The origin of spacetime and its influence on the gravitational constant

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Abstract: This is my earliest paper analyzing the influence of spacetime structure changes on the gravitational constant. In the process of establishing the model, some calculation errors were found, so the model was changed and several papers on the influence of Jupiter on the measurement of the gravitational constant were published a few days ago. Now it seems that the new model that was subsequently established actually has serious problems, so now I try to change back to the original model for analysis. Although the two models are very different, they can obtain basically the same results in analyzing the influence of Jupiter on the gravitational constant. This article believes that the accumulation of electrostatic energy in matter is the basic origin of spacetime. Since the distribution of electrostatic energy produced by matter is very wide, for a matter of a large mass like a star, the accumulated electrostatic energy distribution can reach a range of one or two light-years, which is very huge relative to the mass distribution of stars. However, due to the motion of some huge planets, such as Jupiter, the electrostatic energy distribution structure of galaxies like the entire solar system, that is, the spacetime structure, will change. This change in the spacetime structure will result in the changes of the gravitational constant measured on the earth. In addition, due to the elliptical orbit of the earth, the earth appears at different positions in the spacetime structure, which brings greater uncertainty to the measurement of the gravitational constant on the earth. The analysis results of this paper show that the change of the gravitational constant caused by the change of the spacetime structure can explain the large error of the measurement result of the gravitational constant to a certain extent.

Keywords: gravitational constant; spacetime structure; planetary orbit

1 Introduction

What is spacetime? This is a philosophical question. However, as our understanding of various basic laws of physics gets deeper and deeper, what is spacetime has also begun to become a physical question.

In the process of in-depth thinking in the last period of time, I discovered an energy that is often overlooked but ubiquitous: the electrostatic energy of electrons and protons [1]. It can be found from the current experimental data that the radius of the electron is at least very small. The very small radius means that the electron will have a very large electrostatic field energy. But when we calculate the trajectory of electrons, we do not need to consider the influence of such a large electrostatic field energy carried by the electrons on the trajectory. After all, we can see from the relativistic mass-energy formula that such a large energy can be converted into the corresponding mass.

Since such a large electrostatic field energy has never been considered in the calculation of various dynamics, this energy must have other uses. My assumption is that the electrostatic field energy of the electron and proton has a wider distribution range. This distribution range far exceeds the distribution range occupied by the mass structure of the elementary particle itself. On this basis, this article infers that the distribution range of the electrostatic field energy of such electrons and protons is what we usually call "spacetime".

2 The formation of spacetime structure

2.1 The cumulative effect of electrostatic field energy

According to the relativity mass-energy formula, it means that energy and mass are two different manifestations of the same physical quantity. In the "Foundations of Virtual Spacetime Physics " [2], energy and mass are two different ways of existence of real spacetime and virtual space-time. That is, in real spacetime, the physical quantity expresses energy, while in virtual space-time, the physical quantity expresses the form of mass.

Therefore, we can infer some properties of energy from the properties of mass.

First of all, mass has the characteristic of accumulation. That is, multiple different masses can be combined to form a larger mass. But mass does not have the nature of superposition. From the structure of elementary particles, it is impossible to completely overlap two electrons or protons to form a mass larger electron. Of course, according to Pauli's exclusion principle, two electrons with opposite spin directions can be accommodated in one orbit, but once they are free from the bondage of atoms, the two electrons become free electrons and will separate.

Therefore, we can also assume that the electrostatic field energy has cumulative characteristics. But unlike the electrostatic field itself, the electrostatic field can be superimposed. But the assumption here is that the electrostatic field energy must be added together. Form a larger range of electrostatic field energy. Just as mass is added together to form a larger range of material structures.

In this way, we can obtain a very interesting characteristic of the electrostatic field energy distribution, that is, we will obtain an electrostatic field distribution far exceeding the particle diameter. According to the analysis of my last paper [1], the diameter of an electron may be less than 10^{-17}m, but the distribution range of the electrostatic field energy of an electron may reach 0.1 mm. The difference between the two is 10^{13} times. This is a very large range difference.

Since the radius of electrons and protons is very small, the distribution range of matter composed of electrons and protons is also very small. Even a material as heavy as the earth has a diameter of more than 10,000 kilometers. However, considering that the distribution range of electrostatic field energy far exceeds the distribution range of mass, and electrostatic field energy, like mass, has a cumulative effect, the distribution range of electrostatic field energy of the electrons and protons that make up the earth will also far exceed the distribution range of mass. According to my calculation results, the distribution range of the electrostatic field energy of the earth can reach a distance of 0.03 light-years.

Such a result can be represented by Figure 1

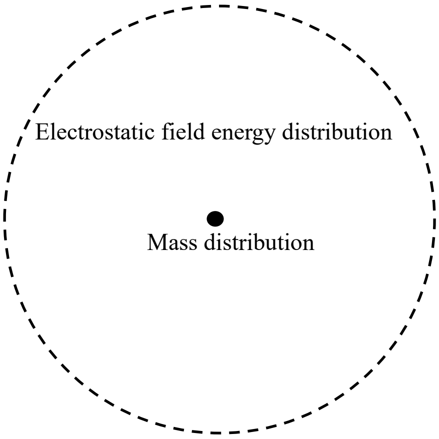

Figure 1. The mass and its electrostatic field energy distribution

It can be seen in Figure 1 that the mass distribution range of a substance is very small. But its electrostatic field energy distribution range is very large. When in motion, the electrostatic field energy distribution represented by the dashed circle moves as a whole, and is not carried by the mass. But the mass distribution plays a role in generating inertia.

Considering that the electrostatic field energy distribution shown in Figure 1 is very wide and the substance is moving in it, this article believes that this electrostatic field energy distribution is actually the "space-time" structure formed by the substance. This is believed to help us form a new understanding of spacetime structure. In order not to cause confusion, the "**spacetime structure**" mentioned later in this article refers to the "**electrostatic field energy distribution**".

Secondly, the distribution of electrostatic field energy can be compressed. It's like mass can be compressed to form a higher density mass distribution. After the electrostatic field energy distribution is compressed, it means that space-time is compressed. After space-time is compressed, the length of unit space will be shortened, which will lead to the increase of gravitational constant [3].

2.2 The influence of mass distribution on spacetime structure

If it can be regarded as a point mass, according to the relationship of symmetry, the spacetime structure corresponding to the mass should be an isotropic sphere. However, when the mass distribution is uneven, the spacetime structure will also be uneven. In this way, when the corresponding mass moves, it will cause the spacetime structure to deform.

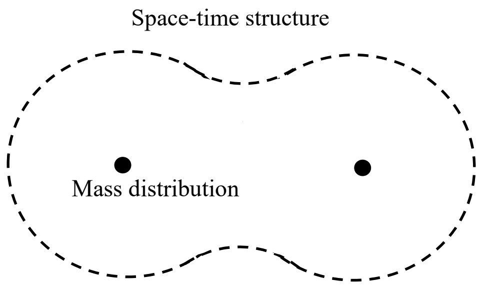

Figure 2. Distortion of Space-time structure caused by mass distribution change

It can be seen from Figure 2 that when the mass distribution changes, it will directly affect the corresponding spacetime structure. Considering that the electrostatic field energy can still generate gravity, this change in the distribution of electrostatic field energy will also affect the state of inertial mass motion.

3 The impact of spacetime structure changes on gravity

3.1 The relationship between the ratio of space-time compressed and the position of the planet

Due to the accumulation of electrostatic field energy in the spacetime structure, it will inevitably generate pressure on the internal space-time and compress it. The "pressure" generated by this electrostatic field energy may be directly related to the depth of the spacetime structure. Here we use some knowledge of liquid pressure to understand this pressure. According to the law of liquid pressure change, the pressure in the liquid is proportional to the depth of the liquid. which is

$$p = kh$$

We also assume here that the pressure generated by the electrostatic field energy in the spacetime structure is directly proportional to the depth. The internal compression of the spacetime structure is directly proportional to the compressed size of the spacetime structure. Consider the isotropic spherical shape here, which means that in the radial direction of the spherical spacetime structure, the degree of spacetime compression is proportional to the depth of the spacetime structure.

As shown in Figure 3, a large circle with an outer radius of r represents the radius of the spacetime structure formed by a certain substance, and the circular position at the inner radius a of the spacetime structure, the depth is

$$b = r - a$$

Therefore, on the spherical surface with radius a in Fig. 3, all positions receive the same pressure, and the corresponding compression degree of spacetime is the same.

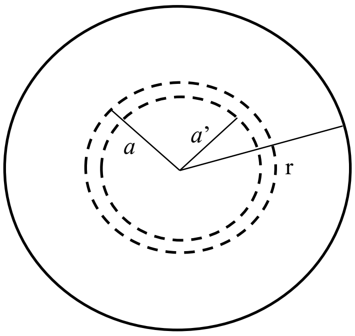

Figure 3. Inside the spherical space-time structure

For the position a' in Figure 3, the distance from the surface of the spacetime structure is

$$b' = r - a'$$

In addition, consider my analysis in another paper [3], the gravitational constant is directly proportional to the degree of space-time compression, namely

$$G = kb$$

$$G' = kb' = k(b + \Delta b)$$

Therefore

$$G' = \left(1 + \frac{\Delta b}{b}\right) G$$

If

$$r \gg a$$

Then

$$G' \approx \left(1 + \frac{\Delta b}{r}\right) G$$

3.2 Equal G line

As in Figure 3, the gravitational constants corresponding to all points on a circle are equal. Here, the circular dotted line in the figure is called "Equal G line".

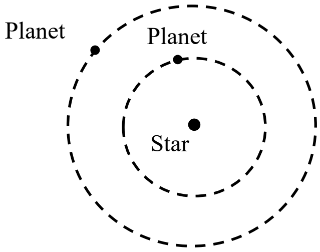

Figure 4. Equal G line

In Figure 4, all circular planetary orbits orbiting stars can be regarded as a kind of "Equal G line". The closer it is to the star, the greater the "pressure" of the star's spacetime structure on the planet, and the more severe the space-time compression.

So on any circular orbit, it means Δb=0

4 Factors affecting the measurement of gravitational constant on the earth's surface

4.1 The influence of the Earth's perihelion and aphelion on the measurement of the Earth's surface gravitational constant

Consider here that the sun mass is M and the earth mass is m_e.

First, we determine some of the parameters.

Considering that the radius of the earth is much smaller than the length of the perihelion of the earth, the radius of the earth can be ignored.

According to the paper [1], the spacetime structure radius of the solar system is

$$r \approx b \approx 2 \times 10^{16} m$$

The actual orbit of the earth is elliptical, so there is a distinction between perihelion and aphelion. The distance between the earth's perihelion and the sun is 1.471×10^{11}m, and the aphelion is 1.521×10^{11}m.

Thus, there is a situation where $\Delta b \neq 0$. In this situation, $\Delta b = 5 \times 10^9 m$

Substituting the above formula, you can calculate

$$G' = \left(1 + \frac{\Delta b}{b}\right) G \approx G \left(1 + \frac{5 \times 10^9}{2 \times 10^{16}}\right) = (1 + 2.5 \times 10^{-7}) G$$

That is, the value of the gravitational constant measured at the position of the perihelion of the earth is larger than the value measured at the position of the aphelion. It can be seen that in this case, the influence of the Earth's perihelion and aphelion on the measurement of the gravitational constant is not too great. The error is about 0.25 ppm, which is far less than the best experimental measurement accuracy.

4.2 The influence of Jupiter's orbit on the measurement of the Earth's surface gravitational constant

Because Jupiter's mass is relatively large, Jupiter orbits the sun again. Different positions of Jupiter will cause the planet's motion to become more complicated.

Due to the existence of Jupiter, the center of mass of the solar system deviates from the center of the sun. The spacetime structure formed in this way is a sphere drawn around the center of mass of the solar system. While the earth revolves around the sun, the distance from the surface of the spacetime structure is different at position B where Jupiter opposes the sun and position A on the opposite side. It is shown in Figure 5.

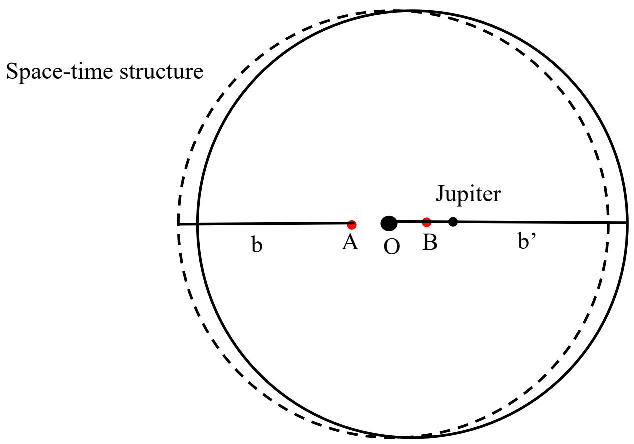

Figure 5. The influence of the space-time structure of Jupiter on the solar system

Due to the movement of stars such as Jupiter, the center of mass is shifted. The center of mass is approximately from the center of the sun

$$1.5 \times 10^9 m$$

This is mainly contributed by Jupiter.

It can be seen from Figure 5 that if the Earth's orbit around the sun is circular, the Earth is located at Jupiter’s opposition to the sun, and the distance from the spacetime structure surface of the solar system should be added

$$b' = b_0 + 1.5 \times 10^9 m$$

Where b_0 is the distance between the earth and the surface of the solar system's space-time structure assuming that the center of mass of the solar system is at the center of the sun and the earth's orbit is circular.

If it is on the other side of Jupiter’s opposition, the distance from the spacetime structure surface of the solar system should be subtracted

$$b' = b_0 - 1.5 \times 10^9 m$$

Therefore

$$\Delta b = 3 \times 10^9 m$$

We can calculate

$$G' \approx G\left(1+\frac{3\times10^{9}}{2\times10^{16}}\right) = (1+1.5\times10^{-7})G$$

If the influence of the Earth's perihelion and aphelion is considered, the maximum influence on the gravitational constant can reach

$$G' \approx (1+4\times10^{-7})G$$

Therefore, in this case, the uncertainty of the gravitational constant is about 0.4 ppm, which is also less than the highest accuracy of the existing gravitational constant measurement.

Of course, the above calculations do not take into account that Jupiter's motion causes the space-time structure of the solar system to change shape as shown in Figure 2. If such a deformation occurs, it means that it will cause a more serious compression of the space-time structure of the earth's position, which in turn will cause a greater range of changes in the gravitational constant.

4.3 The influence of Jupiter's perihelion and aphelion on the gravitational constant

Since Jupiter's perihelion and aphelion differ by approximately 7×10^{10} m

This is about the displacement of the center of mass between the Sun and Jupiter 7×10^{7} m

The difference is relatively small, so it has little effect on the measurement of the gravitational constant on the earth.

5 The influence of spacetime structure radius on the estimation of gravitational constant

It can be seen that in the above analysis process, the spacetime structure radius has the greatest influence. In the process of estimating the spacetime structure radius of the solar system [1], the estimated radius of the Oort cloud of the solar system is used, which is about 1 to 2 light years. However, in fact, the Oort Cloud is probably the material released by the solar system in the early stages of formation. And these materials can still maintain their original shape, and may continue to spread, or it may indicate that the gravity of the solar system no longer plays a role in this range.

At present, there is definite evidence that the gravity of the solar system can also play a role in the Kuiper Belt outside the solar system. The Kuiper Asteroid Belt has a radius of approximately 0.001 light-years. If this radius is expanded ten times for estimation, the spacetime structure radius of the solar system estimated above is only about 10^{14} m

It can be seen that there are still $r \gg a$

From this, it can be calculated that the spacetime structure radius formed by Jupiter's electrostatic field energy distribution is about 10^{13} m

In this way, the difference between the Earth's perihelion and aphelion will affect the gravitational constant up to

$$G' \approx G\left(1 + \frac{5 \times 10^9}{10^{14}}\right) = (1 + 5 \times 10^{-5})G$$

This difference will cause an uncertainty of 50 ppm in the measurement of the gravitational constant.

And the influence of Jupiter and other planets will reach

$$G' \approx G\left(1 + \frac{3 \times 10^9}{10^{14}}\right) = (1 + 3 \times 10^{-5})G$$

This will also cause the uncertainty of the measurement of the gravitational constant to reach 30 ppm.

Therefore, if the above-mentioned estimation of the spacetime structure radius is correct, the uncertainty of the measurement of the gravitational constant caused by the movement of the Earth's perihelion and aphelion and Jupiter and other planets can reach more than 80 ppm. Such a large uncertainty may be an important reason for the large difference in the measurement data of Jupiter's gravitational constant.

6 Discussion

From the mathematical analysis of the influence of the gravitational constant in my previous paper [1], the conjecture in which "the length of a unit space is inversely proportional to the gravitational potential", there is a lot of room for improvement. Because if this conjecture is true, it means that the Earth's perihelion and aphelion will affect the gravitational constant by 4%. This is definitely problematic. If there is such a large uncertainty, it will be discovered in the experiments of measuring the gravitational constant of the past few decades. After all, such a low-precision experiment could have been completed more than a century ago. However, when the above conjecture is applied to the data of adjacent months when the gravitational constant is measured, even if it is applied to the data between adjacent months in different years, the theoretical prediction and experimental data are still in good agreement.

This article uses another spacetime structure model for analysis. This article believes that the electrostatic field energy distribution of electrons and protons that we have neglected in our calculations for a long time are the key factors that constitute the spacetime structure. The electrostatic field energy of electrons and protons has the same cumulative effect as mass. This is a conclusion based on the basic principles of virtual space-time physics [2]. In virtual space-time physics, mass belongs to the energy of virtual space-time, which has the same properties as the energy in real space-time. Therefore, when in real space-time, we see that as the mass of a substance becomes larger and larger, the mass distribution radius of the substance will also become larger. This is the cumulative effect of mass. If electrostatic field energy also has such a cumulative effect, as the accumulation of matter increases, the number of electrons and protons contained in the matter will also increase, and the accumulated electrostatic field energy will also increase. Considering that the electrostatic field distribution far exceeds the mass distribution, the distribution radius of the electrostatic field energy will far exceed the mass distribution radius of the corresponding material. Here, this very wide range of electrostatic field energy distribution is called "spacetime structure", which also reflects a space-time distribution.

Just like the mass distribution, for a huge mass like the earth, the deeper the inside of the earth, the deeper the depth, the greater the pressure there; the shallower the depth, the closer it is to the surface of the earth, which is caused by the mass distribution, the pressure will be lower. This article borrows the calculation formula of the internal pressure of the liquid, that is, the internal pressure of the liquid is proportional to the depth of the liquid. Therefore, this article assumes that the spacetime structure also has roughly the same properties. Therefore, considering the different depths of the Earth's perihelion and aphelion positions from the surface of the solar system's spacetime structure, the degree of spacetime compression at the Earth's location will be different. In this way, we obtain the unit space length change of the different positions of the earth's orbit around the sun. On this basis, we can calculate the factors including the position of the earth's perihelion and aphelion, and the changes of the solar system's center of mass caused by the movement of other planets such as Jupiter, and then get the influence on the gravitational constant. However, this method of borrowing the calculation formula of the internal pressure of the liquid to analyze the compression of the unit space length inside spacetime, there are still many points worth discussing. After all, the spacetime structure is a spherical shape. There is also a non-linear relationship between the pressure change inside the earth and the depth.

The calculation results in this paper show that the spacetime structure model has a relatively large influence on the gravitational constant. If the spacetime structure radius of the solar system is assumed to be as long as 2 light-years, the uncertainty in the measurement of the gravitational constant caused by the changes in the position of the earth’s perihelion and aphelion is about 0.4 ppm. This uncertainty is much smaller than the existing gravity Constant measurement accuracy.

If it is assumed that the spacetime structure radius of the solar system is approximately longer than the radius of the Kuiper Belt of the solar system, this uncertainty will reach more than 80 ppm. This uncertainty can be measured by existing gravitational constant measurement devices. The analysis results are basically consistent with my previous papers [4~6]. However, due to the uncertainty brought about by changes in the spacetime structure, the factors involved may be more complicated. After all, the positions of the perihelion and aphelion of the Earth and Jupiter, and the movements of other planets can all be taken into consideration.

In addition, this article also touches on many issues that we currently don’t know, including whether this spacetime structure of the solar system exists? If this spacetime structure really exists, what is the exact value of its radius? What is the relationship between the unit space length inside the spacetime structure and the spacetime structure is not clear to us now. Therefore, there is still a lot of room for maneuver when calculating and analyzing. However, although the theoretical uncertainty is very large, it at least provides us with a new way to understand the problem of gravitational constant. If there is enough experimental evidence to confirm the change of the gravitational constant, I believe it will greatly promote our understanding of the theory of gravitation.

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Chinese Version

时空的起源及其对引力常数的影响

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摘要：这是我最早分析时空结构变化对引力常数影响的论文。由于在建立模型的过程中，发现了一些计算上的错误，就更改了模型，形成前几天发表的几篇有关木星对引力常数测量影响的论文。现在看起来，后续建立的新模型其实也有很严重的问题，因此现在尝试改回最初的模型来进行分析。两个模型尽管差异很大，但是在分析木星对引力常数影响方面，都可以获得基本相同的结果。本文认为物质中的静电能的累积是时空的基本起源。由于物质所产生的静电能分布非常广泛，因此对于恒星这样大质量的物质，其累积的静电能分布可以达到一两光年的范围，这相对于恒星的质量分布来说是非常巨大的。但是由于一些体积巨大的行星，比如木星的运动，又会导致整个太阳系这样的星系静电能分布结构，也就是时空结构产生变化，这种时空结构的变化将导致在地球上测量到的引力常数产生变化。另外，由于地球轨道为椭圆，导致地球出现在时空结构的不同位置，对在地球上测量引力常数带来了更大的不确定性。本文的分析结果表明，这种时空结构的变化引起的引力常数变化，能够在一定程度上解释引力常数测量结果误差较大的原因。

关键词：引力常数；时空结构；行星轨道

1 引言

时空究竟是什么，这是一个哲学问题，然而随着我们对各种基本物理规律的认识越来越深入，什么是时空，则也开始变成了一个物理的问题。

在最近一段时间的深入思考过程中，我发现了一个经常被人忽视，却又无处不在的能量：电子和质子的静电能[1]。从目前实验数据可以发现，电子的半径至少是非常小的。而非常小的半径意味着电子将具备非常大的静电场能量。但是我们在计算电子的运动轨道的时候，却并不需要考虑电子所携带的这么大的静电场能量对运动轨迹的影响。毕竟我们从相对论质能公式中可以看出这样大的能量是可以折算成相应的质量的。

既然这么大的静电场能量从来就没有被考虑到各种动力学的计算过程中，那么这个能量一定会有其他的用途。我的假设就是，这种电子和质子的静电场能量具有一个更加广泛的分布范围。这个分布范围远超基本粒子本身的质量结构所占据的分布范围。在此基础上，本文推断实际上这种电子和质子的静电场能量分布范围就是我们平时所说的“时空”。

2 时空结构的形成

2.1 静电场能量的累加效应

按照相对论质能公式，意味着能量和质量是同一种物理量的两种不同的表现形式而已。在《虚时空物理学基础》中[2]，能量和质量是实时空和虚时空的两种不同的存在方式。即在实时空中该物理量表现出来的是能量，而在虚时空中，该物理量将表现出质量的形式。

因此我们可以从质量的性质来推测能量的一些性质。

首先，质量具备累加的特性。即多个不同的质量可以组合在一起，形成一个更大的质量。但是质量并不具备叠加的性质。从基本粒子的结构上来看，不可能将两个电子或者质子完全重合在一起，形成一个质量的更大的电子。当然按照泡利不相容原理，两个自旋方向相反的电子可以容纳在 一个轨道上，但一旦脱离了原子的束缚，两个电子成为自由电子将会分开。

因此我们也可以假设静电场能量具备累加的特性。但是跟静电场本身不一样，静电场是能够叠加的。但是这里的假设是静电场能量必须累加在一起。形成更大范围的静电场能量。就像质量被累加在一起以后，可以形成更大范围的物质结构一样。

这样我们就可以获得静电场能量分布的一个非常有趣的特性，就是我们将获得一个远超粒子直径的静电场分布。按照我上一篇论文的分析[1]，一个电子的直径可能要小于 10^{-17}m，但是一个电子的静电场能量分布范围可能达到 0.1 毫米。二者相差 10^{13} 倍。这是一个非常大的范围差别。

由于电子和质子的半径很小，因此由电子和质子构成的物质分布范围也就非常小。即便是像地球这么大重量的物质，其直径也就一万多千米。然而考虑到静电场能量的分布范围远超质量的分布范围，而静电场能量又跟质量一样，具备累加的效应，因此构成地球的电子和质子的静电场能量分布范围也就会远超地球质量分布的直径，即一万多千米。按照我的计算结果，地球的静电场能量分布范围可以达到 0.03 光年的距离。

这样的结果可以用图 1 来表示：

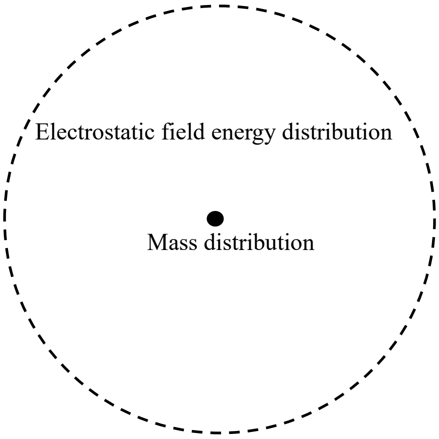

Figure 1. The mass and its static field energy distribution

在图 1 中可以看出一个物质的质量分布范围是非常小的。但是它的静电场能量分布范围则是非常大的。在运动的时候，虚线圆圈所代表的静电场能量分布是作为一个整体运动的，而并非由质量携带而运动的。但是在其中质量分布起到一个产生惯性的作用。

考虑到图 1 显示的静电场能量分布范围非常广阔，而物质又在其中运动，因此本文认为这种静电场能量分布实际上就是该物质所形成的“时空”结构。这相信有助于我们形成对时空结构的新的认识。为了不至于引起混淆，本文后续所说的“时空结构”都是指“静电场能量分布”。

其次，静电场能量分布又是可以被压缩的。这就像质量能够被压缩，并形成更高密度的质量分布一样。静电场能量分布被压缩之后，意味着时空被压缩。时空被压缩之后将导致单位空间长度缩短，进而导致引力常数上升[3]。

2.2 质量分布对时空结构的影响

如果可以近似看作为点质量，则根据对称性的关系，则该质量对应的时空结构应该是一个各向同性的球形。然而当质量分布不均匀的时候则时空结构也将不均匀。这样当对应的质量产生移动的时候，将导致时空结构出现形变。

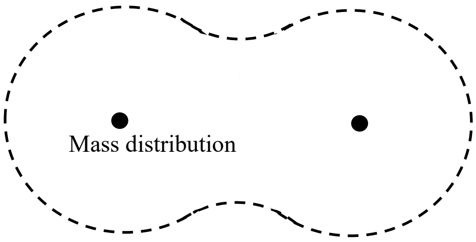

Figure 2. Distortion of Space-time structure caused by mass distribution change

从图 2 可以看出质量分布出现变化的时候，将直接影响到对应的时空结构。考虑到静电场能量仍然能够产生引力，这种静电场能量分布的变化也将对其中的惯性质量运动状态产生影响。

3 时空结构的变化对引力的影响

3.1 时空被压缩的比例与行星所处位置之间的关系

由于时空结构中的静电场能量累积，必然会对内部的时空产生压力，并压缩时空。这种静电场能量产生的“压力”可能跟时空结构的深度有直接联系。这里借助液体压强的一些知识来理解这种压力。按照液体压强变化的规律，液体中的压强大小跟液体的深度成正比。即：

$$p = kh$$

我们在这里也假设，时空结构内部静电场能量产生的压力也直接跟深度成正比。而时空结构内部的压强大小又直接跟该处时空结构被压缩的大小成正比。这里考虑各向同性的球形形状，这也就意味着，在球形时空结构的径向，时空被压缩的程度如何是与该处时空结构的深度成正比的。

如图 3，外部半径为 r 的大园表示某个物质形成的时空结构半径，而在该时空结构内部半径为 a 处的圆形位置由于距离时空结构表面的深度皆为

$$b = r - a$$

因此在图 3 中半径为 a 处的球面上，所有位置受到的压力都是相同的，对应的时空被压缩程

度都是相同的。

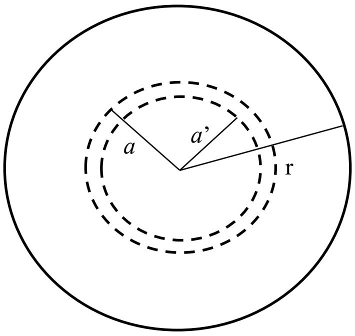

Figure 3. Inside the spherical space-time structure

对于图 3 中的 a'位置，其距离时空结构的表面距离为：

$$b' = r - a'$$

另外再考虑我在另一篇文献[3]中的分析，引力常数跟时空被压缩的程度成正比，即

$$G = kb$$

$$G' = kb' = k(b + \Delta b)$$

因此

$$G' = \left(1 + \frac{\Delta b}{b}\right) G$$

如果

$$r \gg a$$

则

$$G' \approx \left(1 + \frac{\Delta b}{r}\right) G$$

3.2 等 G 线

由于在图 3 中，一个圆形上面的所有点对应的引力常数都是相等的。这里将该图中圆形虚线叫做“等 G 线”。

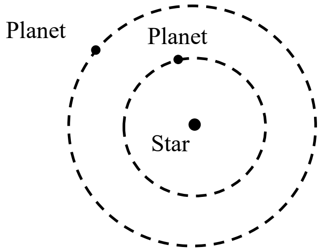

Figure 4. Equal G line

在图 4 中，所有围绕恒星运行的圆形行星轨道都可以看做一种"Equal G line"。离恒星越近，则行星承受的恒星时空结构的"压力"越大，时空被压缩的越严重。

因此在任意一条圆形轨道上面，都意味着$\Delta b = 0$

4 影响地球表面测量引力常数的因素

4.1 地球近日点和远日点对地球表面引力常数测量的影响

这里考虑太阳质量为 M，地球质量为 m_e.

首先我们确定其中的一些参数。

考虑到地球的半径远小于地球的近日点长度，因此地球的半径可以忽略不计。

按照文献[1]，太阳系时空结构半径为

$$r \approx b \approx 2 \times 10^{16} m$$

实际的地球运行轨道为椭圆形的，因此存在近日点和远日点的区分。地球的近日点离太阳的距离为 1.471×10^{11}m，远日点为 1.521×10^{11}m.

这样就存在$\Delta b \neq 0$的情况。这种情况下，$\Delta b = 5 \times 10^9 m$

代入上述公式，可以计算出：

$$G' = \left(1 + \frac{\Delta b}{b}\right) G \approx G\left(1 + \frac{5 \times 10^9}{2 \times 10^{16}}\right) = (1 + 2.5 \times 10^{-7}) G$$

即地球近日点位置测量出的引力常数数值，比远日点位置测量到的数值要大一些。可以看出

这种情况下，地球近日点和远日点对于引力常数测量的影响不算太大。大约为 0.25 ppm 的误差，这远小于目前最好的实验测量精度。

4.2 木星轨道对地球表面引力常数测量的影响

由于木星的质量比较大，对于木星又绕太阳运行。在木星运行的不同位置，将导致行星的运动变得更加复杂。

由于木星的存在，导致太阳系的质心位置偏离太阳中心。这样所形成的时空结构就是围绕太阳系质心所绘制出来的一个球体。而地球围绕太阳运转，在木星冲日的 B 位置和相对一侧的 A 位置，距离时空结构表面的距离是不同的。

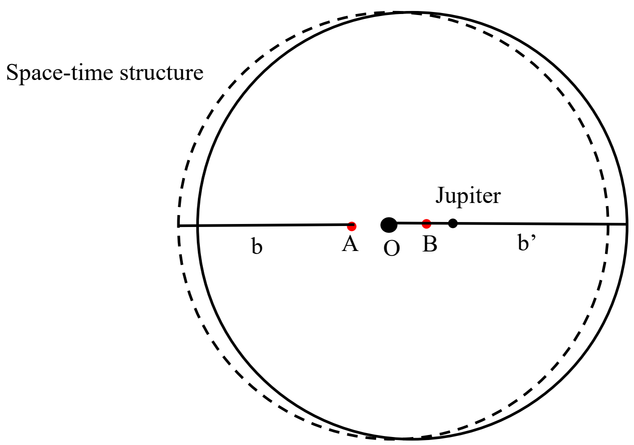

Figure 5. The influence of the space-time structure of Jupiter on the solar system

由于木星等星体的运行，导致质心偏移。质心位置大约距离太阳中心位置

$$1.5 \times 10^9 m$$

这其中主要是由木星贡献的。

从图 5 中可以看出，如果地球绕日轨道为圆形，则地球位于木星冲日位置，其距离太阳系时空结构表面的距离要加上

$$b' = b_0 + 1.5 \times 10^9 m$$

如果位于木星冲日位置另一侧，则其距离太阳系时空结构表面的距离要减去

$$b' = b_0 - 1.5 \times 10^9 m$$

因此

$$\Delta b = 3 \times 10^9 m$$

可以计算出

$$G' \approx G\left(1 + \frac{3 \times 10^9}{2 \times 10^{16}}\right) = (1 + 1.5 \times 10^{-7})G$$

如果考虑到地球的近日点和远日点影响，则对引力常数的影响最大值可达到

$$G' \approx (1 + 4 \times 10^{-7})G$$

因此这种情况下，引力常数的不确定性大约为 0.4ppm，也小于现有引力常数测量的最高精度。

当然上述计算并没有考虑到木星运动导致太阳系时空结构出现如图 2 那样的形状变化。如果出现那样的形变，则意味着会导致出现地球位置时空结构更严重的压缩，进而引起引力常数更大范围的改变。

4.3 木星近日点和远日点对引力常数的影响

由于木星近日点和远日点的相差大约

$$7 \times 10^{10} m$$

这对于太阳和木星之间的质心位移大约为

$$7 \times 10^7 m$$

差异相对来说比较小，因此对于地球上引力常数的测量影响不太大。

5 时空结构半径对引力常数估算的影响

可以看出，在上述的分析过程中，其中影响最大的还是时空结构半径。在太阳系时空结构半径的估算过程中[1]，使用了太阳系奥尔特云的估算半径，大约为 1~2 光年左右。然而实际上奥尔特云很可能是太阳系在形成初期释放出去的物质。而这些物质现在还能够保持最初的形状，且可能还在继续扩散，也可能说明太阳系的引力已经在这个范围不再产生作用了。

目前有确切证据表明太阳系的引力还能够产生作用的是太阳系外围的柯伊伯小行星带。柯伊伯小行星带的半径大约为 0.001 光年。如果将这个半径再扩大十倍来进行估算，则上述估算的太阳系时空结构半径大约只有$10^{14} m$

可以看出仍然有$r \gg a$

由此可以计算出木星的静电场能量分布所形成的时空结构半径大约为$10^{13}m$

这样地球近日点和远日点差异对引力常数的影响将达到

$$G' \approx G\left(1+\frac{5\times 10^{9}}{10^{14}}\right)=(1+5\times 10^{-5})G$$

这个差异将引起引力常数测量达到了 50ppm 的不确定性。

而木星以及其他行星的影响将达到

$$G' \approx G\left(1+\frac{3\times 10^{9}}{10^{14}}\right)=(1+3\times 10^{-5})G$$

这也将引起引力常数测量的不确定性可以达到 30ppm.

因此如果上述时空结构半径的估算是正确的，则地球的近日点和远日点以及木星等其他行星的运动对引力常数的测量所带来的不确定性将可以达到 80ppm 以上。这么大的不确定性可能是引起木星引力常数测量数据差异比较大的一个重要原因。

6 讨论

从文献[1]中对引力常数影响的数学分析来看，其中的猜想“单位空间长度跟引力势成反比”，可以进行改进的余地很大。因为如果这样的猜想成立，则意味着地球的近日点和远日点对引力常数造成的影响将达到 4%. 这肯定是有问题的。如果存在这么大的不确定性，那么在过去几十年的引力常数测量实验中一定会被发现。毕竟这么低精度的实验在一个多世纪之前就已经可以完成了。不过上述猜想在引力常数测量的相邻几个月，即便是不同年份的相邻几个月之间的数据中的应用，理论预测和实验数据符合的还是不错的。

本文采用另一个时空结构的模型来进行分析。本文认为过去很长时间我们在计算中忽略的电子和质子的静电场能量分布是构成时空结构的关键因素。电子和质子的静电场能量跟质量一样具备累积效应。这是基于虚时空物理学[2]的基本原理而得出的结论。在虚时空物理学中，质量属于虚时空的能量，它跟实时空中的能量是具备相同性质的。因此当在实时空中，我们看到随着一个物质的质量越来越大，该物质的质量分布半径也将越来越大。这就是质量的累积效应。如果静电场能量也具备这样的累积效应，则随着物质累积的越来越多，物质中包含的电子和质子数量也越来越多，累积起来的静电场能量也将越来越多。考虑到静电场分布远超质量分布，因此静电场能量分布半径将远超对应物质的质量分布半径。这里将这种范围非常广泛的静电场能量分布称作“时空结构”，它反映的也是一种时空分布。

就像质量分布一样，对于地球这样的巨大质量来说，越往地球内部，深度越深，则该处的压力越大；深度越浅，越接近地球表面，则该处由于质量分布而产生的压力将越小。本文借用了液体内部压强的计算公式，即液体内部的压强与液体的深度成正比。因此本文假设时空结

构内部也具备大致相同的性质。因此考虑到地球近日点和远日点位置距离太阳系时空结构表面的深度不同，将导致地球所在位置时空被压缩的程度也不同。这样我们就获得了地球绕日轨道不同位置的单位空间长度变化，并在此基础上计算出包括地球近日点和远日点位置、木星等其他行星运动导致太阳系质心的变化等因素对地球表面测量引力常数的影响。不过这种借用液体内部压强的计算公式来分析一个时空内部单位空间长度被压缩的方法，其中值得讨论的地方还是很多的。毕竟时空结构是一个球形。而地球内部的压力变化跟深度之间也是一个非线性的关系。

本文的计算结果表明，时空结构模型对引力常数的影响比较大。如果假设太阳系的时空结构半径长达 2 光年，则地球近日点和远日点位置变化等因素对引力常数测量所带来的不确定性大约为 0.4ppm. 这个不确定性远小于现有的引力常数测量精度。

而如果假设太阳系的时空结构半径大约比太阳系柯伊伯小行星带的半径要长一些，则这种不确定性将达到 80ppm 以上。这种不确定性可以被现有的引力常数测量装置所测量出来。分析结果与我前几篇论文是基本一致的[4~6]。但是由于时空结构变化所带来的不确定性，涉及到的因素可能会更加复杂，毕竟地球和木星的近日点和远日点位置，其他行星的运行等都可以被考虑进来。

另外，本文还涉及到我们现在未知的很多问题，包括太阳系的这种时空结构是否存在？如果这种时空结构真的存在，那么其半径的精确值是多少？时空结构内部的单位空间长度跟时空结构之间的关系如何等，我们现在都不是很清楚。因此在计算分析的时候可以回旋的余地还是非常大的。不过尽管理论不确定性非常大，但至少还是提供了我们一个全新的思路来理解引力常数的问题。如果有足够多的实验证据对引力常数的变化进行证实，相信对于提高我们对引力理论的认识有极大地促进作用。

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