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Planck Quantum Gravity Theory

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Abstract

The author describes a new theoretical model that uses methods of quantum field theory to represent gravitational forces. Scalar particles with different rest masses in 4-dimensional space-time can be unified into one scalar particle field in 5-dimensional space-time. Particles have the property of a quantized intrinsic length. This intrinsic length can be identified using the Planck length. This intrinsic length of a particle, which originates from quantization, is invariant in all frames of reference, much like physical quantities such as charge, spin, and zero-point energy. Based on the propagator and intrinsic length of the particle fields, the gravitational effect can be derived using the methods of quantum field theory. Gravitational force is only an additional effect of the particle field, and there is no independent gravitational field. The commutators that transmit the gravitational force are the particles themselves, and there is no independent graviton. Gravitons do not exist. In other words, gravitons are the particles themselves. There is an unknown mapping between 5-dimensional space-time and 4-dimensional space-time. The gravitational force in 4-dimensional space-time is the mapping result of the gravitational force in 5-dimensional space-time. The gravitational effect of the particle field limits the maximum energy of the virtual particle, preventing the divergence of the integrals of propagators. The gravitational property is the missing part of quantum field theory. Gravity imposes a limitation on coordinate transformations, which do not eliminate the intrinsic length of particles.

Keywords: 5-Dimensional space-time; Quantum field theory; QFT; Intrinsic length; Planck length; Length quantization; Propagator; Quantum gravity; Planck gravity; Planck quantum gravity; Klein Gordon equation; Space-time mapping; Compton wavelength; Gravitational radius; Gravitational potential; Coulomb potential; Divergence; Coordinate transformations

Introduction

Since the birth of quantum mechanics in the twentieth century, humans have been pursuing a theory of quantum gravity. The unification of gravity and quantum mechanics has always been a major issue in physics. General relativity and quantum mechanics have not been able to reconcile. There are many theories of quantum gravity that have been developed in the physics community. However, each of these gravitational theories has its own problems. Mankind has never succeeded in solving the problem of quantum gravity. What is the truth about gravity? Why is gravity so special? Can gravity be quantized? Is there a pure theory of quantum gravity? Does graviton exist?

The conventional quantized gravitational processing method treats the gravitational field as an independent quantum field, finds the Lagrangian of the gravitational field, quantizes the classical gravitational field according to the conventional quantum field theory method, and introduces a commutator called graviton. However, the resulting quantized gravitational field has difficulty diverging.

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And this infinite difficulty cannot be eliminated by conventional renormalization methods. Experimentally, no evidence of gravitons has been observed.

In a previous paper, the author proposed a Planck gravity theory [1]. This theory proposes that gravity is force acting in 5 dimensions of space-time. The gravitational phenomenon observed by humans in 4-dimensional space-time is only a mapping result of gravity in 5-dimensional space-time.

The authors found that a purely quantum gravity theory could be developed on the basis of Planck gravity theory in 5-dimensional space-time. We can use the standard quantum field theory approach to represent gravity. The authors found that gravity is only a special property of the particle field, and that gravity is not an independent force. There is no independent gravitational field. Gravitational force is attached to the particle fields. There is no separate particle called a graviton. This paper is about this innovative quantum gravity theory.

Planck Gravity Theory

Planck gravity theory is a theory in 5 dimensions of space-time [1]. In 5-dimensional space-time, there is no rest mass for particles, and all particles move at the speed of light, and all particles produce the same intensity of gravitational force. The gravitational force produced by all particles is identified by the square of Planck length. The gravitational potential is inversely proportional to the square of the distance, and the gravitational potential energy is directly proportional to the energy of the stressed particle. In 5-dimensional space-time, or in 4-dimensional space, the gravitational potential energy is equation (1.1).

$$V = \frac{2\pi L_p^2}{r^2} E \tag{1.1}$$

In equation (1.1), V is the gravitational potential energy of the stressed particle. E is the energy of the stressed particle. L_p is the Planck length. The squared of Planck length is the intrinsic length of a gravitational source particle in 5 dimensions of space-time. r is the 4-dimensional distance between the stressed particle and the gravitational source particle. The energy of the stressed particle is E. Equation (1.2) is satisfied between its energy and momentum.

$$E = PC = \sqrt{P_1^2 C^2 + P_2^2 C^2 + P_3^2 C^2 + P_4^2 C^2} \tag{1.2}$$

In equation (1.2), E is the energy of the stressed particle, P is the momentum of the stressed particle in 5 dimensions of space-time, and there are momentum components in 4 spatial dimensions. In 5-dimensional space-time, particles are similar to photons in 4-dimensional space-time, moving at the speed of light.

Planck gravity theory states that there is no rest mass of particles in 5-dimensional space-time, and all particles are similar to photons, the speed of motion is the speed of light, and the relationship between the energy and momentum of the particle is the equation (1.2). Note, however, that the momentum P in equation (1.2) is the momentum in 5-dimensional space-time with 4 components in 4-dimensional space.

There is an unknown mapping between 5-dimensional space-time and 4-dimensional space-time. The momentum in the 4-dimensional space is mapped to the 3-dimensional space, and the momentum component in the 4th dimension remains the same, which is the rest mass in the 3-dimensional space. This is the physical meaning of the Compton wavelength of a particle in 3 dimensions. The Compton wavelength is the equation (1.3).

$$M = \frac{h}{\lambda_0 C} = \frac{P_4}{C} \tag{1.3}$$

In equation (1.3), M is the rest mass of the particle in 3-dimensional space, λ_0 is the Compton wavelength of the particle, and P_4 is the momentum component of the particle in the 4th dimension. The physical meaning of the Compton wavelength is the De Broglie wavelength corresponding to the momentum component of the particle in the 4th dimension. The energy-momentum relationship of particles in 4-dimensional space is equation (1.2), and when mapped to 3-dimensional space, the energy-momentum relationship is transformed into equation (1.4).

$$E = \sqrt{P_1^2C^2 + P_2^2C^2 + P_3^2C^2 + P_4^2C^2} = \sqrt{P_1^2C^2 + P_2^2C^2 + P_3^2C^2 + M^2C^4} \tag{1.4}$$

In 3-dimensional space, particles have two length properties that are dual. One is the Compton wavelength of the particle, and the other is the gravitational radius of the particle. The gravitational radius of a particle is commonly known as the black hole radius. However, black hole radius is not an accurate concept, and a particle does not become a black hole. A more accurate concept is the gravitational radius of a particle. There is equation (1.5) between the two, and the product of the two is equal to the square of Planck length.

$$\frac{h}{MC}\frac{GM}{C^2} = \lambda_0 r_0 = \frac{hG}{C^3} = 2\pi L_p^2 \tag{1.5}$$

$$\frac{h}{MC} = \lambda_0$$

$$\frac{GM}{C^2} = r_0$$

So, for the gravitational source particles, this mapping has two consequences. One is to bring the rest mass of the particle, and the other is to bring the gravitational radius of the particle. Therefore, under the effect of this unknown mapping, the Planck length in the gravitational potential (1.1) in 4-dimensional space disappears and becomes the gravitational radius of the particle. At the same time, the 4th dimension disappears, leaving 3 dimensions behind. The square of the distance in 4-dimensional space is transformed into the distance in 3-dimensional space. The gravitational potential in 3-dimensional space is transformed into equation (1.6).

$$V = \frac{GM}{C^2}\frac{E}{r} = \frac{r_0}{r}E \tag{1.6}$$

In equation (1.6), V is the gravitational potential in 3-dimensional space. r is the 3-dimensional distance between the stressed particle and the gravitational source particle. E is the energy of the stressed particle, satisfying equation (1.4). r_0 is the gravitational radius of the gravitational source particle. The gravitational force observed by humans in three-dimensional space is actually a mapping effect of gravitational force in four-dimensional space. This mapping, to some extent, can be vividly understood as a projection. But this mapping process cannot simply be understood as a projection. The physical properties of this mapping process are still unknown, and further research is needed on this issue. The gravitational radius in 4-dimensional space is identified by the Planck length and has quantum properties. Mapped into 3-dimensional space, the Planck constant contained in the gravitational radius disappears, the quantum properties contained in gravity disappear, and gravity seems to become a purely classical force. But this is just an illusion, and this illusion misleads humanity. The truth of gravity actually exists in 4-dimensional space (5-dimensional space-time), and gravity actually has quantum properties.

In Equation (1.6), we can easily get Newton gravity equation at a low velocity approximation. At low velocity case, The energy of the stressed particle $E \approx mC^2$. The m is the rest mass of particle. Take it into formula (1.6), so we get the Newton gravitational potential formula (1.7).

$$V = \frac{GM}{C^2}\frac{E}{r} = \frac{GM}{C^2}\frac{mC^2}{r} = \frac{GMm}{r} \tag{1.7}$$

In 3-dimensional space, r_0 is a gravitational marker property of the gravitational source particle, which remains the same in any frame of reference and is an intrinsic length of the particle, called the gravitational radius. This gravitational radius is closely related to Planck length, so it is closely related to quantum mechanics. The intrinsic properties of particles are a special concept in quantum mechanics. In quantum mechanics, the intrinsic properties of particles remains the same in any frame of reference. So this gravitational radius can be seen as the intrinsic length of the particle. Calling it a black hole radius is actually a popular misconception and not entirely correct. In fact, a gravitational source particle does not attract another particle into the particle's interior. It is more accurate to calling the black hole radius of a particle by the gravitational radius of the particle. The radius is simply a characteristic identifier of a particle's gravitational property. Particles do not have the properties of black holes. On the basis of this gravitational radius, the result of black hole entropy can be simply derived. Black hole entropy is simply the result of a special particle distribution system. Black hole entropy has a purely thermodynamic origin [2]. A black hole is just a theoretically equivalent concept of a system of gravitational source particles. Black holes are not space-time singularities. In Planck gravity, there is no space-time singularity.

On the basis of the gravitational equation (1.6), most of the results of general relativity can be deduced, which can explain phenomena such as the bending of light rays and the precession of Mercury in gravity [3].

On the basis of the gravitational equation (1.6), the phenomenon of dark energy can also be explained simply [4]. There is a coupling effect between gravity and the expansion of the universe. It is this coupling effect that causes the universe to expand at an accelerated rate. The essence of dark energy is this coupling effect. Dark energy is not an independent energy.

In equation (1.1), Planck length squared plays a key role. The properties of a gravitational field are given entirely by the Planck length. Therefore, the author named it by Planck gravity theory.

In addition, the reader is invited to pay special attention to the distinction. The intrinsic length property of particles is a special concept that is unique to quantum mechanics. It does not exist in classical physics. For this intrinsic length, the particle is not a solid sphere of radius Planck length. This intrinsic length, similar to the charge, spin, and zero-point energy of a particle, is a quantized property of particles, and cannot be viewed in the way of classical physics. Particles are point particles in quantum mechanics, and the particles themselves do not have size. Particles have the property of a quantized intrinsic length, and Planck lengths can be used to characterize the value of this intrinsic length. This is exactly the real physical meaning of Planck length. Planck length characterizes the properties of a quantized intrinsic length of a particle. The particle itself is not a solid sphere of radius of Planck length. In 5-dimensional space-time, the value of this intrinsic length is the square of Planck length, so this intrinsic length obviously cannot be regarded as the radius of the particle. It's just that this intrinsic property has a dimension of length. The intrinsic length of particles does not break the symmetry of space-time. In the gravitational process, both the conservation of energy and the conservation of momentum are still valid. Understanding this intrinsic length is the key to a proper understanding of quantum gravity. One of the key properties of quantum gravity is precisely this intrinsic length.

Planck Quantum Gravity Theory

The Planck gravity theory in the 5-dimensional space-time described above, although it includes Planck length, already has some quantum properties. However, because the distance r is included in equation (1.1), it still has the property of a distinctly classical force, and is not yet a fully quantized force. Because of the uncertainty principle, the distance r cannot be determined completely accurately in quantum mechanics, so for a fully quantized force, the distance r should not be included in the equation. The method of using quantum field theory to represent gravity is quantum gravity. How can we use the methods of quantum field theory to build a gravity theory that does not include the distance r?

In 4-dimensional space-time, the quantization of electromagnetic forces is done using the methods of Quantum Field Theory (QFT) [5, 6]. In QFT, different particles have different properties such as rest mass, charge, spin, etc., and each particle corresponds to a particle field. Ignoring other properties such as spin and charge, and considering only the simplest scalar particles, the particle field can be described by the Klein Gordon equation to obtain a scalar particle field [7, 8].

Using the same QFT approach, we will only discuss the case of a simple scalar particle field. In 5-dimensional space-time, since there is no rest mass of the particles, the energy-momentum relation of all the particles satisfies equation (1.2). So, all particles can be considered to be of the same type. There is only a difference in energy and momentum between the particles, and nothing else. So, all particles belong to the same particle field. Referring to the Klein Gordon equation in 4-dimensional space-time, the scalar particle field equation in 5-dimensional space-time satisfies equation (2.1).

$$\frac{\partial_{\varphi}^{2}}{\partial_{x_1}^{2}}+\frac{\partial_{\varphi}^{2}}{\partial_{x_2}^{2}}+\frac{\partial_{\varphi}^{2}}{\partial_{x_3}^{2}}+\frac{\partial_{\varphi}^{2}}{\partial_{x_4}^{2}}+\frac{\partial_{\varphi}^{2}}{\partial_{x_5}^{2}}=0 \tag{2.1}$$

In equation (2.1), the left is the field operator for the particle field. Referring to the field operator in 4-dimensional space-time, we use the symbol $\boxdot$ to identify this operator, and we get equation (2.2), which corresponds to the Klein Gordon equation in 4-dimensional space-time.

$$\boxdot\ \varphi=0 \tag{2.2}$$

The wave function of the particle field at a point in 4-dimensional space satisfies equation (2.3).

$$\varphi(x)=\int\frac{d_{p}^{4}}{(2\pi)^{4}}\frac{1}{\sqrt{2E_{p}}}\left(a_{p}e^{ip\cdot x}+a_{p}^{+}e^{-ip\cdot x}\right) \tag{2.3}$$

The propagator corresponding to this particle field is equation (2.4).

$$D(x-y)=\int\frac{d_{k}^{5}}{(2\pi)^{5}}\frac{e^{-ik(x-y)}}{k^{2}+i\varepsilon} \tag{2.4}$$

We use the field operator $\boxdot$ to compute the propagator and get the result (2.5).

$$\boxdot\ D=\boxdot\int\frac{d_{k}^{5}}{(2\pi)^{5}}\frac{e^{-ik(x-y)}}{k^{2}+i\varepsilon}=-i\delta(x-y) \tag{2.5}$$

Above is a quantum field theory description of free scalar particles in this 5-dimensional space-time. All of the above formulas are obtained by referring to the Klein Gordon equation in 4-dimensional space-time, which is fully in line with the standard quantum field theory method.

Following the quantum field theory approach in 4-dimensional space-time, we consider two excited point source particles in 5-dimensional space-time (4-dimensional space).

$$J=J(\overrightarrow{x_1})+J(\overrightarrow{x_2})=\delta(\overrightarrow{x_1})+\delta(\overrightarrow{x_2}) \tag{2.6}$$

We can then get the potential energy between two excited point source particles.

$$E(J)=D(\overrightarrow{x_1}-\overrightarrow{x_2})=D(\vec{r})=\int\frac{d_{k}^{4}}{(2\pi)^{4}}\frac{e^{-i\vec{k}\cdot\vec{r}}}{k^{2}+i\varepsilon}=\frac{1}{2\pi r^{2}} \tag{2.7}$$

The equation (2.7) is exactly the inverse square part of Planck gravitational potential energy equation (1.1). Using the particle field theory method in 5-dimensional space-time, we successfully derive the inverse square relationship of distance in equation (1.1). That is, we have successfully achieved second quantization of gravity.

In 5-dimensional space-time, a particle has an intrinsic length property, which is the square of Planck length. Therefore, the point source particles represented in equation (2.6) should actually be added with their intrinsic length attributes. So we get Equation (2.8).

$$J = J(\overrightarrow{x_1}) + J(\overrightarrow{x_2}) = L_p^2\delta(\overrightarrow{x_1}) + L_p^2\delta(\overrightarrow{x_2}) \tag{2.8}$$

Therefore, (2.7) should actually be revised to (2.9).

$$E(J) = L_p^2 D(\overrightarrow{x_1} - \overrightarrow{x_2}) = L_p^2 D(\vec{r}) = L_p^2 \int \frac{d_k^4}{(2\pi)^4}\frac{e^{-i\vec{k}\cdot\vec{r}}}{k^2+i\varepsilon} = \frac{L_p^2}{2\pi r^2} \tag{2.9}$$

Equation (2.9) and (1.1) are compared, only the constants are different. So, we can add a constant term to the intrinsic length of the point source particle in (2.8) to get (1.1) completely.

$$J = J(\overrightarrow{x_1}) + J(\overrightarrow{x_2}) = 4\pi^2 L_p^2\delta(\overrightarrow{x_1}) + 4\pi^2 L_p^2\delta(\overrightarrow{x_2}) \tag{2.10}$$

$$E(J) = 4\pi^2 L_p^2 D(\overrightarrow{x_1} - \overrightarrow{x_2}) = 4\pi^2 L_p^2 D(\vec{r}) = 4\pi^2 L_p^2 \int \frac{d_k^4}{(2\pi)^4}\frac{e^{-i\vec{k}\cdot\vec{r}}}{k^2+i\varepsilon} = \frac{2\pi L_p^2}{r^2} \tag{2.11}$$

Equation (2.11) is a potential function generated by a particle point source. It is exactly the same as the potential function in Equation (1.1). So, we think that this potential is the gravitational potential.

A stress particle is excited at a point in space, its energy satisfies the shell condition, and the particle energy E satisfies equation (1.4). So, the complete gravitational potential energy of the particle is equation (1.1), or the equation below.

$$V = \frac{2\pi L_p^2}{r^2}E$$

In the above description, it can also be seen. In 5-dimensional space-time, the exchanger of the gravitational potential generated by the two excitation point source particles is the particle field itself. The commutator of the gravitational field is the virtual particle of the particle field itself. Therefore, there is no separate graviton field. The graviton, which exists independently, does not exist. In 5-dimensional space-time, all particles have the same properties and do not have rest mass, similar to photons in 4-dimensional space-time. So in 5-dimensional space-time, the particle field itself can transmit gravitational effects. Because particles in 5-dimensional space-time do not have the property of rest mass, that is the commutator does not have rest mass, so the gravitational force acts at an infinite distance.

From the equation (2.10), we can find a conclusion. A gravitational source is an excitation point source of the particle field. A stressed particle is also a point source particle excited in the particle field. The propagator (2.4) is the integral of a monochromatic wave of the possible frequencies of the particle field. That is, every monochromatic wave is a virtual particle of the field. Because virtual particles do not have the property of excitation point sources, so virtual particles do not exert gravitational effects. So, the particle field itself does not generate gravity. Only the particles that are excited, or the particles that can be used as the point source of the δ function, will have a gravitational effect. Once the excitation point source particles are annihilated and disappear, there is no longer a gravitational effect. To be more accurate, an on-shell particle is a gravitational source. An off-shell virtual particle does not be a gravitational source. So, there is no infinite cycle of gravitational force here, which does not lead to the problem of infinite gravitational potential energy.

From here, we can draw a conclusion. Because the zero-point energy of the particle field is not an excitation point source of the field, the zero-point energy of the particle field does not produce a gravitational effect. Because there are only virtual particles produced by energy fluctuations in the vacuum, and there are no real excited particles in the vacuum, so the vacuum does not produce a gravitational effect.

From Equation (2.8), it can also be seen. A simple particle point source cannot produce a gravitational effect. The point source particle must be given an intrinsic length property of Planck length, the particle can produce a gravitational effect. This intrinsic length property of a particle can be called length quantization in some sense. So, in some sense, we can say that gravity originates from the quantization of length. Therefore, the gravitational effect can be seen as an intrinsic property of the particle field itself.

We can also look at it from the perspective of a physical image. The intrinsic length of a particle can be seen to some extent as a spatial topological property. When an on-shell particle is excited from this field, and this particle has an intrinsic length property, the excited particle will inevitably affect the behavior of this field. The intrinsic length of the excited particle has an effect on the particle field itself, and this effect is the gravitational effect. Therefore, the gravitational effect can be seen as an intrinsic property of the particle field itself. This physical image can help us understand the gravitational effect.

We can also draw a conclusion. The particle field excites two real on-shell particles, and the virtual particles of the particle field transmit a gravitational effect between the two on-shell particles. These virtual particles also have the properties of particle waves and also have wavelengths. Obviously, the wavelength of these virtual particles cannot be less than the intrinsic length of two on-shell particles. It can be deduced that in the case of gravitational effect between two on-shell particles, the maximum energy of the virtual particle can only reach Planck energy. Therefore, there exist a maximum value for the wave vector K in the propagator (2.4) above. Use K_m to identify this maximum. The maximum integral limit of the wave vector K in the propagator can only be K_m.

$$K_m = \frac{1}{L_p} \tag{2.12}$$

Therefore, the divergence problem in quantum field theory can be reasonably solved. It is this intrinsic length property of the particle that prevents the energy of the virtual particle from diverging. Because virtual particles have wave properties, the wavelength of virtual particles is limited by the intrinsic length of the excited on-shell particle, and cannot be less than this intrinsic length. Therefore, quantum field theory has a self-consistent theoretical framework. The wave-like nature of the particle, combined with the intrinsic length property of the particle, combine to prevent the infinity of the virtual particle's energy. The renormalization technique of quantum field theory is not necessary. Renormalization is not a necessary theory of quantum field theory, but only a technique for eliminating infinity. This technique was introduced only because it was the result of not taking into account the gravitational effect of the particle field itself. A complete quantum field theory needs to include the gravitational effects of the particle field itself. With gravitational effects included, quantum field theory becomes completely self-consistent and no longer has infinite results. This is a windfall we get from Planck quantum gravity.

It can also be found from the formula (1.1) for the gravitational potential energy of the particle. The energy of the on-shell particles excited from the particle field cannot exceed the Planck energy. The energy of the free particle, plus the gravitational potential energy of the particle, the total energy of the particle is (2.13).

$$E_{all} = E - \frac{2\pi L_p^2}{r^2}E = (1 - \frac{2\pi L_p^2}{r^2})E \tag{2.13}$$

If the distance between two particles $r < \sqrt{2\pi}L_p$, the total energy of the particle will become negative, which is not physically allowed. Therefore, the distance between two particles can only be $r \gg \sqrt{2\pi}L_p$. Therefore, the energy E of the stressed particle must satisfy the following formula.

$$E \ll \frac{hC}{\sqrt{2\pi}L_p} = \sqrt{2\pi}E_p$$

From the derivation process of quantum field theory above, it can also be seen. The propagator of a particle field can only give the inverse square property of the gravitational force. But propagators cannot give the properties of gravitational point sources. The gravitational point source must also be given by the intrinsic length (2.8) of the particle point source. If there is only propagator, but there is no intrinsic length property of the excitation point source, the complete gravitational effect cannot be obtained. The existence of an excitation point source cannot be directly given by the field equation (2.1) of the particle field. The point source is introduced into the particle field as an external condition. Therefore, we cannot directly represent the full gravitational effect by the field equation itself. In addition to the particle field itself, there is another condition for the gravitational effect, which is the intrinsic length of the excitation point source. The intrinsic length of the excitation point source particle, as well as the propagator of the particle field, combine to give a complete expression of the gravitational effect. Therefore, gravity is purely an additional effect of the particle field, and there is no independent gravitational field. The Lagrangian of the gravitational field is the Lagrangian of the particle field itself. There is no independent Lagrangian of gravity.

The conventional method of quantizing gravity is to first find the Lagrangian of an independent gravitational field, and then quantize the Lagrangian. Therefore, this conventional method of gravitational quantization is completely wrong and cannot solve the problem of gravitational quantization. This is an inspiration provided by Planck quantum gravity theory.

On the other hand, in the derivation process above, it can also be seen. In 5-dimensional space-time, the inverse square nature of the gravitational potential is given entirely by the propagators of the particle field. Mapping 5-dimensional space-time to 4-dimensional space-time gives the inverse distance property of the gravitational potential. Therefore, we can assume that the inverse distance property of the gravitational potential in 4-dimensional space-time is actually given by the propagators of the particle field. This is similar to the derivation process of the Coulomb potential of QED in 4D space-time. Therefore, in 4-dimensional space-time, the gravitational potential and the Coulomb potential, which have similar properties, both have inverse distance properties. Through the gravitational derivation process of this quantum field theory method, we can give a reasonable solution to this similarity. Both are the result of quantum field theoretic approaches. The distance inverse properties of both can be calculated from the propagators of quantum field theory. So the two have a similar inverse distance property. This is another takeaway offered by Planck quantum gravity theory.

In the above derivation, it can also be seen. Because in 5-dimensional space-time, particles do not have rest mass, and all particles satisfy equation (2.1). Therefore, all particles can be described by a unified particle field, and then the expression formula of gravity can be derived. In 4-dimensional space-time, particles have rest mass, and different particles have different rest mass, so it is not possible to describe all particles through a unified particle field, and therefore cannot give a unified gravitational expression. In addition, in 4-dimensional space-time, many kinds of particles have rest mass, and if the particles themselves are used to act as gravitational commutator, it will be deduced that gravity is a short-range force, which is inconsistent with the facts. Therefore, in 4-dimensional space-time, another independent graviton must be assumed to play the role of gravitational commutator. This leads gravitational quantization astray. Therefore, in 4-dimensional space-time, the problem of gravitation quantization cannot be solved. Only in 5-dimensional space-time, when the rest mass property of the particle disappears, and all particles can be described using a unified particle field, and the particles do not have rest mass, and the particles themselves can be used to play the role of gravitational commutator, so we can successfully obtain a quantum gravity theory. We can also see that in 5-dimensional space-time, the energy momentum of all particles satisfies a uniform formula (1.2). We can assume that in 5-dimensional space-time, there is a unified particle field. Gravitational properties are an intrinsic property of this unified particle field. Therefore, gravity is universal, any particle produces gravity, and any particle is also affected by gravity. This unified particle field only diverged in 4-dimensional space-time, and it was differentiated into many different kinds of particle fields. This is a topic that is worth exploring and studying in depth.

In this theoretical model, the gravitational force in 5-dimensional space-time must be mapped to 4-dimensional space-time in order to obtain the gravitational force in 4-dimensional space-time. The nature of this mapping is unknown. This mapping effect, to some extent, can be understood as a kind of projection, which can help us understand. It is not yet known what kind of process this mapping from 5-dimensional space-time to 4-dimensional space-time actually is. Obviously, the relationship between 5-dimensional space-time and 4-dimensional space-time is not a simple projection. However, we already have at least some of the information about the role of this mapping, which is equation (1.5). Through this mapping, the Planck length square in 5-dimensional space-time is differentiated into two physical properties in 4-dimensional space-time, one is the particle's rest mass and the other is the particle's gravitational radius. What is the relationship between this and the Higgs mechanism in quantum field theory? This is also a question worth exploring.

From the derivation process above, it can also be seen. For equations (2.10) and (2.11), only the results of the lowest order propagators of the particle field are calculated. Similar to QED, quantum gravity also has higher-order propagators, which will result in gravitational potential not strictly following the inverse distance property. The computation of this higher-order propagator is too complex, so it will not be described in this paper. Interested readers can delve into the research and calculations on this topic.

In the description above, only scalar particle fields are used. But similar to the φ field theory in QFT, this approach can be generalized to vector and spinor fields.

The above derivation and description are actually a new theoretical approach. This approach has two key points. The first is the propagator of quantized particle field. The second is the intrinsic length property of the excited particle. This approach doesn't just apply to gravity. Any quantized particle field, as long as the excited point source particles have similar intrinsic length properties, must have similar gravitational effects, and the same approach can be used to express this gravitational effect. The intrinsic length of other particles may not be identified by Planck length. However, similar gravitational effects of this type of particle can also be expressed using the same theoretical approach.

This theoretical approach is actually a supplement to quantum field theory. Quantum field theory, which lacks gravitational effects, is actually not a complete theoretical framework, so it has divergent problems. Quantum field theory, including gravitational effects, is a self-consistent and complete theoretical framework. There is no divergent problem in complete quantum field theory.

In condensed matter physics, quasi-particles can be described by methods of quantum field theory. If the quasi-particles also have the intrinsic length property, so the quasi-particle fields in condensed matter physics should have similar gravitational effects. The intrinsic length of the quasi-particle is not equal to Planck length obviously. The property of the intrinsic length of quasi-particles is still a problem and needs to be studied. If quasi-particles with similar gravitational effects are detected experimentally, this theoretical approach can be confirmed.

In 5-dimensional space-time, the particle's intrinsic length is the square of Planck length, and the gravitational potential energy is inversely proportional to the square of the distance. The quasi-particle field exists in 4-dimensional space-time. Here one dimension is reduced. The velocity of the quasi-particle is also no longer the speed of light. We use V_q to identify the velocity of the quasi-particle, and use L_q to identify the intrinsic length of the quasi-particle. So we can guess that the intrinsic length of the quasi-particle is (2.14).

$$L_q = \sqrt{\frac{hG}{V_q^3}} \tag{2.14}$$

Of course, the formula (2.14) is just a guess. The actual intrinsic length may be something else. The value of intrinsic length needs to be determined by experimental measurements.

The field equation of the quasi-particle is formula (2.15).

$$\Box\varphi = 0 \tag{2.15}$$

The wave function of the quasi-particle is formula (2.16).

$$\varphi(x) = \int \frac{d_p^3}{(2\pi)^3} \frac{1}{\sqrt{2E_p}} (a_p e^{ip\cdot x} + a_p^+ e^{-ip\cdot x}) \tag{2.16}$$

The propagator of the quasi-particle field is formula (2.17).

$$D(x-y) = \int \frac{d_k^4}{(2\pi)^4} \frac{e^{-ik(x-y)}}{k^2+i\varepsilon} \tag{2.17}$$

With similar derivation above, we can get the gravitational potential energy of the quasi-particle. It is formula (2.18).

$$V = \frac{L_q}{r} E \tag{2.18}$$

But unlike the speed of light, the velocity of a quasiparticle is not an invariant. To the quasi-particle, its velocity decreases as the temperature decreases. From (2.14), its intrinsic length will increase. And the distance is very small in the cases of quasi-particle field. So we can guess that the gravitational effects of the quasi-particle field will become significant in extreme cases of condensed matter physics.

The above discussion is just an analogy to the derivation process of Planck quantum gravity. However, in practice, the intrinsic length of the quasi-particle may not follow the formula (2.14). As long as the excited quasi-particle has an intrinsic length property, it will bring about a similar gravitational effect. So, in some extreme cases, the quasi-particles may have a significant intrinsic length, and quasi-particle systems may also exhibit significant similar gravitational effects. It is possible to confirm this theory experimentally.

Discussion about Planck Gravity Theory

The formula for gravitational potential energy in 5-dimensional space-time is (1.1) and in 4-dimensional spacetime is (1.6). We can spot a distinct feature. As long as the gravitational source is determined, the gravitational potential of a certain point in space in this gravitational field is completely determined, and the gravitational potential has nothing to do with the stress particles. For stressed particles, the gravitational field can be seen entirely as a background field in which the particles move. In this background field, the properties of motion of all the stressed particles are the same. Because one of the physical sources of gravity is the intrinsic length property of particles. In some sense, the intrinsic length property of particles can be regarded as an intrinsic space topological property of particles. Therefore, the gravitational field can be treated as a kind of background space-time. There is some similarity between this and general relativity. But, apparently, it's just gravity that exhibits this property on a macroscopic scale. The background spatiotemporal nature of gravity is only a macroscopic equivalent treatment, not the truth of gravity. At the microscopic level, gravity is still derived from the particle field and has a very clear property of quantum field theory.

In 4-dimensional space, a particle is moving in a gravitational field with an initial energy of E_0. Then, the moving energy of this particle in the gravitational field is E, the gravitational potential energy is $-\frac{r_0}{r}E$, and the total energy of the particle satisfies the following formula.

$$E - \frac{r_0}{r}E = E_0 \tag{3.1}$$

Change the form of the formula to get equation (3.2).

$$\frac{E}{E_0} = \frac{1}{1 - \frac{r_0}{r}} = \frac{r}{r - r_0} \tag{3.2}$$

From Equation (3.2), we can clearly see the characteristics of the background space-time of the gravitational field. On the left side of the equation is a representation of the energy of the particle in the gravitational field, and on the right side of the equation is a spatial representation of the gravitational field. The energy of the particle in the gravitational field exactly corresponds to the spatial characteristics of the gravitational field. This result is not surprising, because it can be seen from the above gravitational derivation using the quantum field theory method that gravity originates from the intrinsic length properties of particles, this intrinsic length can be seen as an intrinsic space topology of the particle, so gravity can be equivalent to a space-time background field. What is the relationship between this spatial feature of the gravitational field and the general theory of relativity, this topic is worth further studying.

From equation (3.2), we can see a result. When the distance r is infinitely close to the gravitational radius r_0, the energy E of the particle is getting closer and closer to infinity, so the distance r can never reach r_0. The r_0 is the limit value of r. Here again, an obvious conclusion is drawn that the radius r of the distance between the particle and the gravitational source can only be infinitely close to the gravitational radius r_0 and cannot reach the gravitational radius, let alone be less than the gravitational radius. So, in Planck gravity theory, there is no singularity in space-time.

But this is only a conclusion reached in the case of classical physics. In the case of quantum mechanics, particles also have wave properties, and the wavelength of the particle wave cannot be less than r_0. This introduces a limitation in quantum field theory, where particles have a maximum energy value. Virtual particles in quantum field theory also follow quantum mechanics, so the wavelength of the virtual particle cannot be less than r_0, so there is also a maximum energy value for virtual particles. This naturally solves the problem of divergence of the integrals of propagators in quantum field theory.

In equation (3.2), in the case of a weak gravitational force where r is much greater thanr_0, Newton gravity equation (3.3) can be derived by taking the expansion result of the first order on the right side of the equation.

$$E = E_0\left(1 + \frac{r_0}{r}\right) = E_0 + \frac{E_0 r_0}{r} = E_0 + \frac{m_0 C^2}{r}\frac{GM}{C^2} \approx E_0 + \frac{GMm_0}{r} \tag{3.3}$$

As you can see, Newton gravitation is just a first-order approximation of Planck gravity at low velocity and weak force. In the case of strong gravity, there are many higher-order correction results. In the case of high-speed motion, the initial energy of the particle can no longer take the rest ass of the particle, and it will also bring high-order correction results. In the case of strong gravity and high-speed motion, these two higher-order correction results have a significant impact on gravity, making gravity deviate significantly from the results of Newton gravitation.

In equation (3.3), r is allowed to approach zero and the gravitation will become infinite. However, in reality, equation (3.3) is only a simplified approximation and cannot be generalized to the case where r is close to the gravitational radius r_0. Mathematical formulas have a physical range of adaptation. Using formulas without limits, applying them beyond the scope of their physical application, can give extremely absurd results.

For the gravitational equation (3.2), we can also find that it has a very strange property. If we do a coordinate transformation

$$R = r - r_0$$

Equation (3.2) is converted to (3.4).

$$\frac{E}{E_0}=\frac{r}{r-r_0}=\frac{R+r_0}{R}=1+\frac{r_0}{R} \tag{3.4}$$

Mathematically, equation (3.4) is exactly the same as equation (3.3). If we do a low-velocity approximation of the particles, we get Newton gravitation equation completely. The R in equation (3.4) may be infinitely close to zero, which seems very reasonable. In equation (3.4), there is no longer a length limit of r_0 for R, R can be infinitely close to zero, and therefore the energy E can be infinitely large. This results in equation (3.4) where there is a space-time singularity of R=0. The distance limit r_0 in equation (3.2) completely eliminated by the coordinate system transformation. The higher-order correction of gravity present in Equation (3.2) also disappears completely, and the higher-order correction in Equation (3.4) is completely absent.

This is a very strange phenomenon. From this we find a very surprising phenomenon. Purely mathematical transformations are very deceptive, and in many cases do not lead to correct physical results. Mathematical formulas must be combined with specific physical situations in order to obtain correct physical results. The gravitational radius is originally the intrinsic length of a gravitational source, which is an intrinsic property of particles. This intrinsic property should not be physically eliminated by coordinate transformations, and particles should have this intrinsic length property in any coordinate system. But if we perform the above coordinate conversion, convert Equation (3.3) to Equation (3.4). This intrinsic length property of the gravitational source is eliminated by this coordinate transformation. The limits of distance and energy no longer exist. Obviously, such a coordinate transformation is mathematically valid. However, in physics, such a coordinate transformation completely eliminates important physical properties, so that the intrinsic length properties of particles can no longer be seen in the formula, and also brings the result of the space-time singularity of R=0. This reminds us that in physics, for gravitational processes, coordinate transformations cannot be used arbitrarily. If a physical object has the property of intrinsic length, then the coordinate transformation must be done carefully. If we use coordinate transformations arbitrarily, we may eliminate the intrinsic length property of a physical object and get the wrong physical result. From this we can conclude that a prerequisite for the use of coordinate transformations is that the physical properties of this physical object cannot have a length property. But gravity happens to be very special, and the physical nature of gravity originates from the intrinsic length properties of particles. Moreover, this intrinsic length property has very important physical significance, and it cannot be arbitrarily eliminated by coordinate transformation.

Or look at the problem from a different perspective. L_p^2 in 5-dimensional space-time, or r_0 in 4-dimensional space-time, are invariant in any frame of reference and are intrinsic length properties of particles, which should not be eliminated by coordinate transformations. In any coordinate system, particles have this intrinsic length property. Therefore, any coordinate transformation should not eliminate the intrinsic length of this particle. Therefore, the gravitational effect can exist in any coordinate system. If this intrinsic length of the particle can be eliminated by the coordinate transformation, then in some coordinate systems, the particle no longer has the intrinsic length property, and the gravitational effect will disappear. Therefore, there is a prerequisite for any coordinate transformation, that is, the intrinsic length of the particle cannot be eliminated. This is a physical limitation of the gravitational effect on the coordinate system. There is no such limitation in mathematics alone. However, there is a physical limitation for the coordinate system. It is also the revelation of a new nature of gravity. Therefore, in any coordinate system, there is no space-time singularity for a physical object. There is a minimum of the distance between two particles that cannot be infinitely close to zero. This minimum distance is the gravitational radius of the particle that is the source of gravity. This property of gravity is similar to the existence of zero-point energy. The zero-point energy cannot be eliminated by the coordinate system transformation. Similarly, the intrinsic length of a particle cannot be eliminated by a coordinate system transformation. Zero-point energy is the result of the quantization of energy. Therefore, intrinsic length can also be seen as the result of quantization of length. It is precisely because of the quantization of length that it brings about a special gravitational effect. It can be seen that because of quantization, there are many unexpected results in physics. Zero-point energy and gravitational effects are both special results of quantization. Neither of these is the result of classical physics that does not exist. Gravitational force actually originates from quantization and does not possess the properties of classical physics. Gravity is a classical force, which is a complete illusion.

Conclusion

In this paper, the authors describe a new quantum gravity theory. In 5-dimensional space-time, particles have a special intrinsic length property, which can be identified by Planck length, which has the origin of quantum mechanics. This phenomenon can be called length quantization. On the basis of this intrinsic length, the authors use standard quantum field theory methods to derive a gravity theory that can explain the actual observed gravitational phenomena. This macroscopic approximation of the quantum gravity theory is Planck gravity theory. Therefore, this quantum gravity theory is named by Planck quantum gravity theory. This quantum gravity theory offers a lot of new perspectives. In 5-dimensional space-time, there is a unified quantized particle field. Gravity is an additional effect of this particle field. There is no such thing as a gravitational field that is independent of the particle field. The virtual particles of this particle field itself are the commutators of gravity. There is no such thing as a special, independent graviton. The gravitational field does not exist alone. Gravity is just an additional property of the particle field. The gravitational effect is a key factor preventing the divergence of quantum field theory. By including gravitational effects in quantum field theory, the divergence problem can be eliminated consistently. Quantum field theory is a completely self-consistent theory. At the macroscopic level, gravity has the property of a background field, so on the macroscopic scale, the spatiotemporal method can be used to deal with gravitational effects equivalently. But at the microscopic level, gravity still has the origin of a quantized particle field. This intrinsic length property of gravity imposes a limitation on the coordinate transformation, which cannot eliminate the intrinsic length of the particle. In this paper, the author simply presents the basic framework of Planck's theory of quantum gravity. There are still many problems in this theory that need to be studied in depth. More researchers need to be involved to continue to develop this theory.

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