Physical Mechanism of Forming Gravitational Field

Li Yake

Abstract: Objects make $\mu_0\varepsilon_0$ form a changing scalar field in space, and the gravitational field strength E_g is equal to the negative gradient of the reciprocal of $\mu_0\varepsilon_0$. In spaces with different $\mu_0\varepsilon_0$, their relative time speed and spatial distance can be different. Objects and space are inseparably and intrinsically connected, and gravitational interaction and electromagnetic interaction are unified on the electromagnetic properties of objects and space.

Keywords: gravitational field; curved space-time; $\mu_0\varepsilon_0$; energy; mass; space; time

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Introduction: Isaac Newton first discovered in 1687 that there is a mutual attractive force even if objects do not touch each other, and he published this discovery in his book *The Mathematical Principles of Natural Philosophy*. Although Newton's Law of Universal Gravitation has achieved great success, he also left us with a difficult problem that has not yet been solved, that is, what the physical mechanism of force transmission without any mutual contaction between objects or what the transmission medium is. Initially, it was explained as the action at a distance, and then the field was discovered, which was considered as the medium of all interactions, without any direct action or action at a distance between objects. The discovery of gravitational field should be a major progress in understanding the physical mechanism of gravitation. However, at present, our understanding about gravitational field is still only limited to the mathematical description, and we don't know its physical mechanism. So some new theories have emerged to explain the physical mechanism of gravity. For example, based on the gravitational field, quantum mechanics puts forward the hypothesis of gravitons, which holds that the attraction between objects is realized by exchanging gravitons, but the gravitons has not been detected so far. Likewise, the dark matter with gravitational effects as envisioned has not been detected.

In 1916, Albert Einstein founded the general relativity, which is currently the most successful theory of gravity. The correctness of the general relativity has been confirmed by many observational experiments, which will not be repeated here. Unfortunately, general relativity still does not answer the question of the physical mechanism by which gravity arises. From the equivalence principle, one of the two fundamental principles of general relativity, namely, the kinetic effects of the inertial force field and the gravitational field are locally indistinguishable. It can be seen that general relativity ignores the basic fact that gravitational and inertial force fields have fundamentally different physical mechanisms from the starting point of the study. So general relativity deals only with the effects of gravitational fields, not with their causes. Therefore, it is also impossible to find the answer in an in-depth study of general relativity. Nevertheless, general relativity provides us with an important clue to find out the physical mechanism of forming gravitational field. The famous physicist, John Archibald Wheeler, has a famous saying about general relativity: "Spacetime tells matter how to move, matter tells spacetime how to curve". That is, general relativity believes that the gravitational force between objects is generated by the curved spacetime. Then, if we find out what kind of physical factor exerts influence on the object by curved spacetime or what kind of physical factor changes in space to produce the curved spacetime, we will also find the physical mechanism of forming the gravitational field.

1. Conjecture of the physical mechanism of gravitational field

If gravitational interaction is a real physical phenomenon, then there must be objective physical factors in space that produces this physical phenomenon.

It is known that under the action of the solar gravitational field, the direction of light propagation will be deflected [1], and according to the solar radar echo testing, it is found that there is an echo delay phenomenon [2]. Both of these two observations prove that the speed of light on the solar side is indeed relatively reduced. According to the relationship between the speed of light c and the vacuum dielectric coefficient ε_0 and vacuum permeability μ_0[3]:

$$\mathbf{c} = \frac{\mathbf{1}}{\sqrt{\mu_0 \varepsilon_0}} \qquad (1)$$

According to Equation (1), we can know that the relative decrease of the speed of light on the solar side indicates the relative increase of $\mu_0 \varepsilon_0$ near the solar side. Based on these experimental facts, the above phenomenon of light deflection can be explained only according to the principle of refraction of light without considering the effect of gravitational field. Then, whether it is the gravitational field that deflects the light, independent of the principle of refraction of light, or this deflection is a phenomenon of refraction of light, independent of the gravitational field. Since both views have their own theoretical and experimental support, it would be wrong to deny either one of them. Therefore, the only solution to this problem can be conceived as follows: the $\mu_0 \varepsilon_0$ of spatial variation is not only the cause of refraction of light, but also the cause of the formation of the gravitational field. Or, the mass (internal energy) of an object (such as the sun) causes an incremental change of $\mu_0 \varepsilon_0$ in space from far to near, and this change results in both refraction of light and gravitational field. So, how can the $\mu_0 \varepsilon_0$ of spatial variation apply the gravitational force on the object, thus acting as a gravitational field? Let's explore this question below.

2. Physical mechanism of forming gravitational field

We know that the total energy **E** of an object is equal to the sum of its internal energy $\mathrm{E_i}$ and kinetic energy E_v:

$$\mathrm{E} = \mathrm{E_i} + \mathrm{E_v} \qquad (2)$$

When an object with a mass of m enters a space with increasing $\mu_0 \varepsilon_0$ at a uniform speed in a straight line without any external force, the speed of light will decrease correspondingly due to the increase of $\mu_0 \varepsilon_0$. According to the mass-energy formula [4] (6), the internal energy of the object will be reduced accordingly. Since the object is not subjected to any external force, the total energy change is zero:

The amount of change in the total energy of the object: $\Delta \mathrm{E} = \Delta \mathrm{E_i} + \Delta \mathrm{E_v}$

Because: $\Delta \mathrm{E} = 0$

So: $\Delta \mathrm{E_v} + \Delta \mathrm{E_i} = 0$

$$\Delta \mathrm{E_v} = -\Delta \mathrm{E_i} \qquad (3)$$

According to Equation (3), the reduced internal energy of the object is equal to the increased kinetic energy of the object, which is also a manifestation of energy conservation. If we equate the increment of the kinetic energy of the object to the work A done by the force F_m for a certain distance Δs:

$$A = F \cdot \Delta s = \Delta E_v$$

The equivalent force F_m is: $$F_m = \frac{\Delta E_v}{\Delta s} \quad (4)$$

Substitute Equation (3) into Equation (4): $$F_m = -\frac{\Delta E_i}{\Delta s}$$

$$F_m = -\frac{dE_i}{ds} \quad (5)$$

Mass − energy equation: $$E_i = mc^2 \quad (6)$$

The rate of change of internal energy with space: $$\frac{dE_i}{ds} = m\frac{dc^2}{ds} + c^2\frac{dm}{ds} \quad (7)$$

Since the objects we are discussing are moving at low speed or at rest, the mass is considered to be the same

So: $$m = m_0$$
$$dm = 0$$

Equation (7) is simplified as: $$\frac{dE_i}{ds} = m\frac{dc^2}{ds} \quad (8)$$

Substitute Equation (8) into Equation (5): $$F_m = -m\frac{dc^2}{ds} \quad (9)$$

Substitute Equation (1) into Equation (8): $$F_m = -m\frac{d}{ds}\left(\frac{1}{\mu_0\varepsilon_0}\right) \quad (10)$$

After the above derivation, we get the conclusion expressed by Equation (10). That is, in the space where $\mu_0\varepsilon_0$ changes, the object is indeed subjected to a force F_m pointing in the direction where $\mu_0\varepsilon_0$ increases. However, this force F_m is from the object itself, and there is no direct relationship with other objects. Specifically, when all objects increase the value of $\mu_0\varepsilon_0$ around them by their own mass (energy), objects are actually moving in the direction where $\mu_0\varepsilon_0$ increases, at this time, what we can see is the attractive force between the objects with mutual aggregation. Therefore, gravity is only the compound and equivalent of this force F_m.

The object will always spontaneously generate a force moving in the direction where $\mu_0\varepsilon_0$ increases, regardless of the reason for the change of $\mu_0\varepsilon_0$. In essence, the direction where $\mu_0\varepsilon_0$ increases is the direction where the internal energy of the object can decrease. Any object will spontaneously move in a certain direction with a lower energy state. This is the natural attribute of all matter, and the force F_m is just an external performance and measurement of this spontaneous tendency. There is no need for us to find another force-applying object for this force F_m in a non-inertial physical environment.

From Equation (9) (10), we can obtain the acceleration g of the object:

$$g = -\frac{dc^2}{ds} \quad (11)$$

$$g = -\frac{d}{ds}\left(\frac{1}{\mu_0\varepsilon_0}\right) \quad (12)$$

From Equation (12), we can see that in a $\mu_0\varepsilon_0$ changing space, objects have the same acceleration regardless of their mass, which is the physical reason why they all have the same acceleration in a gravitational field.

The "gravitational force" F_m and inertial force produced by the object are from the internal energy of the object, so the gravitational mass and inertial mass of the object must be equivalent.

The gravitational field strength $E_g = g$. As we can see from Equation (12), the gravitational field strength E_g is equal to the negative gradient of the reciprocal of $\mu_0\varepsilon_0$. It can be seen that $\mu_0\varepsilon_0$ that changes in space are the physical mechanism that forms the gravitational field. Gravitational interaction and electromagnetic interaction are finally unified on the basis of electromagnetic properties.

3. Relationship between $\mu_0\varepsilon_0$ and time and space

The speed of light is relatively variable and also absolutely invariable. For example, $\mu_0\varepsilon_0$ on the sun side is relatively increased. Outside of this changing area, we can measure that the speed of light on the sun side is relatively slow. From this point of view, the speed of light is relatively variable. The reason why we say that the speed of light is absolutely invariable is that in the area where $\mu_0\varepsilon_0$ is relatively increased on the sun side, the measured speed of light is still c, which is consistent with the speed of light outside the area. The fact that the speed of light is absolutely invariable constitutes the principle of the invariance of the speed of light. The principle of the invariance of the speed of light is a law that has been experimentally verified and is a law that we must uphold. Otherwise, if the radar echo we measured comes from a space lower than the $\mu_0\varepsilon_0$ of earth, the radar echo will not be delayed, but will be advanced, so we will mistakenly believe that there is the superluminality in the area, which is obviously wrong.

Then, what is the correlation between the relative variation and the absolute invariance of the speed of light with time and space? In other words, what effect will the relative change of $\mu_0\varepsilon_0$ have on space and time? For the sake of discussion, we assume that there are two adjacent vacuum spaces, one is called Space A, the other is called Space B. Space A and B are uniformly homogeneous in each direction, and time is also lost uniformly in each direction. The only difference is that $\mu_0\varepsilon_0$ of Space B is larger than that of Space A. Assume that there is an inertial reference system respectively in Space A and B, according to the principle of relativity, all physical laws in the two inertial reference systems are the same. If Space A and B are not compared, no one can notice any difference between them.

Now, let's take the spatial interval and time of Space A as the benchmark and compare what is the difference between Space B and Space A. Assume that in one second, the distance that light passes in Space A is s_a, and the distance that the light passes in Space B is measured as s_b according to Space A. Because the $\mu_0\varepsilon_0$ in Space B is larger than that in Space A, the speed of light in Space B is lower than that in Space A, so we can get $s_b < s_a$. But according to the principle of the invariance of the speed of light, the distance that light passes in Space B in one second is still the speed of light c, and its value is the same as that in Space A. In other words, the 300,000 kilometers in Space B is shorter than the 300,000 kilometers in Space A measured by Space A. This shows that the spacing distance of Space B has shrunk compared with Space A. Conversely, if the $\mu_0\varepsilon_0$ in Space B is smaller than that in Space A, the 300,000 kilometers in Space A is shorter than that in Space B. At this time, we can't say that there is the superluminality in Space B, only that the spacing distance of Space B is stretched relative to Space A. This is how the difference of $\mu_0\varepsilon_0$ affects the spatial spacing distance. Let the relative expansion and contraction coefficients of Space A and Space B be k_l:

$$k_l = \frac{s_b}{s_a} = \frac{c_b}{c_a} \qquad (12)$$

$$s_b = k_l s_a \qquad (13)$$

$$s_b = s_a \sqrt{\frac{\mu_{0a}\varepsilon_{0a}}{\mu_{ab}\varepsilon_{ab}}} \qquad (14)$$

It should be noted here that, according to the principle of the invariance of the speed of light, the $\mu_0\varepsilon_0$ in the respective spaces measured in Space A or in Space B are equal. Only when $\mu_0\varepsilon_0$ in Space B is measured indirectly in Space A will it be found there are relative changes. To facilitate the distinction, let $\mu_{0a}\varepsilon_{0a}$ be $\mu_0\varepsilon_0$ in Space A, and $\mu_{ab}\varepsilon_{ab}$ is $\mu_0\varepsilon_0$ of Space B measured in Space A.

Now let's discuss the influence of the difference of $\mu_0\varepsilon_0$ on the speed of time loss. The $\mu_0\varepsilon_0$ of Space B is larger than that in Space A, so while the space distance of Space B is contracted relative to that of Space A, the speed of time loss should also be slower than that of Space A to ensure that its ratio is still the speed of light c. In other words, the time expansion and contraction ratio $\mathrm{k_t}$ and the space expansion and contraction ratio $\mathrm{k_l}$ should be the same. Let this common expansion and contraction ratio be k:

$$\mathrm{k} = \mathrm{k_l} = \mathrm{k_t} \qquad (15)$$

$$t_b = k t_a \qquad (16)$$

$$t_b = t_a \sqrt{\frac{\mu_{ab}\varepsilon_{ab}}{\mu_{0a}\varepsilon_{0a}}} \qquad (17)$$

According to the relative variation of the speed of light and the absolute invariance of the speed of light, we can easily get the above Equations (14) and (17). Simply put, when $\mu_0\varepsilon_0$is relatively increased, the space is relatively contracted, and the clock is relatively slow. When $\mu_0\varepsilon_0$ is relatively reduced, the space is relatively stretched, and the clock is relatively fast.

These simple equations above contain a lot of important physical information. It can be seen from Equation (17) that $\mu_0\varepsilon_0$ controls the speed of time loss in the local area. Since $\mu_0\varepsilon_0$ is always a positive number greater than zero, the time loss will never stop, let alone reverse. $\mu_0\varepsilon_0$ is the master factor of the speed of time loss.

If $\mu_0\varepsilon_0$ of Space B is greater than that of Space A, the clock in Space B is slower than that in Space A. For the same photon, the frequency measured in Space A is lower than that measured in Space B. In fact, the photon has not changed, but the time standard we use for measurement has changed. Just as $\mu_0\varepsilon_0$ on the surface of the sun is greater than that on the surface of the earth, the frequency of photons emitted from the surface of the sun will decrease when measured on the surface of the earth. This phenomenon is also called gravitational redshift [5].

It can be seen from Equation (14) that $\mu_0\varepsilon_0$ controls the expansion and contraction of the spatial distance. For example, the distance of 1 meter in Space B is shorter than that in Space A, and the distance measured in Space B is the true distance in Space B, or it is called physical distance. The distance measured in Space A is not the true distance in Space B, so it is called the observation distance. Because the $\mu_0\varepsilon_0$ of Space A and Space B is different, the observation distance is different from the physical distance. For example, the observation distance from the earth to the sun is shorter than the physical distance. Vice versa, if $\mu_0\varepsilon_0$ in Space B is much lower than that in Space A, then K>>1, which means that the physical distance of 300,000 kilometers in Space B at this time may be the observation distance of 3 million kilometers in Space A on the earth. Although we cannot get the physical superluminality in Space B, it is completely possible to cross the observation distance of 3 million kilometers in Space A within one second. Since the distribution of $\mu_0\varepsilon_0$ in the universe changes relatively, the physical distance of the universe also changes relatively. When we make observations in a large range, we should fully consider the difference between the observation distance and the physical distance. For example, the abnormal revolution speed of the spiral galaxy arm should be due to the fact that $\mu_0\varepsilon_0$ at the edge of the galaxy is lower than that in the center of the galaxy, and the abnormally fast speed is only the calculation error caused by the observation distance being longer than the physical distance. The equal spatial distance from the center of the galaxy to the edge of the galaxy is the source of error and has nothing to do with the influence of other matter.

4. Discussion on $\mu_0\varepsilon_0$

Experimental observations show that $\mu_0\varepsilon_0$ in vacuum is relatively variable. On this basis, we discussed the physical effects of $\mu_0\varepsilon_0$ that change in space and reached some important conclusions. For example, we explained the physical mechanism of forming gravitational field, explained why the acceleration of the objects in the gravitational field are the same, and explained why the gravitational mass and the inertial mass are equivalent. We also explained that the gravitational interaction is just a fit of the object moving in the direction where $\mu_0\varepsilon_0$ increases, so that the gravitational interaction and the electromagnetic interaction are unified on the basis of the electromagnetic properties of the objects and space. In addition, we discussed the control effect of $\mu_0\varepsilon_0$ on space and time, and clarified that objects and space have a deep and inseparable internal connection. Through an in-depth discussion on $\mu_0\varepsilon_0$, we explained a series of physical problems. This is not a coincidence, nor is it groundless. As we all know, both the special theory of relativity and the general theory of relativity have achieved great success, and the speed of light c is a ubiquitous physical quantity. It is not only a speed parameter, it represents electromagnetic waves, the electromagnetic properties of space, and the principle of the invariance of the speed of light. It is this principle of invariance that makes the Lorentz transformation replace the Galilean transformation, and since then makes us realize the internal connection between space and objects. However, whether it is electromagnetic waves, the principle of the invariance of the speed of light, or the Lorentz transformation, all involve $\mu_0\varepsilon_0$. Many of our discussions above are just a continuation of the discussion on the physical effects of $\mu_0\varepsilon_0$.

5. Conclusion

The object makes $\mu_0\varepsilon_0$ form a changing scalar field in space, and the gravitational field strength E_g is equal to the negative gradient of the reciprocal of $\mu_0\varepsilon_0$. This is the physical mechanism of forming gravitational field formation. $\mu_0\varepsilon_0$ controls the speed of time loss and the spacing distance between spaces. Objects and space are inseparably and intrinsically connected, and gravitational interaction and electromagnetic interaction are unified on the electromagnetic properties of objects and space. Now that we have realized the physical mechanism of forming gravitational fields, we can realize the dream of forming the man-made anti-gravitational field soon.

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《形成引力场的物理机制》

李亚克

摘要：物体使$\mu_0\varepsilon_0$在空间中形成了一个变化的标量场，引力场强度E_g等于$\mu_0\varepsilon_0$倒数的负梯度。在$\mu_0\varepsilon_0$不同的空间中，其相对的时间快慢与空间距离都会不同。物体与空间具有不可分割的内在联系，引力相互作用与电磁相互作用在物质和空间的电磁性质基础上得到了统一。

关键词：引力场、弯曲时空、$\mu_0\varepsilon_0$、能量、质量、空间、时间

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引言： 物体间不相互接触，也会有一种相互吸引力，这是牛顿 1687 年首先发现的，他将这个发现发表在他所著的《自然哲学的数学原理》一书中，虽然牛顿创立的万有引力定律获得了巨大的成功，但他也给我们留下了一个至今未解的难题；物体间不相互接触不需要传输介质其作用力传导的物理机制是什么？起初解释为超距作用，之后发现了场的存在，场被认为是所有相互作用的媒介，物体间不存在任何的直接作用或超距作用，引力场应该是对万有引力产生的物理机制认识的一个重大进步，但是，目前引力场也只是停留在数学描述上，形成引力场的物理机制仍不清楚，为此产生了一些新的理论来解释万有引力产生的物理机制，如量子力学在引力场的基础上，提出了引力子的假设，认为物体间相互吸引是通过交换引力子来实现的，但至今也没有探测到引力子的存在。同样，也没有探测到设想中具有引力效应的暗物质的存在。

1916 年，爱因斯坦创立了广义相对论，广义相对论是目前最成功的引力理论，广义相对论的正确性，得到了许多观测实验的证实，在此不再赘述。遗憾的是，广义相对论仍然没有回答万有引力产生的物理机制问题，从广义相对论的两个基本原理之一的等效原理，即：惯性力场与引力场的动力学效应是局部不可分辨的。由此可见，广义相对论从研究的出发点上就忽略了引力场与惯性力场具有根本不同的物理机制这一基本事实，所以，广义相对论研究的只是引力场产生的效果，而不是引力场产生的原因。因此，我们也不可能在对广义相对论的深入研究中找到答案。尽管如此，广义相对论还是为我们提供了寻找引力场形成物理机制的重要线索，著名物理学家惠勒有一句关于广义相对论的名言："物质告诉时空如何弯曲，时空告诉物质如何运动"，也就是说，广义相对论认为物体间的引力是一种经过弯曲时空来

实现的，那么，如果我们找到了弯曲时空以一种什么样的物理因素对物体施加影响，或者说是空间中一种什么物理因素的变化产生了时空弯曲的现象，我们也就找到了产生引力场的物理机制。

1. 引力场物理机制的猜想

引力相互作用是一个实在的物理现象，那么，在空间中就必然有产生这种物理现象的客观的物理因素。

众所周知，在太阳引力场的作用下，光的传播方向会发生偏折【1】，再就是根据太阳雷达回波测试，发现有回波延迟现象【2】，这两个观测现象都证明在太阳侧的光速确实是相对地降低了，根据光速 c 与真空介电系数ε_0与真空磁导率μ_0的关系式【3】：

$$\mathbf{c} = \frac{\mathbf{1}}{\sqrt{\mu_0 \varepsilon_0}} \qquad (1)$$

根据式(1) 可知，太阳侧的光速相对降低，就说明靠近太阳侧的$\mu_0\varepsilon_0$相对增加，根据这些实验事实，不考虑引力场的作用，仅根据光的折射原理就可以解释以上的光的偏折现象，那么，究竟是引力场使光线产生了偏折，与光的折射原理无关，还是这种偏折就是一种光的折射现象，与引力场无关，因为这两个观点都有各自的理论和实验支持，否定任一个观点都是不对的，因此，只能这样设想才是这个问题唯一的解：空间变化的$\mu_0\varepsilon_0$不仅是这种光折射的原因，同时也是形成引力场的原因。或者说，由于物体（如太阳）的质量（内能）使其存在空间的$\mu_0\varepsilon_0$发生了由远至近的递增变化，这种变化既是产生光折射的原因也是产生引力场的原因。那么，空间变化的$\mu_0\varepsilon_0$怎么能使物体受到一个引力，从而起到引力场的作用呢？以下我们就来探讨这个问题。

2. 形成引力场的物理机制

我们知道，一个物体的总能量E等于其内能$\mathrm{E_i}$与动能E_v之和:

$$\mathrm{E = E_i + E_v} \qquad (2)$$

当一个质量为m的物体， 在不受任何外力的情况下, 匀速直线运动地进入一个$\mu_0\varepsilon_0$递增的空间，由于$\mu_0\varepsilon_0$的增加, 光速就会相应降低，根据质能公式【4】（6），物体的内能就会相应降低，由于物体未受任何外力，故总能量的变化量为零：

物体总能量的变化量： $\Delta\mathrm{E} = \Delta\mathrm{E_i} + \Delta\mathrm{E_v}$

因为： $\Delta\mathrm{E} = 0$

所以： $\Delta\mathrm{E_v} + \Delta\mathrm{E_i} = 0$

$$\Delta\mathrm{E_v} = -\Delta\mathrm{E_i} \qquad (3)$$

根据式（3），物体减少的内能等于物体增加的动能，这也是能量守恒的一种体现。如果，我们将该物体动能的增量，等效于一个力F_m作用了一段距离Δs后所做的功 A:

$$\mathrm{A = F \cdot \Delta s = \Delta E_v}$$

其等效作用力F_m为: $F_m = \frac{\Delta\mathrm{E_v}}{\Delta\mathrm{s}} \qquad (4)$

将式（3）代入式（4）得： $F_m = -\frac{\Delta\mathrm{E_i}}{\Delta\mathrm{s}}$

$$F_m = -\frac{\mathrm{dE_i}}{\mathrm{ds}} \qquad (5)$$

质能公式： $\mathrm{E_i = mc^2} \qquad (6)$

内能随空间的变化率：　$$\frac{\mathrm{d}E_i}{\mathrm{ds}} = m\frac{dc^2}{ds} + c^2\frac{dm}{ds} \qquad (7)$$

由于我们讨论的物体运动都是在低速或静止状态，故认为质量保持不变

故：
$$\mathrm{m} = \mathrm{m}_0$$
$$\mathrm{dm} = 0$$

式（7）减化得：　$$\frac{\mathrm{d}E_i}{\mathrm{ds}} = m\frac{dc^2}{\mathrm{ds}} \qquad (8)$$

将式(8)代入式(5)得：　$$F_m = -\mathrm{m}\frac{dc^2}{ds} \qquad (9)$$

将式(1)代入式(8)得：　$$F_m = -\mathrm{m}\frac{d}{ds}\left(\frac{1}{\mu_0\varepsilon_0}\right) \qquad (10)$$

经过以上推导，我们得到了由式（10）表达的结论，在$\mu_0\varepsilon_0$变化的空间中，物体确实受到了一个指向$\mu_0\varepsilon_0$增加方向的力F_m，然而，这个力F_m是来自物体自身，与其它物体没有直接关系，也就是说，物体间的相互吸引力，首先是所有物体通过自身的质量（能量），使其周边的$\mu_0\varepsilon_0$的值得到了增加，物体实际都是在朝$\mu_0\varepsilon_0$增加的方向运动，外在表现为物体间具有相互聚集的吸引力，因此，万有引力只是这种力F_m的复合与等效。

物体总会自发地产生一个朝$\mu_0\varepsilon_0$增加的方向运动的力，而与$\mu_0\varepsilon_0$变化的原因无关。本质意义上讲，$\mu_0\varepsilon_0$增加的方向，就是物体内能降低的方向，任何物体都会自发地朝能量状态更低的方向运动，这是一切物质的自然属性，而力F_m只是这种自发趋向的外在表现和量度。我们没有必要在一个非惯性的物理环境中，为这个力F_m再去寻找另一个施力物体。

由式（9）（10）可得物体的加速度 g:

$$g = -\frac{dc^2}{ds} \qquad (11)$$

$$g = -\frac{d}{ds}\left(\frac{1}{\mu_0\varepsilon_0}\right) \qquad (12)$$

由式（12）可见，在$\mu_0\varepsilon_0$变化的空间中，不论物体质量大小，物体都具有相同的加速度，这也就是在引力场中物体都具有相同加速度的物理原因。

物体产生的“引力”F_m与惯性力同源于物体的内能，故物体的引力质量与惯性质量必然是等价的。

引力场强度$E_g = g$，由式（12）可见，引力场强度E_g等于$\mu_0\varepsilon_0$倒数的负梯度。由此可见，空间变化的$\mu_0\varepsilon_0$就是形成引力场的物理机制。引力相互作用与电磁相互作用最终在电磁性质的基础上得到了统一。

3. $\boldsymbol{\mu_0\varepsilon_0}$与时间、空间的关系

光速具有相对变化的一面，也有绝对不变的一面，如在太阳侧的$\mu_0\varepsilon_0$相对增加了，在这个变化的局域外，我们可测得太阳侧的光速相对变慢了，这是光速相对变化的一面，而光速绝对不变的另一面，是说在太阳侧$\mu_0\varepsilon_0$相对增加的局域内，测得的光速仍然是光速 c，与局域外的光速一致。光速绝对不变的一面就是光速不变原理。光速不变原理是经过了实验验证的定律，也是我们一定要秉持的，否则，如果我们测得的雷达回波来自比地球$\mu_0\varepsilon_0$更低的空间，雷达回波不仅不会延迟，反而会提前，这样我们就会误认为该局域内出现了超光速现象，

这显然是不对的。

那么，光速的相对变化和光速的绝对不变与时间和空间有什么关联呢？或者说相对变化的$\mu_0\varepsilon_0$对空间和时间会产生什么影响呢？为了便于讨论，我们假设有两个相邻的真空空间，一个称为 A 空间，另一个称为 B 空间， A、B 空间各向均匀同性，时间也各自均匀地流失，唯一不同的是 B 空间$\mu_0\varepsilon_0$的值大于 A 空间，设在 A、B 空间中各有一个惯性参照系，根据相对性原理，两惯性参照系中的一切物理定律都是相同的。如果 A、B 空间不进行比较，没有人能察觉到 A、B 空间有什么不同。

现在，我们以 A 空间的空间间隔和时间为基准，比较 B 空间与 A 空间有什么差异。设同样是一秒钟时间，光在 A 空间通过的距离为s_a，光在 B 空间通过的距离由 A 空间的来量度是s_b,因为B空间$\mu_0\varepsilon_0$的值比A空间的大,那么B空间的光速就相对A空间低,这样就有$s_b < s_a$，但根据光速不变原理，光一秒钟在 B 空间内通过的距离仍然是光速 c，在数值上与 A 空间相同，也就是说，B 空间内的 30 万公里在 A 空间来量度，比 A 空间 30 万公里的距离短,这说明 B 空间的间隔距离相对 A 空间收缩了，反之，如果 B 空间$\mu_0\varepsilon_0$的值比 A 空间的小，则 A 空间 30 万公里的距离就比 B 空间内的 30 万公里短,这时我们不能说 B 空间有超光速的现象发生，只能说 B 空间的间隔距离相对 A 空间拉伸了，这就是$\mu_0\varepsilon_0$的不同对空间间隔距离产生的影响，设 A、B 空间的相对伸缩比例系数为k_l:

$$k_l = \frac{s_b}{s_a} = \frac{c_b}{c_a} \qquad (12)$$

$$s_b = k_l s_a \qquad (13)$$

$$s_b = s_a\sqrt{\frac{\mu_{0a}\varepsilon_{0a}}{\mu_{ab}\varepsilon_{ab}}} \qquad (14)$$

这里要特别说明的是，根据光速不变原理，在 A 空间或在 B 空间中所测得各自空间内的$\mu_0\varepsilon_0$的数值是相等的，只有在 A 空间间接测 B 空间的$\mu_0\varepsilon_0$才会发现有相对变化。为了便于区分，设$\mu_{0a}\varepsilon_{0a}$表示为 A 空间的$\mu_0\varepsilon_0$，而$\mu_{ab}\varepsilon_{ab}$为 A 空间测得 B 空间的$\mu_0\varepsilon_0$

现在我们来讨论由于$\mu_0\varepsilon_0$的不同对时间流失速度的影响,因为B空间的$\mu_0\varepsilon_0$大于A空间。那么在 B 空间的空间距离相对 A 空间收缩的同时, 时间的流失速度也应该相对 A 空时变慢，这样才能保证其比值仍然是光速 c,也就是说时间的伸缩比$\mathrm{k_t}$与空间的伸缩比$\mathrm{k_l}$应相同,这个共同的伸缩比设为 k:

$$\mathrm{k} = \mathrm{k_l} = \mathrm{k_t} \qquad (15)$$

$$t_b = kt_a \qquad (16)$$

$$t_b = t_a\sqrt{\frac{\mu_{ab}\varepsilon_{ab}}{\mu_{0a}\varepsilon_{0a}}} \qquad (17)$$

根据光速变化的相对性和光速不变的绝对性，我们很容易得出以上关系式(14)(17)，简单地说，当$\mu_0\varepsilon_0$相对增加时，空间就相对收缩，时钟就相对变慢，当$\mu_0\varepsilon_0$相对减小时，空间就相对拉伸，时钟就相对变快。

在以上这些简单的关系式中，却蕴含了许多重要的物理信息。由式(17)可见，$\mu_0\varepsilon_0$控制着局域内的时间流失速度,由于$\mu_0\varepsilon_0$始终是大于零的正数,所以,时间的流失永远不会停止,更不会逆转。$\mu_0\varepsilon_0$是时间流失速度的主宰。

若 B 空间的$\mu_0\varepsilon_0$大于 A 空间，则 B 空间的时钟就比 A 空间的时钟慢, 同是一个光子，A 空间测得的频率就比 B 空间测得的频率低，其实光子并没有发生变化，只是我们用于计量的时间标准发生了变化。就如太阳表面的$\mu_0\varepsilon_0$大于地球表面的$\mu_0\varepsilon_0$， 那么从太阳表面发出的光

子，在地球表面测量其频率就会降低，这个现象也称为引力红移[5]。

由式(14)可见，$\mu_0\varepsilon_0$控制着空间距离的伸缩，如B空间1米的距离比A空间1米的距离短，在B空间内测得的距离，才是B空间的真实距离，或称为物理距离，而在A空间测得B空间的距离不是B空间的真实距离，故称为观测距离，由于A空间与B空间的$\mu_0\varepsilon_0$不同，观测距离与物理距离就不相同，如地球到太阳的观测距离比物理距离短就是例证。如果反过来,若B空间的$\mu_0\varepsilon_0$远低于A空间的$\mu_0\varepsilon_0$，这时K>>1，也就是说此时B空间中30万公里的物理距离，就可能是地球A空间300万公里的观测距离，我们虽然在B空间中做不到物理意义上的超光速，但一秒钟内穿越A空间300万公里的观测距离则完全是可能的。由于宇宙空间中$\mu_0\varepsilon_0$的分布是相对变化的，那么宇宙空间的物理距离也是相对变化的, 我们在作大尺度范围观测时，应充分考虑观测距离与物理距离间的差异，如星系旋臂公转速度异常，应该是星系边沿的$\mu_0\varepsilon_0$比星系中心低，速度异常的快只是观测距离比物理距离长所引起的计算误差。从星系中央到星系边沿等分空间距离是误差的根源，与其它物质的影响无关。

4. 关于 $\mu_0\varepsilon_0$的讨论

实验观测表明，真空中的$\mu_0\varepsilon_0$是相对可变的。在此基础上，通过对空间变化的$\mu_0\varepsilon_0$的物理作用进行了探讨，并得出了一些重要结论，如我们解释了引力场形成的物理机制，解释了为什么在引力场中物体所获得的加速度都相同，解释了引力质量与惯性质量为什么等价，解释了引力相互作用只是物体朝$\mu_0\varepsilon_0$增加的方向运动的一种契合，使引力相互作用与电磁相互作用在物体与空间的电磁性质基础上得到了统一，以及讨论了$\mu_0\varepsilon_0$对空间和时间的控制作用，阐明了物体与空间具有深刻的不可分割的内在联系，通过对$\mu_0\varepsilon_0$的深入探讨，解释了一联串的物理问题，这不会是巧合，也不是空穴来风，众所周知，狭义相对论和广义相对论均获得了巨大的成功，而光速c在其中是一个无所不在的物理量，它不仅是一个速度参数，它代表的是电磁波，代表的是空间的电磁性质，代表的是光速不变原理，正是这个不变原理，使洛伦兹变换替代了伽利略变换，从此使我们认识到了空间与物体存在的内在联系，然而，不论是电磁波，光速.、光速不变原理，还是洛伦兹变换等，幕后都有$\mu_0\varepsilon_0$的身影，我们以上的诸多讨论，只是对$\mu_0\varepsilon_0$物理作用探讨的继续。

5. 结语

物体使$\mu_0\varepsilon_0$在空间中形成了一个变化的标量场，引力场强度E_g等于$\mu_0\varepsilon_0$倒数的负梯度，这就是引力场形成的物理机制。$\mu_0\varepsilon_0$控制着时间的流失速度与空间的间隔距离。物体与空间具有不可分割的内在联系。引力相互作用与电磁相互作用在物质和空间的电磁性质基础上得到了统一。既然我们认识到了引力场形成的物理机制，那么，实现人造反引力场的愿望就为时不远了。

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