_m = 2\pi\, r_m \quad .$$

Prince Louis de Broglie mentioned the "meta law of Nature" in his Nobel Prize awarded work [4], as the "cause of periodic phenomenon associated to each portion of energy with the proper mass m ". That was the doctoral thesis of his exceptional work. By supposing that this periodic phenomenon must not necessarily occur in the interior of an energy packet, de Broglie moved away from the metaphysical law of Nature, because the periodic phenomenon according to metaphysics should be associated with the material particle itself, not its kinetic energy exclusively, as his theory concluded! It is not the particle's kinetic energy that represents its essence. In that respect, the new concept of matter regards the periodic phenomenon or frequency and wavelength in the form of a rotational wave, not as the particle's property but as a material particle itself, regardless of its kinetic energy. Ultimately, that rotational wave's related centripetal acceleration is directly manifested and, therefore, detectable as gravitational interaction as we know it. These facts are opening up legitimate questions regarding the value and origin of the “metaphysical law of Nature“ [6][7].

References:

[1] Lev Okun , *The Concept of Mass* , (June 1989, Physics Today)

[2] Fiorentini, Okun, Vysotsky , *Is G a conversion factor or a fundamental unit?* , arXiv:physics/0112006v1

[3] Duff, Okun, Veneziano , Trialogue on the number of fundamental constants , arXiv:physics/0110060v3

[4] Louis de Broglie, *Recherches sur la Théorie des Quanta* , (English translation by: A.F.Kracklauer)

[5] Sylvain Poirier, *Special Relativity*

[6] Subhash Kak , *Indian Physics: Outline of Early History* , arXiv:physics/0310001v1

[7] Subhash Kak , *Concepts of Space, Time, and Consciousness in Ancient India* , arXiv:physics/9903010v2