Projection gravitation, a projection force from 5-dimensional space-time into 4-dimensional space-time

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Abstract: A new gravity theory. Gravity is a projection force from 5-dimensional space-time into 4-dimensional space-time. The Lorentz symmetry is a projection of particle-wave symmetry from 5-dimensional space-time into 4-dimensional space-time. The gravity is an additional projection force of Lorentz symmetry. The new gravity is an extension to Lorentz symmetry. The new gravity can be seen as some kind of symmetry. Gravity only exists in 4-dimensional space-time. In 5-dimensional space-time, there not have gravity. Equivalence principle is invalid in the new gravitation. In the new gravitation, there does not have gravitational acceleration. In the new gravitation, there only have inertial coordinates, not have non-inertial coordinates. In the new gravitation, the gravity source is only the rest mass, not energy. The particle can't be the gravity source if the particle not has rest mass. The photon not has gravity. But any particle can be affected by gravity. The photon is affected by gravity also. The gravitational mass is only equivalent to the rest mass. Under approximate weak gravity and approximate circular orbit condition, the new gravitation is equivalent to the General Relativity. The four classic experimental tests, the deflection of light by the sun, the precession of mercury, the red shift of light by the sun, the radar echo delay, are experimental tests to the new gravitation also. But even under approximate weak gravity condition, if the orbit is not approximate circular, if the orbit has higher eccentricity, there exists obvious difference between the General Relativity and the new gravitation. This difference can be a experimental test to distinguish which one is more realistic. The space-time is flat in the new gravitation, not is curved. In the new gravitation, the energy is conserved. The new gravitation is simpler than the General Relativity. In the new gravitation, the photon's equivalent gravitational acceleration is twice of the acceleration in Newton Gravitation. In the new gravitation, there not exists black hole, but exists empty hole, and not exists space-time singularity and energy singularity. The new gravity has obvious scale effect. The new gravity has the scale factor. In gravity field, the scale factor determines the quantization results of particle's motion. The new gravity perhaps is a force that inhibits the uncertainty of macroscopic objects. The new gravitation can derive out the result of the Planck Energy.

Keywords: new gravitation; 5-dimensional space-time; particle-wave symmetry; Lorentz symmetry; projection gravity; rest mass; gravitational mass; General Relativity; equivalence principle; Newton Gravitation; flat space-time; inertial coordinates; approximate weak gravity; approximate circular orbit; eccentricity; deflection of light; precession of mercury; red shift of light; radar echo delay; black hole; empty hole; gravitation quantization; scale effect; scale factor; Planck Energy.

Introduction

Since Newton proposed the theory of gravitation, the study of gravitation has become more and more deeply. Newton gravitation can't explain deflection of light and precession of mercury. In the early 20th century, Einstein proposed the Special Relativity, and further proposed General Relativity. The General Relativity theory can explain these phenomena. General relativity is more perfect than Newton gravity theory. In the 20th century, human find the quantum phenomena, and proposed the Quantum Mechanics, and proposed the Quantum Field Theory. But, human find that, between General Relativity and Quantum Mechanics, there are contradictions, and gravity cannot be quantized. The problem of gravitation becomes more and more complicated and difficult. By now, humans have not solved the problem of gravitational quantization.

In the face of this situation, human has proposed a variety of new theories of gravity. Based on the theory of quantum mechanics, the author puts forward a new gravitational model in the flat space-time. Under approximate weak gravity and approximate circular orbit condition, the new gravitational model is equivalent to the General Relativity. For the gravitational quantization problem, this new model may provide a new way to solve it.

1. Gravity is projection force from 5-dimensional space-time

In the previous two papers[1][2], author has proposed a new physical model, the particle-wave symmetry in 5-dimensional space-time. Particle wave is present in 5-dimensional space-time. The particle wave group velocity must be equal with its phase velocity, and the two speed value is invariant, and the two speed value is the light speed C. In this case, the 5-dimensional space-time is 4-dimensional space and 1-dimensional time. Cosmic space-time observed by human is 3-dimensional space and 1-dimensional time. This likes figure 1.

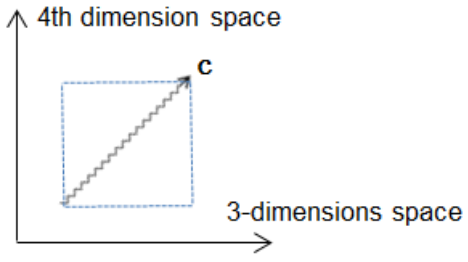

Figure 1

From this simple model, we projected the particle-wave symmetry into 4-dimensional space-time, so we can derive out the result of the Lorentz symmetry, and we can derive out result of the mass-energy equation in the Special Relativity Theory. So the Lorentz symmetry in 4-dimensional space-time is just a projection of the particle-wave symmetry in 5-dimensional space-time actually. So the Lorentz symmetry is the effect of this projection. Please reader read the previous two papers[1][2] at first, you will understand the new particle-wave symmetry

model. Author is no longer to repeat the description in this paper.

In this new model, there exist two key concepts. Firstly, there exists the particle-wave symmetry in the 5-dimensional space-time. Secondly, there exists a projection action from 5-dimensional space-time into 4-dimensional space-time. The projection action is like figure 2.

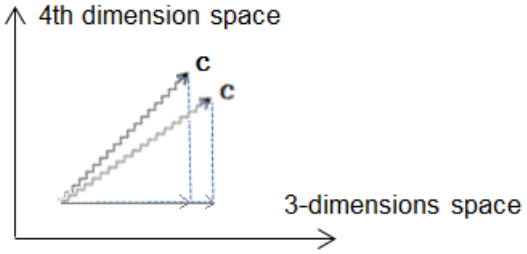

Figure 2

The new particle-wave symmetry model is based on the wave-particle duality of quantum mechanics. Therefore, it is naturally in accordance with quantum mechanics, there is no contradiction between quantum mechanics and the new particle-wave symmetry model. So the Lorentz symmetry becomes a derived out result of quantum mechanics.

The Lorentz symmetry is a global symmetry. In a inertial coordinates, at every space-time point, the symmetry is same. So we can understand it in such a way. The projection action from 5-dimensional space-time into 4-dimensional space-time have same projection factor at every space-time point. The projection factor is 1. Please be careful to understand this. This is very important. To Lorentz symmetry, the projection factor is 1 at every point. So we can ask a question. If the projection factor is not same at every point, but different point have different projection factor, what will happen? This question will direct to a new gravity model. This is the key of new gravity theory.

We know, gravity follows the two equation (1.1) and (1.2) in Newton gravitation.

$$F = -\frac{GMm}{r^2} \tag{1.1}$$

$$V = -\frac{GMm}{r} \tag{1.2}$$

So the Newton gravity is a function of space actually. So the Newton gravity can be seen as a effect of space.

Analogy Newton gravitation, if we take the projection factor into a function form similar to Newton gravity function, this will bring effect similar to the Newton gravity. So we will get extra gravity effect based on the Lorentz symmetry. So we build an association between Lorentz symmetry and gravity. So we can get a new gravitational theory satisfying Lorentz symmetry.

In physics, the Lorentz symmetry is manifested in mass-energy equation (1.3).

$$E = \sqrt{P^2C^2 + m_0^2C^4} \tag{1.3}$$

Author guess that the gravity will behaves as a additional factor of this equation (1.3). So, author proposed a new equation (1.4). This equation is the new gravitational equation.

$$E_v = -\frac{GM}{C^2 r}\sqrt{P^2C^2 + m_0^2C^4} \tag{1.4}$$

In this equation, E_v is the gravitational potential energy. The gravitational potential energy is negative. M is the rest mass of gravitational source. m_0 is the rest mass of the particle affected by gravity. r is the distance from the particle to the gravitational source. P is the momentum of particle. The projection factor is $\frac{GM}{C^2 r}$. The gravity is some kind of projection power. So the gravity has relationship with 5-dimensional space-time. The gravitational source is the particle-wave symmetry's projection action from 5-dimensional space-time into 4-dimensional space-time. So the new gravity can be seen as some kind of symmetry. This symmetry is extension of the Lorentz symmetry. This symmetry is based on the Lorentz symmetry. For simplified instructions, we first thought that the gravitational source and the particle is point particle, their mass is concentrated in a central point.

Why the projection factor is $\frac{GM}{C^2 r}$? This is inspired by the analogy of Newton gravitation. The new gravity must be able to approximate the results of Newton's gravity. The new gravity must satisfy the Lorentz symmetry. And the new gravity must satisfy the law of synthesis of gravity. So we take the projection factor for this form. This is a guessing result. Whether it is correct, rely on experiments to test it. Does the 5th dimension really exist? What is the projection action's property from 5-dimensional space-time into 4-dimensional space-time? Why exist this projection action? These questions are a new physics subject that needs further study.

Obviously, in the new gravitation, when the particle's speed is small, its momentum is small, omit momentum item in (1.4), we will get the result of Newton gravitation approximately.

$$E_v \approx -\frac{GM}{C^2 r} m_0 C^2 \approx -\frac{GMm_0}{r}$$

Plus the energy of the particle itself, in a gravitational field, the motion equation of a particle is equation (1.5). This is the new gravitational equation. Whether it is correct, rely on experiments to test it.

$$E = \sqrt{P^2 C^2 + m_0^2 C^4} - \frac{GM}{C^2 r} \sqrt{P^2 C^2 + m_0^2 C^4} \qquad (1.5)$$

In equation (1.4), why the gravitational source mass is only its rest mass, why it not is its all energy mass like the General Relativity? This can be inferred from the projection action. We projected he particle-wave symmetry in 5-dimensional space-time into 4-dimensional space-time, so we get the Lorentz symmetry. The effect of this action is that transfer the 4th motion component of particle into the rest mass of particle in 3-dimensional space. In this projection action, the motion component of particle in 3-dimensional space is not change. At other words, the projection action only has relationship with rest mass, not has relationship with all energy of particle. The gravity is only a additional effect of this projection action. So the gravity projection factor should have relationship with the rest mass of the source only, not should have relationship with all energy of source. So the gravitational mass of source only is equal with its rest mass.

So, if a particle does not have rest mass, it can't act as a gravitational source, it can't generate gravity. The photon can't generate gravity. The momentum can't generate gravity. In mass-energy equation, the increased momentum, and the increased energy, can't generate

additional gravity. In mass-energy equation, the equivalent mass of energy can't generate gravity. The mass and energy which not have Lorentz invariance can't generate gravity. Only the rest mass with Lorentz invariance can generate gravity, can act as gravitational source.

From equation (1.4), we can get a result. When a particle move in gravity filed, the value of the gravity that the particle accept have relationship with particle's momentum. When a particle move in gravity filed, the inertia mass of the particle have relationship with particle's rest mass, and the inertia mass of the particle have relationship with particle's momentum also. The inertia mass of the particle have this equation.

$$m = \frac{E}{C^2} = \frac{\sqrt{P^2C^2 + m_0^2C^2}}{C^2}$$

So, the inertia mass of the particle is not equal with its rest mass. In the new gravitation, the object which generate gravity, and the object which receive gravity, are not in reciprocal roles. The momentum can't generate gravity. But the momentum can affect the value of the gravity that the particle accept.

In the gravitational equation (1.4), the projection factor is $\frac{GM}{C^2 r}$. To a gravitational source, this factor is a constant. And this factor has scale property. So we can define a new scale constant r_0 . So we get a new formula (1.6). This constant r_0 is an identifier constant of a gravitational source. We can use this constant to simplify the form of equations.

$$r_0 = \frac{GM}{C^2} \qquad (1.6)$$

From formula (1.6), we can find a property of gravity. The gravity has scale effect. The property of a gravitational source is uniquely identified by its scale constant r_0 . To a gravitational source, it has larger rest mass, its scale constant r_0 is larger. This is also the embodiment of the projection action. To a projection action, it is bound to be related to a scale factor.

So, we can simplify the equation (1.4) to equation (1.7), and we can simplify the equation (1.5) to equation (1.8).

$$E_v = -\frac{r_0}{r}\sqrt{P^2C^2 + m_0^2C^4} \qquad (1.7)$$

$$E = \sqrt{P^2C^2 + m_0^2C^4} - \frac{r_0}{r}\sqrt{P^2C^2 + m_0^2C^4} \qquad (1.8)$$

Because the gravity is additional projection effect of Lorentz symmetry, so we can get this result. In a gravity field, to a same observer, every space point is in the same inertial coordinates. To a same observer, the space-time in the gravity field is flat space-time. The space-time in the gravity field is not curved. This is very different from the General Relativity.

The Lorentz symmetry is related to the speed of the observer's motion. In the gravity field, the observer is affected by the gravity, so the observer will move in the gravity field. The observer move to another space point, the observer's speed will change also. This process will bring a new Lorentz transformation, and bring a new inertial coordinates. That means, to every space point in the gravity field, there exist one inertial coordinates correspondingly. Different space point has

different inertial coordinates. Determine a space point, will determine a inertial coordinates. In this determined inertial coordinates, the space-time is flat, not curved.

So, in the gravity field, the observer at a space point do observe, will get this result. The every space point is in the same inertial coordinates, and the time at every space point is same. Different space point has different coordinate value only, not have different local coordinates. There not exist coordinates transformation between different space points. For example, when observe the gravity field from infinite distance, the every space point is in the same inertial coordinates, the time at every space point is same; there not exist space-time bending effect; there not exist clock delay. A particle move in the gravity field, its movement property is determined by equation (1.5). So, the space-time is flat in the new gravity, not is curved. There not exist the local inertial coordinates. There only exist one global inertial coordinates. This is the great difference between the new gravity and the General Relativity.

From the above discussion, we can find this result. In the new gravity model, there only exist inertial coordinates, not exist non-inertial coordinates. The gravity can change the movement speed of particle. The acceleration can change the movement speed of particle also. The two have same effect. But the gravity and the acceleration are different. The gravity can change the movement speed of particle, this is because different space point have different projection factor, it is not because acceleration. In fact, there is no acceleration of particle motion in Newton mechanics in the new gravity model. Acceleration is only the concept of macroscopic classical physics, which cannot be brought into quantum theory. In quantum theory, there only have the change of quantum state. The change of quantum state will show effect like the change of speed. In fact there is no acceleration. The change of the quantum state is the transition mutation, which cannot be equivalent to acceleration. If the acceleration is equivalent to acceleration, it is infinitely large. The new gravity is only a additional projection effect based on the Lorentz symmetry. The new gravity only changing the particle state, not accelerate the particle. Just a continuous state change brings an accelerated macro effect. But there is no real gravitational acceleration. The new gravity is very similar to quantum theory. Therefore, in principle, the new gravity model can be reconciled with the quantum theory, do not produce contradictions. The new gravity model may solve the problem of gravitational quantization.

The Lorentz symmetry, and the gravity, the two are the projection action from particle-wave symmetry in 5-dimensional space-time. The particle-wave symmetry is one property of quantum theory. So, between the gravity and the quantum theory, there is some kind of deep connection that has not been revealed. The quantum theory in 5-dimensional space-time is an area that needs to be studied in depth. The 5th dimension, or the 4th space dimension, maybe it is real.

The motion equation of particle in gravity field is equation (1.8). It can be simplified to equation (1.9).

$$E = (1-\frac{r_0}{r})\sqrt{P^2C^2 + m_0^2C^4} = (1-\frac{r_0}{r})mC^2 \tag{1.9}$$

From equation (1.9), we can get a result. The motion equation of particle in gravity field can satisfy the Lorentz symmetry.

From equation (1.4), we can get a result. To the new gravity, its value has relationship with particle's momentum. So, the new gravity is not a linear force. The new gravity is a nonlinear force. The gravity increases the momentum of particle. The increased momentum conversely

increases the gravity accepted by particle. This is a positive feedback loop process. Therefore, the new gravity accepted by particle is larger than the Newton gravity. So the new gravity is stronger than the Newton gravity. To two particles, when the distance between two particles reaches a value, the gravity force between two particles will exceed the Coulomb force.

Because the new gravity equation (1.4) is equation in flat space-time, the calculation method in the new gravitation is similar to the Newton gravitation. So, the accumulated calculation method in Newton gravitation can still be used in the new gravitation. This is a big advantage of the new gravitation.

In the new gravitation, every observer is in one inertial coordinates. The inertial coordinates is in a flat space-time. The space-time is not curved. So, the motion of particle in the gravity field will keep the energy conservation. So, the new gravitation does not destroy the conservation of energy. This is another big advantage of the new gravitation. The new gravity is a central force also. This is same with the Newton gravity. So, the motion of particle in the gravity field will keep the conservation of angular momentum.

From equation (1.8), we can find a property. It can be easily quantized. So we can write a wave function equation of particle moving in gravity field. And the wave function equation can satisfy the Lorentz symmetry. This is a big advantage of the new gravitation. The aim that author proposed the new gravity model, is try to solve the problem of gravitational quantization.

In the equation (1.9), there have a property which is similar to equivalence principle. If we take m as the inertia mass of the particle, the equivalence principle is shown in the equation (1.9), the gravity strength is equal the acceleration. But, this is formal. The m is not the real mass of particle. The m is not a real physical quantity. The m is only a formal equivalence mass. The m does not have real physical meaning. So, in the new gravitation, the equivalence principle in Newton gravitation is not really set up.

In the new gravitation, the real physical quantity is the momentum P and the rest mass m_0 of particle. The motion state of the particle can be determined by the two physical quantity. That is, the motion state of the particle be determined by $\sqrt{P^2C^2 + m_0^2C^4}$. That is, the momentum P and the rest mass m_0 uniquely identify a motion state. The two physical quantity have different value, this is a different motion state. In the equation (1.9), in the gravity field, at a space point, the gravitational force factor is not has relationship with the motion state. In the gravity field, at a space point, to any particle, and to any motion state, has the same gravitational force factor. This can be understood as the equivalence principle in the new gravitation. However, the equivalent principle in the new gravitation is based on the motion state of the particle, is not based on the acceleration of the particle. The new equivalent principle can be understood as a broader equivalent principle. But this understanding, relatively reluctantly, does not have clear physical meaning, easy to produce conceptual confusion. The author tends to conclude that, in the new gravity, the equivalence principle is not set up. This can avoid conceptual confusion. The equivalence principle in Newton gravitation is only a result in approximate weak gravity, is not strictly set up.

In the new gravitation, because the equivalence principle in Newton gravitation is not strictly set up, so the concept of acceleration actually no longer exists in the new gravitation. The

new gravity does not accelerate a particle. The new gravity is change a state of particle. There's a big difference between the two statements. The front statement is not applicable to quantum theory. But the behind statement is applicable to quantum theory. Because there only exist state changing in quantum theory, not exist acceleration process. The gravity effect is changing the particle's motion state A to state B, not accelerate the particle. The formula in Newton Mechanics, $F = m_0 a$, is not set up in the new gravity. If replace the m_0 with m, can keep this formula. But the m is a equivalent mass, is not a really mass. In the later chapters, we can find that, even if we use the concept of equivalent mass, and use the formula to calculate the motion orbit, can't get the correct orbit result, it will lead to large errors. This equivalent processing method does not compute the correct orbit results.

There not exist acceleration in the new gravity, and there not exist acceleration in quantum theory. The concept of acceleration only exists in Newton Mechanics. Therefore, the non-inertial coordinates will disappear. So the non-inertial coordinates does not exists. This is the great difference between the new gravitation and the General Relativity. The new gravity can remain consistent with the Quantum Mechanics. But the new gravity is completely different with the General Relativity.

The more important distinction between the new gravity and the General Relativity is that, how to understand the Lorentz symmetry? The General Relativity is based on the Special Relativity. In the Special Relativity, the Lorentz symmetry is understood as space-time symmetry, the Lorentz transformation is space-time transformation. But the new gravity is based on the particle-wave symmetry in the 5-dimensional space-time. The particle-wave symmetry is a property of particle wave, is not a property of space-time. We projected the particle-wave symmetry into 4-dimensional space-time, so we get the Lorentz symmetry in 4-dimensional space-time. So the Lorentz symmetry is a property of particle wave also, is not a property of space-time. In this projection process, we add another additional projection factor. So we can get the gravity effect in 4-dimensional space-time. The gravity is the additional projection effect. So, the new gravity and the Lorentz symmetry, the two are projection effect, the two are not space-time effect. The physics space-time is the 5-dimensional space-time. The 4-dimensional space-time observed by human is just a projection of 5-dimensional space-time. In the 4-dimensional space-time, there miss a dimension of space. These magical effects in relativity theory, like the time delay and expansion, actually comes from the missing of dimension of space. These magical effects are just observation effect, are not really physics result. In the 5-dimensional space-time, these magical effects will disappear, not exist. The gravity only exists in 4-dimensional space-time. In 5-dimensional space-time, the gravity will disappear.

In the new gravitation, the gravity only has relationship with the rest mass of the gravitational source, and the gravity not has relationship with the momentum of the gravitational source. But, the gravity has relationship with the momentum of the particle which accepts the gravity. Therefore, the new gravity does not follow the Newton's Third Law. This is a very obvious result. For example, the photon can accept gravity, but the photon can't generate gravity. So, the gravity between a photon and a electronics does not satisfy the Newton's Third Law, and the total momentum of the two particles is not conserved, perhaps the total angular momentum of the two particles is not conserved also. The new gravity is just additional projection effect of Lorentz symmetry, there not have reaction of gravity inevitably. We can think about it in another way. The

gravity has relationship with the 5-dimensional space-time. Therefore, in the 4-dimensional space-time, the two particles are not an independent closed-system actually. So the new gravity does not follow the Newton's Third Law. This problem needs further study.

The new gravitation has many new properties. It needs to be further studied.

2 The new gravitational experimental verification

By actual calculation, we can get a result. In the case of weak gravitational field approximation and near-circular orbit approximation, the orbital equation obtained by the new gravity and the orbital equation obtained by the General Relativity are exactly the same. In the case of weakly gravitational field approximation and near-circular orbit approximation, the two theory are completely equivalent. Therefore, the experimental verification of the General Relativity under the weak gravitational field approximation can also prove the validity of the new gravity. Therefore, the experimental verification under the approximation of the weak gravitational field does not distinguish whether the General Relativity is correct or the new gravity is correct. But the new gravity theory is a theory in the flat space-time. The new gravity theory is much simpler than the General Relativity.

By actual calculation, we can get a result. Even under the approximation of the weak gravitational field, there are obvious differences between the new gravity and the General Relativity. Only in the weak gravitational field and the near-circular orbit, when two conditions are satisfied simultaneously, the two theory are completely equivalent. When only the weak gravitational field approximation is satisfied, the results of the two theory calculations will be significantly different for the non near-circular orbits with large eccentricity. This difference can be used for experimental testing, which theory is more accurate, which is more in line with the actual physical processes.

2.1 The precession of mercury

Under the force of the Sun gravity, refer to the method of calculating the orbit of mercury in Newton Gravitation, and refer to the method of calculating the orbit of mercury in the General Relativity. The following calculations can be performed on the orbit precession of mercury.

The mercury moves in the sun gravity field. Its motion equation is the equation (1.8). The rest mass of the mercury is m_0 . The rest mass of the sun is M. Please note that. The momentum P of the mercury is also the function of r. Its value varies with r. So we can get equation (2.1.1).

$$E^2 = (1-\frac{r_0}{r})^2(P^2C^2 + m_0^2C^4) \qquad (2.1.1)$$

Under the approximation of the weak gravitational field, the approximate momentum of the mercury is formula (2.1.2).

$$P = m_0V \qquad (2.1.2)$$

So get

$$E^2 = (1-\frac{r_0}{r})^2(m_0^2V^2C^2 + m_0^2C^4) \quad (2.1.3)$$

$$\frac{E^2}{m_0^2C^2} = (1-\frac{r_0}{r})^2(V^2 + C^2) \quad (2.1.4)$$

In polar coordinates

$$V^2 = (\frac{dr}{dt})^2 + r^2(\frac{d\theta}{dt})^2 \quad (2.1.5)$$

The angular momentum of the mercury is

$$L = m_0 r^2 \frac{d\theta}{dt}$$

For simplifying formula, we take the angular momentum of the unit rest mass. So get

$$L = r^2 \frac{d\theta}{dt}$$

So get

$$\frac{d\theta}{dt} = \frac{L}{r^2}$$

$$\frac{dr}{dt} = \frac{dr}{d\theta}\frac{d\theta}{dt} = L(\frac{1}{r^2})\frac{dr}{d\theta} = -L\frac{d(1/r)}{d\theta}$$

Put this into formula (2.1.5), so get

$$V^2 = L^2(\frac{d(1/r)}{d\theta})^2 + \frac{L^2}{r^2} \quad (2.1.6)$$

Put this into formula (2.1.4), so get

$$\frac{E^2}{m_0^2C^2} = (1-\frac{r_0}{r})^2L^2((\frac{d(1/r)}{d\theta})^2 + \frac{1}{r^2}) + (1-\frac{r_0}{r})^2C^2 \quad (2.1.7)$$

We set $u = \frac{1}{r}$, put this into formula (2.1.7), so get

$$\frac{E^2}{m_0^2C^2} = (1-r_0u)^2L^2((\frac{du}{d\theta})^2 + u^2) + (1-r_0u)^2C^2 \quad (2.1.8)$$

On both sides of the equation, do differential calculation by θ, so we get a complex equation.

$$L^2(1-2r_0u+r_0^2u^2)\frac{d^2u}{d\theta^2} - r_0L^2(1-r_0u)(\frac{du}{d\theta})^2 + 2L^2r_0^2u^3 - 3L^2r_0u^2 + (L^2 + r_0^2C^2)u - r_0C^2 = 0 \quad (2.1.9)$$

To $\frac{d^2u}{d\theta^2}$ item, the r_0u and $r_0^2u^2$ are small, omit it. To $(\frac{du}{d\theta})^2$ item, the r_0u is

small, omit it.

$2L^2r_0^2u^3 - 3L^2r_0u^2 = L^2r_0u^2(2r_0u - 3)$, r_0u is small, omit it.

To u item, $L \approx rV \approx r\frac{GM}{2r} \approx \frac{GM}{2}$, $r_0C = \frac{GM}{C^2}C = \frac{GM}{C}$, so, the $r_0^2C^2$ is small, omit it.

So, the equation (2.1.9) is simplified to,

$$L^2\frac{d^2u}{d\theta^2} - r_0L^2(\frac{du}{d\theta})^2 - 3L^2r_0u^2 + L^2u - r_0C^2 = 0$$

$$\frac{d^2u}{d\theta^2} + u = \frac{r_0C^2}{L^2} + 3r_0u^2 + r_0(\frac{du}{d\theta})^2$$

$$\frac{d^2u}{d\theta^2} + u = \frac{GM}{L^2} + 3\frac{GM}{C^2}u^2 + \frac{GM}{C^2}(\frac{du}{d\theta})^2 \qquad (2.1.10)$$

The (2.1.10) is the motion equation of mercury moving in the sun gravity field. The front three items is the result in Newton Gravitation. The next two items is the correction of the new gravity. This correction will get the result of the precession of mercury's orbit.

The General Relativity get this equation,

$$\frac{d^2u}{d\theta^2} + u = \frac{GM}{L^2} + 3\frac{GM}{C^2}u^2 \qquad (2.1.11)$$

The result in the new gravity, and the result in the General Relativity, we compare the two results. The front four items is same exactly.

But, in the new gravity, there add a item $\frac{GM}{C^2}(\frac{du}{d\theta})^2$.

$$\frac{du}{d\theta} = \frac{d(1/r)}{d\theta} = -\frac{1}{r^2}\frac{dr}{d\theta} = -\frac{1}{r^2}\frac{dr}{dt}\frac{dt}{d\theta} = -\frac{1}{r^2}\frac{dr}{dt}\frac{1}{L/r^2} = -\frac{1}{L}\frac{dr}{dt} = -\frac{V_r}{rV_\theta} = -u\frac{V_r}{V_\theta}$$

Put into formula (2.1.10), so get

$$\frac{d^2u}{d\theta^2} + u = \frac{GM}{L^2} + 3\frac{GM}{C^2}u^2 + \frac{V_r^2}{V_\theta^2}\frac{GM}{C^2}u^2 \qquad (2.1.12)$$

Therefore, in the new gravity, when the radial motion speed is far less than the lateral motion speed, the 5th item is small item. If we omit the 5th item, so we can get the same result in the General Relativity. The mercury orbit meets this condition approximately. So the 5th item can be omitted. To mercury orbit, the new gravity can get the same result in the General Relativity. The new gravity theory can explain the precession of mercury.

We compare the two equations, (2.1.12) and (2.1.11). We can found that. Even under the approximation of the weak gravitational field, there are obvious differences between the new gravity and the General Relativity. Only in near-circular orbit, the condition that the radial motion speed is far less than the lateral motion speed can be satisfied. The 5th item can be omitted. The result of the new gravity can be same with the result of the General Relativity. When only the

weak gravitational field approximation is satisfied, but the orbit is non near-circular orbit with large eccentricity, the results of the two theory calculations will be significantly different. We measure the orbits of stars with large eccentricity. This can be an experimental test. So we can distinguish that. Which theory is more accurate, which is more in line with the actual physical processes.

Remind readers. In the new gravity, to the calculation of orbit precession, can't use the method of calculation to acceleration. If we use $ma = F = -\frac{dE_v}{dr}$ to compute orbit like in the Newton gravitation, we can't get the correct result. This is because the equivalence principle is set up approximately in the new gravity. The equivalence principle is only a result in approximate weak gravity, is not strictly set up. There not exists the gravity acceleration strictly. So we can't use the acceleration method to compute orbit correction. The acceleration method will lead to large errors. We must calculate directly from the equation (1.8), we can get the desired orbit correction result. This also proves that. In the new gravity, the concept of acceleration in Newton gravity is invalid. The acceleration is only a approximate method, can't be used in strict calculation.

2.2 The deflection of light by the sun

From the equation (1.8), we can get a result. The photon has no the rest mass, so it can't act as the gravitational source, it can't generate gravity. But the photon has the momentum, so its motion can be affected by the gravity.

The rest mass of the photon is zero. So the equation (2.1.1) change to equation (2.2.1).

$$E^2 = (1 - \frac{r_0}{r})^2 P^2 C^2 \qquad (2.2.1)$$

Set $u = \frac{1}{r}$, so get

$$E^2 = (1 - r_0 u)^2 P^2 C^2 \qquad (2.2.2)$$

Now we must convert P to a formula of V, we can compute its motion orbit. So, to the photon, we define a formula (2.2.3), the m_0 is a equivalent mass of the photon.

$$P = m_0 V \qquad (2.2.3)$$

So get

$$E^2 = (1 - r_0 u)^2 m_0^2 V^2 C^2 \qquad (2.2.4)$$

Similar to the calculation of mercury 's orbit, in polar coordinates

$$V^2 = (\frac{dr}{dt})^2 + r^2 (\frac{d\theta}{dt})^2 \qquad (2.2.5)$$

take the angular momentum of the unit equivalent mass

$$L = r^2 \frac{d\theta}{dt}$$

So get

$$\frac{E^2}{m_0^2C^2} = (1-r_0u)^2L^2((\frac{du}{d\theta})^2 + u^2) \qquad (2.2.6)$$

On both sides of the equation, do differential calculation by θ , so we get

$$L^2(1-2r_0u+r_0^2u^2)\frac{d^2u}{d\theta^2} - r_0L^2(1-r_0u)(\frac{du}{d\theta})^2 + 2L^2r_0^2u^3 - 3L^2r_0u^2 + L^2u = 0 \qquad (2.2.7)$$

To $\frac{d^2u}{d\theta^2}$ item, the r_0u and $r_0^2u^2$ is small, omit it. To $(\frac{du}{d\theta})^2$ item, the r_0u is small, omit it.

$2L^2r_0^2u^3 - 3L^2r_0u^2 = L^2r_0u^2(2r_0u-3)$, r_0u is small, omit it.

So the equation (2.2.7) is simplified to

$$L^2\frac{d^2u}{d\theta^2} - r_0L^2(\frac{du}{d\theta})^2 - 3L^2r_0u^2 + L^2u = 0$$

$$\frac{d^2u}{d\theta^2} + u = 3r_0u^2 + r_0(\frac{du}{d\theta})^2$$

$$\frac{d^2u}{d\theta^2} + u = 3\frac{GM}{C^2}u^2 + \frac{GM}{C^2}(\frac{du}{d\theta})^2 \qquad (2.2.8)$$

The (2.2.8) is the motion equation of photon moving in the sun gravity field.

We compare it with the result in the General Relativity. The front three items is same exactly.

But, in the new gravity, there add a item $\frac{GM}{C^2}(\frac{du}{d\theta})^2$ 。

Similar to the calculation of mercury ‘s orbit.

$$\frac{du}{d\theta} = \frac{d(1/r)}{d\theta} = -\frac{1}{r^2}\frac{dr}{d\theta} = -\frac{1}{r^2}\frac{dr}{dt}\frac{dt}{d\theta} = -\frac{1}{r^2}\frac{dr}{dt}\frac{1}{L/r^2} = -\frac{1}{L}\frac{dr}{dt} = -\frac{V_r}{rV_\theta} = -u\frac{V_r}{V_\theta}$$

Therefore, in the new gravity, when the radial motion speed is far less than the lateral motion speed, the 4th item is small item. If we omit the 4th item, so we can get the same result in the General Relativity. To the question of the deflection of light by the sun, it meets this condition approximately. We can omit the 4th item. So the new gravity can get the same result in the General Relativity. The new gravity theory can explain the deflection of light by the sun.

Similar to the calculation of mercury ‘s orbit. To the motion of photon in the gravity field, there are obvious differences between the new gravity and the General Relativity. Only the condition that the radial motion speed is far less than the lateral motion speed be satisfied, the 4th item can be omitted. The result of the new gravity can be same with the result of the General Relativity. When the motion of photon is not a sideways sweep of stars, the photon has a large

radial motion speed, the results of the two theory calculations will be significantly different. We measure various type of photon. This can be an experimental test. So we can distinguish that. Which theory is more accurate, which is more in line with the actual physical processes.

From the equation (2.2.1), we can get the result. The speed of photon moving in the gravity is the light speed C. The gravity does not change the speed value of photon, but change the momentum of photon, and change the motion orbit of photon. This is a very obvious conclusion. Because the new gravitation is based on the Lorentz symmetry, so it should not take a result conflict with the Lorentz symmetry.

Although the photon move with the speed C in the gravity, but the gravity will change the momentum of photon, and will change the motion orbit of photon. The photon move between two space points, compared with the movement in the vacuum, movement in the gravity field will take more time. This is equivalent to the slow motion speed of the photon in the gravity field, or can be considered equivalent to a time delay. But this is an equivalent way of thinking. It is not true. In fact, the photon's moving speed in the gravity field maintains the light speed C, is not changed. And there not exist time delay in the gravity. The new gravitational space-time is flat.

In some special case, to the motion of photon in the new gravity, there have an equivalent method.

In the Newton gravitation, the movement of particle affected by the gravity, will generate acceleration.

$$ma = F = -\frac{dE_v}{dr} \tag{2.2.9}$$

The new gravitational force is the equation (1.4). The rest mass of photon is zero. The photon only has the momentum. So the equation (1.4) change to,

$$E_v = -\frac{GM}{C^2 r} PC = -\frac{GMP}{Cr} \tag{2.2.10}$$

$$F = -\frac{dE_v}{dr} = -(\frac{GMP}{Cr^2} - \frac{GM}{Cr}\frac{dP}{dr}) \tag{2.2.11}$$

On the condition that the radial motion speed is far less than the lateral motion speed, there exists this formula approximately.

$$L = rP$$

Because conservation of angular momentum, so

$$\frac{dL}{dt} = \frac{dL}{dr}\frac{dr}{dt} = (P + r\frac{dP}{dr})\frac{dr}{dt} = 0$$

So get

$$\frac{dP}{dr} = -\frac{P}{r}$$

Put into (2.2.11), get

$$F = -\frac{dE_v}{dr} = -(\frac{GMP}{Cr^2} - \frac{GM}{Cr}(-\frac{P}{r})) = -\frac{2GMP}{Cr^2} \tag{2.2.12}$$

Similar to Newton Mechanics, we define an equivalent mass of the photon. So get

$$P = m_0 V = m_0 C$$

Put into (2.2.12), so get

$$F = -\frac{2GMm_0}{r^2} \qquad (2.2.13)$$

The acceleration is

$$a = -\frac{2GM}{r^2} \qquad (2.2.14)$$

The photon's equivalent gravitational acceleration is twice of the acceleration of the particle which has rest mass, and is twice of the acceleration in Newton Gravitation. But the acceleration does not increase speed of photon. The acceleration decrease speed of photon. This is a surprising result.

Therefore, if we compute the motion of photon by the method of Newton gravitation, the acceleration of the photon must be twice of the acceleration in Newton Gravitation. But this is a approximate result. This is correct only on the special condition that the radial motion speed is far less than the lateral motion speed. To ordinary case, this no longer is correct.

The motion of photon in the gravity is very special. The photon has no rest mass, so it is very different with the ordinary particles which have rest mass. To ordinary particles, we can draw on Newton gravitation, using force and acceleration to see the gravitational phenomenon. However, the motion of photon can no longer be viewed in terms of gravitational forces and accelerations. For photons, the gravitational view as a space-time projection effect, thus affecting the photon, in this perspective to see the problem, more easily understood. This is similar to the General Relativity. But the space-time projection effect of the new gravity is different from the space-time effect of the General Relativity. The new gravitational space-time is flat, not is curved.

2.3 The red shift of light by the sun

In the new gravity, the space-time is flat, not is curved. Every observer is in an inertial coordinates. So, in the new gravity field, the motion of photon keeps the energy conservation. So the question of the red shift of light by the sun is very simple.

In the new gravity, the motion equation of photon is (1.8). The rest mass of photon is zero. So, get

$$E = (1 - \frac{r_0}{r})PC \qquad (2.3.1)$$

The photon is emitted from space point r1, its momentum is P1. The energy E1 is

$$E1 = (1 - \frac{r_0}{r_1})P_1C$$

The photon move to space point r2, its momentum change to P2. The energy E2 is

$$E2 = (1 - \frac{r_0}{r_2})P_2C$$

The energy is conserve. E1=E2. So get

$$(1-\frac{r_0}{r_1})P_1C=(1-\frac{r_0}{r_2})P_2C \tag{2.3.2}$$

Not include the gravitational energy, the energy of the photon itself meet this formula.

$$E=PC=h\nu \tag{2.3.3}$$

So get

$$(1-\frac{r_0}{r_1})h\nu_1=(1-\frac{r_0}{r_2})h\nu_2 \tag{2.3.4}$$

$$\frac{\nu_1}{\nu_2}=\frac{1-\frac{r_0}{r_2}}{1-\frac{r_0}{r_1}}=\frac{r_1(r_2-r_0)}{r_2(r_1-r_0)} \tag{2.3.5}$$

The red shift of light is defined as

$$\Delta\nu=\frac{\nu_1}{\nu_2}-1 \tag{2.3.6}$$

$$\Delta\nu=\frac{r_1(r_2-r_0)}{r_2(r_1-r_0)}-1=\frac{(r_2-r_1)r_0}{r_2(r_1-r_0)}\approx\frac{(r_2-r_1)r_0}{r_2r_1}\approx(\frac{1}{r_1}-\frac{1}{r_2})r_0$$

Here, we do a approximate processing, $r_1-r_0\approx r_1$. To the question of the red shift of light by the sun, the gravity is an approximate weak gravity, so we can do this approximation.

So the red shift of light by the sun is

$$\Delta\nu=(\frac{1}{r_1}-\frac{1}{r_2})\frac{GM}{C^2} \tag{2.3.7}$$

This result is same with the General Relativity. And this result is same with the Newton gravitation.

From the above description, we can find that. In the new gravity, to one observer, the calculation of the deflection of light by the sun, and the calculation of the red shift of light by the sun, are follow the same gravitational equation, are in the same inertial coordinates, are in the same flat space-time. There not exist effect of curved space-time. There not exist time delay. There not exist coordinates transform. The method in the new gravity has consistent logic.

In the General Relativity, the calculation of the deflection of light by the sun is based on the motion equation. But the calculation of the red shift of light by the sun must use the method of time delay, can use the method of motion equation. The two calculation must use different method, does not have consistent logic. This is also a aspect being doubted to the General Relativity.

2.4 The radar echo delay by the sun

The calculation of the radar echo delay by the sun is similar to the calculation of the deflection of light by the sun.

From the above description of the calculation of the deflection of light by the sun, the motion equation of photon is

$$\frac{d^2u}{d\theta^2}+u=3\frac{GM}{C^2}u^2+\frac{GM}{C^2}(\frac{du}{d\theta})^2 \qquad (2.4.1)$$

In the General Relativity, the calculation of the radar echo delay by the sun is based on the equation (2.4.2).

$$\frac{d^2u}{d\theta^2}+u=3\frac{GM}{C^2}u^2 \qquad (2.4.2)$$

Similar to the calculation of the deflection of light by the sun, if we only take the front three items of the equation (2.4.1), the two equations is same exactly. So the new gravity can take same result with the General Relativity. So the new gravity can explain the radar echo delay by the sun.

Similar to the calculation of the deflection of light by the sun, there must meet a condition that the radial motion speed is far less than the lateral motion speed, the result is correct. We can get the same result with the General Relativity.

If the condition can't meet, the radial motion speed can't be omitted. So there have obvious differences between the new gravity and the General Relativity. So, if we measure the result of the radar echo delay in various situations, we can distinguish that. Which theory is more accurate, which is more in line with the actual physical processes.

We study the equation (2.3.1) again. This equation is the motion equation of photon in the gravity. We can found that. It can be seen equivalently as that the light speed is decreased by the gravity. But, please distinguish it carefully. This just is an equivalent processing method. The light speed is not decreased in fact.

In the new gravity, we define an equivalent speed of light.

$$C_g=(1-\frac{r_0}{r})C$$

So the equation (2.3.1) will have a same form with the photon in the vacuum.

$$E=PC_g$$

This is equivalent with the time delay in the General Relativity. In the General Relativity, in the approximate weak gravity field, the time delay is

$$t_g=t\sqrt{1-\frac{2GM}{rC^2}}\approx(1-\frac{GM}{rC^2})t\approx(1-\frac{r_0}{r})t$$

This effect is completely equivalent with the speed decreased of light. The decreased factor is $1-\frac{r_0}{r}$.

But, please note. This equivalence can be set up only in the approximate weak gravity field. In the new gravity, whether the gravity is strong or weak, the decreased factor is same, it is $1-\frac{r_0}{r}$. But in the General Relativity, when the gravity is strong, the factor is $\sqrt{1-\frac{2GM}{rC^2}}=\sqrt{1-\frac{2r_0}{r}}\neq 1-\frac{r_0}{r}$. So, in strong gravity, the result of the new gravity is not same with the result of the General Relativity.

3 The empty hole in the new gravitation

In the new gravity, the motion equation of particle is equation (1.8). From this equation, we can strictly calculate the particle's relational function between the motion speed and the space point.

From equation (1.8), get

$$E_0=(1-\frac{r_0}{r})\sqrt{P^2C^2+m_0^2C^4} \qquad (3.2.1)$$

The E_0 is the energy of particle in the gravity field. Because the energy is conserved, so the energy E_0 is the initial energy. This energy will remain unchanged. It is a constant.

To a particle which has the rest mass, in the gravity, it meets the Lorentz symmetry. So get

$$P=mV=\frac{m_0}{\sqrt{1-V^2/C^2}} \qquad (3.2.2)$$

So get

$$\frac{E_0^2}{C^2(1-\frac{r_0}{r})^2}-m_0^2C^2=m^2V^2=\frac{m_0^2}{1-\frac{V^2}{C^2}}V^2$$

After a complex calculation, the final result is

$$V=C\sqrt{1-\frac{m_0^2C^4}{E_0^2}(1-\frac{r_0}{r})^2} \qquad (3.2.3)$$

The equation (3.2.3) is the relational function between the motion speed and the space point in the gravity field. But this equation is correct to the particle which has the rest mass. To the particles which not have rest mass, it is not correct. The speed of particles which not have rest mass will keep the speed of light, like photon. From equation (3.2.2), as long as we know particle's the rest mass and its initial energy, so we can calculate its motion speed at any space point.

We first discuss the area $r\geq r_0$.

In this area, when particle move in the gravity field, with the decrease of the distance r, the speed V of the particle will increase continuously. The speed will close to C, but never reach C. This is similar to the velocity variation in the Lorentz symmetry, where V is constantly increasing, close to C, but can never reach C. In other words, particles can only be infinitely close to r_0, but can't achieved r_0.

From (3.2.3), we find that. There exists a very special position. At $r = r_0$, at this special sphere, the speed of particle will reach C. To any particles, if it achieves this special position, its speed must be C. But we view the equation (3.2.1) again. If the particle achieves the r_0 position, its energy must be zero. Because energy is conserved, so, if a particle can achieve the r_0 position, its initial energy must be zero. But we view the equation (3.2.1) again. If a particle's initial energy is zero, only the particle's initial position is r_0. As long as the particle's initial position is not r_0, its initial energy can't be zero. So we prove that, the particle can't achieve the r_0 position.

From the equation (3.2.1), we can find that. As long as the particles appear in the area $r < r_0$, its energy must be negative. But the energy is conserved. So the particles in the r_0 outside area, can't move into the r_0 inner area. The particles can appear in the inner region, only the particles are excited directly in the inner area. Does the particles can be excited in the inner area? This question need further research.

From above discuss, we can seen the scale factor of the new gravity as the black hole radius. The black hole radius of the new gravity only be half of the General Relativity, and only be half of the Newton gravitation also.

But, the concept of the black hole in the new gravity is different with the General Relativity. In the new gravitation, the particles in the outside area of black hole can't move into the inner area of black hole. The new gravitation not have a special coordinates which particles can move into inner area from outside area. Observer in any space point and in any coordinates, we will take the same equation. So, in the new gravitation, the result applies to all coordinates.

In the new gravity, because the gravity force, to the two particles, as long as one has the rest mass, it must have the black hole radius. So, the distance between the two particles only can be infinitely close to the black hole radius, can't reach the black hole radius, can't be less than the black hole radius.

Therefore, the concept of the black hole in the new gravitation is very different. In fact, the black hole is a empty hole, in the new gravitation. It is a empty hole which prohibits the entry of outside particles. This is similar a no-fly zone. The empty hole of the new gravity does not suck in particles, but prohibits particles into this area. The empty hole of the new gravity is similar to the

wind eye of hurricanes and typhoons. So, in the new gravity, there not have the space-time singularity and the energy singularity.

In above discuss, we put all the rest mass of the gravitational source at a central point, and we see the gravitational source as a point particle.

But, in fact, a gravity source is collection by a large number of particles, is not a point particle. To the sun, if we observer it in the outside of the sun, we can calculate a empty hole radius of the sun. But, if we observer it in the inside of the sun, the inner rest mass of the sun is decreasing. The more you enter the sun's core, the smaller the inner rest mass of the sun. Until the sun has been reduced to a quantized point particle, this process can be interrupted. That is, the more you enter the sun's core, the smaller the empty hole of radius of the sun. So, the question of the sun's empty hole is very complex. We cannot simply assume that, particles cannot enter into the inner area of the empty hole of the sun. This question needs further research.

In fact, this is a manifestation of the gravitational scale effect. The radius of the empty hole depends on the total rest mass of the gravitational source. But, the total rest mass of the gravitational source is changing with the the observed distance. The more you enter the gravitational source's core, the smaller the total rest mass of the gravitational source. Unless the gravitational source is a quantized point particle, its total rest mass does not change. Only the gravitational source is a quantized point particle, its radius of the empty hole does not change with the observed distance, can keep a constant. So, to the gravitational source which is not a quantized point particle, its radius of the empty hole will change with the observed distance. The empty hole has a scale effect. So the empty hole or black hole may not be real.

About the empty hole or black hole, it needs further research.

4 Quantization in the new gravity

The motion equation of the particle in the new gravity field is (1.8). From (1.8), can get

$$E^2 = (1-\frac{r_0}{r})^2 P^2C^2 + (1-\frac{r_0}{r})^2 m_0^2C^4 \qquad (4.1)$$

This equation is similar to the Klein-Gordon equation. It meets the Lorentz symmetry. The equation is very easy to be quantized. So we can turn the motion equation into a quantum wave function equation. The motion of a particle in a gravity field can be described as quantized. And the quantum wave function equation meets the Lorentz symmetry. This is the remarkable advantage of new gravity.

Follow the standard quantization method, turn energy into an operator and turn momentum into an operator, so we can get a quantum wave function equation.

$$-\hbar^2 \frac{\partial^2 \Psi}{\partial t^2} = -\hbar^2 C^2 (1-\frac{r_0}{r})^2 \nabla^2 \Psi + (1-\frac{r_0}{r})^2 m_0^2 C^4 \Psi \qquad (4.2)$$

We define the stationary state wave function

$$\Psi = e^{-iEt/\hbar}\varphi \qquad (4.3)$$

So we can get the stationary state wave function equation.

$$E^2\varphi = -\hbar^2C^2(1-\frac{r_0}{r})^2\nabla^2\varphi + (1-\frac{r_0}{r})^2 m_0^2C^4\varphi \tag{4.4}$$

The new gravity is the center force field. So we can refer to the calculation method of wave equation of the hydrogen atom. After complex processing, we get the radial equation (4.5) finally. To solve this radial equation, we can calculate the quantized energy of the particle moving in the gravity field.

$$\frac{d^2u}{dr^2} + \left[\frac{E^2}{\hbar^2C^2(1-\frac{r_0}{r})^2} - \frac{m_0^2C^4}{\hbar^2C^2} - \frac{l(l+1)}{r^2}\right]u = 0 \tag{4.5}$$

In general, the solution of this equation is too difficult. The author only makes a simplified calculation to two special cases, and discusses some special properties of the quantization of the new gravity. In general computing, interested readers can study this topic in depth, revealing the quantum properties of the new gravity in general situations.

4.1 Quantization in the approximate weak gravity

In the approximate weak gravity, $r_0 << r$, so

$$\frac{1}{(1-\frac{r_0}{r})^2} \approx (1+\frac{r_0}{r})^2 \approx 1+\frac{2r_0}{r}+\frac{r_0^2}{r^2}$$

So the (4.5) can be simplified to

$$\frac{d^2u}{dr^2} + \left[\frac{E^2 - m_0^2C^4}{\hbar^2C^2} + \frac{2E^2r_0}{\hbar^2C^2r} - \frac{l(l+1) - \frac{E^2r_0^2}{\hbar^2C^2}}{r^2}\right]u = 0 \tag{4.6}$$

This equation is similar to the radial equation of the hydrogen atom. So we solve this equation referring to the hydrogen atom.

We define a new quantum number of angular momentum.

$$l'(l'+1) = l(l+1) - \frac{E^2r_0^2}{\hbar^2C^2} \tag{4.7}$$

Then define

$$n = n_r + l' + 1 \tag{4.8}$$

The n is the quantum number of energy of the particle. The n_r is the radial quantum number. So can get

$$\frac{E^2 - m_0^2C^4}{\hbar^2C^2} = -\frac{1}{4n^2}(\frac{2E^2r_0}{\hbar^2C^2})^2 \tag{4.9}$$

So we get the formula of the quantized energy.

$$E^2 = (\sqrt{1+\frac{4r_0^2 m_0^2 C^4}{n^2\hbar^2 C^2}} - 1)\frac{n^2\hbar^2 C^2}{2r_0^2} \tag{4.10}$$

This is only a simplified result. Because the n have relationship with E^2, so the equation of the E is a quartic equation. Its calculation is very complex. Here we only make simplified calculation and make simple approximate discussion. So the following discussion is only a reference. It perhaps has error.

Because we get the equation (4.9) and (4.10) only in the approximate weak gravity, the result (4.10) has actual physical meaning when the n is big. That is the long distance motion. To the near distance motion, or the n is small, the result (4.10) does not have actual physical meaning. Please note this.

We observe the formula (4.7) carefully. There exists a limit on energy E actually. If the energy E does not meet formula (4.7), so the energy E does not satisfy the above solving process. Therefore, if the energy E does not meet formula (4.7), it cannot be a quantized energy. This means that. Not in all cases, the motion of particles in the new gravity have quantized energy. That is, not in all cased the motion of particles can be quantized. This is a very strange conclusion.

We analyze the (4.10) in two cases.

(1) If the particle satisfies

$$m_0^2 C^4 << \frac{h^2 C^2}{r_0^2} \tag{4.11}$$

On the condition of (4.11), we observe the (4.10). If only take the first level approximation, we get result $E^2 = m_0^2 C^4$. So we must take the second level approximation. So get

$$E^2 = m_0^2 C^4 (1 - \frac{m_0^2 C^4 r_0^2}{n^2\hbar^2 C^2}) \tag{4.12}$$

(2) If the particle satisfies

$$m_0^2 C^4 >> \frac{\hbar^2 C^2}{r_0^2} \tag{4.13}$$

Define a new number N

$$N^2 = \frac{m_0^2 C^4 r_0^2}{\hbar^2 C^2}$$

The number N is very big. From (4.10), as long as n<2N, the value 1 in equation (4.10) is a small item, omit it. So get

$$E^2 = m_0 C^2 \frac{n\hbar C}{r_0} \tag{4.14}$$

But we observer the (4.7), we can get.

$$(l^{'}+\frac{1}{2})^2 = l(l+1)+\frac{1}{4}-\frac{E^2 r_0^2}{\hbar^2 C^2} \geq 0$$

The range of the value of the number l is from 0 to n-1. By approximate estimation, the energy E must meet this condition $E^2 \leq \frac{n^2\hbar^2 C^2}{r_0^2}$. But from (4.13) and (4.14), we can find that. In this case, the energy E can't satisfy this condition. So we can get this conclusion that. In this case, there is no energy solution to the equation (4.6). So in this case, the motion of particles does not have quantized energy. But under the above condition $m_0^2 C^4 << \frac{\hbar^2 C^2}{r_0^2}$, there have energy E which can satisfy the (4.12) and (4.7), the motion of particles have quantized energy. The two cases are different.

So, we found that. To the equation (4.6), not in all cases, we can solve the quantized energy solution of this equation. Whether we can solve the quantized energy solution, it is associated with the rest mass m_0 of particle and the factor r_0 of the source. In some cases, the equation does not have quantized energy solution. In some cases, the equation has quantized energy solution. This is a surprising new feature of the new gravity.

For example, to the sun, $\frac{\hbar C}{r_0} \approx 10^{-30}$ J. Obviously, in the sun's gravity field, the most particles and objects can't satisfy this condition $m_0^2 C^4 < \frac{\hbar^2 C^2}{r_0^2}$. So in the gravity field of sun, the most particles and objects can't have quantized energy. All particles and objects move in continuous orbit in the sun's gravity field.

From the formula (4.9), we can find that. In the approximate weak gravity, the rest mass of the photon is zero. So to the photon, it can't satisfy the formula (4.9). So the photon can't have quantized energy.

4.2 Quantization in the strong gravity

To the strong gravity, r->r0 . So get.

$$\frac{1}{(1-\frac{r_0}{r})^2} = \frac{r^2}{(r-r_0)^2}$$

Make a variable replacement. Set

$$x = r - r_0$$

r->r0 is x->0

$$\frac{1}{r^2}=\frac{1}{(x+r_0)^2}\approx\frac{1}{r_0^2}$$

So, the equation (4.5) change to

$$\frac{d^2u}{dx^2}+\left[\frac{E^2}{\hbar^2C^2}-\frac{m_0^2C^4}{\hbar^2C^2}-\frac{l(l+1)}{r_0^2}\right]u+\frac{2r_0E^2}{\hbar^2C^2x}u+\frac{r_0^2E^2}{\hbar^2C^2x^2}u=0 \qquad (4.15)$$

This equation is similar to the radial equation of the hydrogen atom. So we solve this equation referring to the hydrogen atom.

We define a equivalent quantum number of angular momentum.

$$l^{'}(l^{'}+1)=-\frac{r_0^2E^2}{\hbar^2C^2} \qquad (4.16)$$

Then define

$$n=n_r+l^{'}+1 \qquad (4.17)$$

The n is the quantum number of energy of the particle. The n_r is the radial quantum number. So can get

$$\frac{E^2}{\hbar^2C^2}-\frac{m_0^2C^4}{\hbar^2C^2}-\frac{l(l+1)}{r_0^2}=-\frac{1}{4n^2}(\frac{2E^2r_0}{\hbar^2C^2})^2 \qquad (4.18)$$

So we get the formula of the quantized energy.

$$E^2=(\sqrt{1+\frac{4r_0^2m_0^2C^4}{n^2\hbar^2C^2}+\frac{4l(l+1)}{n^2}}-1)\frac{n^2\hbar^2C^2}{2r_0^2} \qquad (4.19)$$

Similar to the approximate weak gravity, this is only a simplified result. Because the n have relationship with E^2, so the equation of the E is a quartic equation. Its calculation is very complex. Here we only make simplified calculation and make simple approximate discussion. So the following discussion is only a reference. It perhaps has error.

Because we get the equation (4.18) and (4.19) only in the strong gravity, the two equation have actual physical meaning when the n is small. That is the near distance motion. To the long distance motion, or the n is big, the two equation does not have actual physical meaning. Please note this.

Please note the (4.16). The (4.16) can change to,

$$(l^{'}+\frac{1}{2})^2=\frac{1}{4}-\frac{r_0^2E^2}{\hbar^2C^2}$$

This means that the E must satisfy.

$$E^2\le\frac{\hbar^2C^2}{4r_0^2} \qquad (4.20)$$

This means that. To the near distance cases, the scale factor of the gravitational source has

great impact on the quantized energy of the motion. The scale factor is different, the result is different.

Because is in the strong gravity, we only observer the near distance motion. That is n is small.

At first, we analyze the case, n=1.

(1) n=1

When n=1, the value of l only be zero. So get

$$E^2 = (\sqrt{1+\frac{4r_0^2 m_0^2 C^4}{\hbar^2 C^2}} - 1)\frac{\hbar^2 C^2}{2r_0^2} \qquad (4.21)$$

We analyze it in two cases.

(1.a) $m_0^2 C^4 << \frac{\hbar^2 C^2}{r_0^2}$

From (4.21), get

$$E^2 \approx m_0^2 C^4 (1 - \frac{m_0^2 C^4 r_0^2}{\hbar^2 C^2}) \qquad (4.22)$$

(1.b) $m_0^2 C^4 >> \frac{\hbar^2 C^2}{r_0^2}$

From (4.21), get

$$E^2 \approx m_0 C^2 \frac{\hbar C}{r_0} \qquad (4.23)$$

But, please note. There have a condition of (4.20). The energy E must meet (4.20), we can get the solution of (4.21). obviously, to the solution (4.23), the energy E can't satisfy the (4.20). So the solution (4.23) does not exist. So, under the condition $m_0^2 C^4 >> \frac{\hbar^2 C^2}{r_0^2}$, the solution n=1 does not exist. That is, the quantized energy n=1 does not exist.

When n=1, the value of l only be zero. The rest mass of the photon is zero. So to the photon, it can't satisfy the condition (4.18). So the photon can't have the quantized energy n=1.

(2) n=2

When n=2, the value of l can be 1 or 0. When n=0, the discussion is very similar to n=1. No longer repeat the discussion.

When the value of l is 1, from (4.19), we get

$$E^2 = (\sqrt{3+\frac{r_0^2 m_0^2 C^4}{\hbar^2 C^2}} - 1)\frac{2\hbar^2 C^2}{r_0^2} \qquad (4.23)$$

We discuss in two cases also.

(1.a) $m_0^2 C^4 << \frac{\hbar^2 C^2}{r_0^2}$

From (4.23), can get

$$E^2 \approx (\sqrt{3}-1)\frac{2\hbar^2 C^2}{r_0^2}$$

But we find that. In this case, the energy E can't meet the constraint condition (4.20). So, in this case, there does not have a quantized energy.

(1.b) $m_0^2 C^4 >> \frac{\hbar^2 C^2}{r_0^2}$

From (4.23), can get

$$E^2 \approx m_0 C^2 \frac{2\hbar C}{r_0}$$

Obviously, in this case, the energy E can't meet the constraint condition (4.20). So, in this case, there does not have a quantized energy.

(3) n>2

In the case n>2, we do calculation by the same method, we can find that.

To the case $m_0^2 C^4 << \frac{\hbar^2 C^2}{r_0^2}$, whether there have a quantized energy, it has relationship with the value of l.

To the case $m_0^2 C^4 >> \frac{\hbar^2 C^2}{r_0^2}$, to any value of l, there not have quantized energy.

To the photon, from (4.19), we can get.

$$E^2 = (\sqrt{1+\frac{4l(l+1)}{n^2}}-1)\frac{n^2\hbar^2 C^2}{2r_0^2} \qquad (4.24)$$

If $l=0$, E=0. So, the smallest value of l must be 1. When $l \geq 1$

$$E^2 \geq \frac{2\hbar^2 C^2}{r_0^2}$$

The energy can't satisfy (4.20). So, in the strong gravity field, the photon does not have quantized energy.

Combined with the above discussion, we can get the conclusion.

To the case $m_0^2 C^4 << \frac{\hbar^2 C^2}{r_0^2}$, in the approximate weak gravity, there have quantized energy. In the strong gravity, there have quantized energy in some cases, there does not have quantized energy in some cases.

To the case $m_0^2 C^4 >> \frac{\hbar^2 C^2}{r_0^2}$, whether in the approximate weak gravity or in the strong gravity, there does not have quantized energy.

To the photon, there does not have quantized energy whether in the approximate weak gravity and in the strong gravity.

We can find. To a gravity, the $\frac{\hbar C}{r_0}$ is a special variable, it has special meaning. It is a attributes that can be used to characterize gravitational quantization. So we define a new constant.

$$E_{gq} = \frac{\hbar C}{r_0} = \frac{\hbar C^3}{GM} \tag{4.25}$$

This energy is the gravitational energy scale. The scale factor depends on the total rest mass M of the gravitational source. The M may be very large. So its energy scale may be very small. This will cause that most particles and objects does not have quantized energy in this gravity. So there only have classical continuous energy and orbit.

For example, to the sun, $E_{gq} \approx 10^{-30}$ J. Obviously, most particles and objects does not have quantized energy in the gravity field of the sun, only have classical continuous energy and orbit.

To the neutron, $E_{gq} \approx 10^{28}$ J. Obviously, most particles have quantized energy in the gravity field of the neutron.

To the electronics, $E_{gq} \approx 10^{31}$ J. Obviously, most particles have quantized energy in the gravity field of the electronics.

To the surprising phenomenon, we analyze its physical causes. There are two reasons. The first, to the new gravity, its value has relationship with particle's momentum. In the wave function equation, the momentum is change to a differential operator. So it lead to this result. The second reason is the scale effect of the new gravity. To a gravitational source, its scale factor depends on its total rest mass, the scale factor is not a invariant. The source have more rest mass, its scale factor is larger. The factor is larger, the macro effect is more obvious. The macro effect is more obvious, the quantization effect is more weak. So the scale factor can affect the quantization of motion of the particles.

To the sun, its scale factor reach thousands of kilometers, this is a micro scale. In the gravity field of the sun, the motion of particles and objects can't show the quantization properties. This is a reasonable conclusion.

If above results are correct, so we must rethink about the question of quantization of the gravity field. To the motion of particles and objects in the gravity field, in some case there have quantized energy, in some case there does not have quantized energy. There is no consistent result. It's worth thinking carefully. This raises a question. The gravity field itself can really be quantized? Is there really a graviton? If the gravity field itself can be quantized, if the gravity force is transmitted by the exchange of the gravitons, then the motion of the particles and objects should have a consistent quantized result, all motions should be quantized, and all motions should have quantized energy. But the derived result from the wave function equation is not like this. This is a contradiction.

This is just a simple conclusion that the author deduced in the approximate condition, it is not the definitive conclusion. It needs to be further studied. Only we solve the strict solution of the wave function equation, we can get the exact reliable conclusion.

In the new gravity model, the gravity is a projection force from the 5-dimensional space-time. The gravity only appears in the 4-dimensional space-time. In the 5-dimensional space-time, there have no gravity. From this perspective, we can draw a conclusion. The gravity field is not a quantum exchange field in the 4-dimensional space-time. The gravity field is different from the electromagnetic field. The two fields are not the same kind of fields.

The new gravity can be seen as additional effect of the Lorentz symmetry. The new gravity can be seen as a symmetry which has the space factor. The new gravity is extension of the Lorentz symmetry. So, the new gravity should not be quantized. A symmetry should not be quantized.

Above conclusion is only in the 4-dimensional space-time. But there have the projection action. So, in the 5-dimensional space-time, there perhaps have an unknown force corresponding to the gravity in the 4-dimensional space-time. The unknown force maybe is a quantum exchange field in the 5-dimensional space-time. This need to be further studied.

The gravitational scale factor determines the quantized results of particle motion. The scale factor is determined by the total rest mass of the gravitational source. But, in fact, a gravity source is collection by a large number of particles, is not a point particle. For example, to the sun, the total rest mass observed in the outside area is different with the total rest mass observed in the inside area. So the scale factor is not same. So the quantization result is not same. This needs to be further studied.

About the gravitational energy scale E_{gq}, it has a surprising result. If we suppose that the gravitational energy scale E_{gq} is equal with the rest energy of the gravitational source. So we can derive out the result of the Planck Energy. In this case, the rest mass of the gravitational source is equal with the Planck Mass. Therefore, there have some kind of relationship between the gravitational energy scale and the Planck Energy.

If we set

$$E_{gq} = \frac{hC^3}{GM} = MC^2$$

So we get

$$M = \sqrt{\frac{\hbar C}{G}}$$

This result is just the Planck Mass. So, in this case, the gravitational energy scale is equal with the Planck Energy, $E_{gq} = E_p$. This is a surprising result. This result is the natural derivation of the new gravity, not a patchwork result. What is the physical meaning of this result? Does the Planck Energy have other properties that are not revealed? The question needs further study.

The quantization of particle's motion in the new gravity field has relationship with another

question also. In quantum mechanics, there always have a problem that has not been solved. Microscopic particles are uncertain, but macroscopic objects are deterministic. What is the cause of this difference. This problem, perhaps with the new gravity, has some kind of association. Macroscopic objects are affected by gravity greatly. In the gravity field of the sun and the earth, macroscopic objects do not have quantized energy, so they do not have the properties of quantization, so macroscopic objects are not uncertain. In other words, gravity is a force that inhibits the uncertainty of macroscopic objects. But for microscopic particles, affected by gravity is small, mainly affected by the electromagnetic force, so the properties is uncertain. This is only a author's guess, and it needs further research.

Therefore, the new gravity has many completely different new properties, needs the other interested reader to carry on the thorough research.

Conclusion and discussion

The author proposes a new gravitational model. In the new gravitational model, the gravity is a projection force from 5-dimensional space-time into 4-dimensional space-time. The gravity is some kind of projection effect. The gravity exists in the 4-dimensional space-time. The gravity does not exist in the 5-dimensional space-time. The gravity satisfies the Lorentz symmetry. In fact, the gravity is a extension of the Lorentz symmetry. In the new gravity, the space-time is flat, is not curved. There only have inertial coordinates. There does not have non-inertial coordinates. In the new gravity, the value of gravity depends on the rest mass of the gravitational source, not have relationship with the energy of the gravitational source. And the value of gravity has relationship with the momentum of moving objects. The particles which have no rest mass can't generate gravity, like the photon. But the particles which have no rest mass be affected by the gravity, like the photon.

The calculation of the new gravitation is simpler than calculation of the General Relativity. Under approximate weak gravity and approximate circular orbit condition, the new gravitation is equivalent to the General Relativity. Under this condition, the experimental tests to the General Relativity are the experimental tests to the new gravitation also. But even under approximate weak gravity condition, if the orbit is not approximate circular, if the orbit has higher eccentricity, there exists obvious difference between the General Relativity and the new gravitation. This difference can be an experimental test to the new gravitation.

It is just the beginning of a research field. In the new gravitation theory, there are a lot of problems need to be solved. More researchers are needed to study this theory, to develop it and perfect it.

In the new gravitation, these problems need to be further studied in order to be solved.

1. Under approximate weak gravity condition, we need to find a real stars orbit which has higher eccentricity, do actual measurements to it, compare with result of theoretical calculation. Through experiments to test correctness of the new theory.
2. The question of the black hole and the empty hole in the new gravitation. Whether black holes are real or not?
3. We need to solve the strict solution of the wave function equation, to give the exact answer to the problem of gravitational quantization.

4. What is the relationship between the collection of the rest mass of the gravitational source and the scale effect of the gravitational source?
5. What is the relationship between the 5-dimensional space-time and the 4-dimensional space-time? Why there exists the projection action?
6. The author simply discusses the situation where the gravitational source is stationary. This is only the static gravity field. The situation where the gravitational source is moving need to be further studied.

In the new gravitational theory, there have a very important question. That is the source of the rest mass of the particles. This is actually a big problem that hasn't been solved yet. For example, according to the quantum field theory, a part of the electron's rest mass comes from the electromagnetic energy. After the quantization of the electromagnetic field, the energy of the electromagnetic field is actually comes from the photon energy. Photons have no rest mass, only have motion energy. The motion energy of the photon does not have the Lorentz invariance. No matter how many photons there are, the collection of these photons should only have motion energy, should not have rest mass. So, there have an important question. How does the energy of the electromagnetic field turn into the rest mass of electrons? The motion energy of the photon does not have the Lorentz invariance, but the rest mass of electrons have Lorentz invariance. How does the non-Lorentz invariance turn into the Lorentz invariance? This is a question. And this question does not have an exact answer. To protons and neutrons, have this question also. From the non-Lorentz invariance turning into the Lorentz invariance, there exist an unknown physical process. The new gravitation perhaps has relationship with the unknown physical process. The renormalization of quantum field theory perhaps has relationship with the unknown physical process also. Because only the rest mass can generate gravity in the new theory, so this question is very important.

This is just the beginning, the authors expect more researchers to join the ranks of this research.

References:

[1] XiaoLin Li

A new equivalent theory with Special Relativity Theory,particle wave in 5-dimensional Space-time

International Journal of Physics , August 2016, Vol. 4, No. 5

http://pubs.sciepub.com/ijp/4/5/2/index.html

[2] XiaoLin Li

Particle-wave symmetry in Quantum Mechanics And Special Relativity Theory

International Journal of Current Research, June 2017, Volume 09, Issue 06

http://www.journalcra.com/sites/default/files/23679.pdf

[3] "The Feynman Lectures on Physics(Volume I,II,III)",R. P. Feynman,R. B. Leighton,M. Sands, ISBN 9787506272476,ISBN 9787506272483,ISBN 9787506272490.

[4] “The Quantum Theory of Fields”, Steven Weinberg, ISBN 0-521-55001-7.

[5] “GRAVITATION AND COSMOLOGY: PRINCIPLES AND APPLICATIONS OF THE GENERGAL THEORY OF RELATIVITY”, Steven Weinberg, ISBN 0-471-92567-5.

[6] M. Planck, The Theory of Radiation, Dover (1959) (translated from 1906).