Discussion of a possible approach for the quantization of the gravitational field

Yandong Yang

Abstract—**In this paper, the author first reviews the essential contradictions of general relativity(GR) and quantum mechanics(QM) from the perspective of background manifolds,while pointing out a fundamental principle that both must be satisfied. Schrodinger's cat experiment, Yang's double slit interference experiment, and the ERP paradox are discussed based on this principle. The author proposes to unify GR and QM in a mathematical context by introducing the concept of virtual potential field and virtual mass. A model of black hole is given under the inspiration of this discussion, and a possible explanation for black hole information paradox is offered under this scheme, which may also provide some hints for the mystery of the antimatter. The author analyzes the possible applications of virtual particles to quantum field theory, including the treatment of divergent terms in the quantization of real scalar field and the physical implications of the Pauli-Villars renormalization method, while giving an estimate of the Lamb movement. Finally, the author suggests a plausible approach for the quantization of the gravitational field.**

Index Terms—**virtual particles, black hole information paradox, antimatter,quantum gravity.**

I. Introduction

The biggest conflict between general relativity(GR) and quantum mechanics(QM) may be that the two describe the four basic forces of nature in a different manner. The theory of quantum mechanics holds that forces are generated by the exchange of particles, i.e., exchange of photons produces electromagnetic force, exchange of weak standard bosons produces weak interaction force, exchange of gluons generates strong interaction force, with gravity has yet to be "quantized" [1]; While the theory of general relativity holds that gravity is caused by the bending of time and space, but the other three forces can not be "geometricized".

Y. D. Yang is with Economic and Technological Research Institute, Ningxia Electric Power Co., LTD. Yinchuan, Ningxia, 753000, P.R.China e-mail: mermaidyy@126.com.

Manuscript received , 2024; revised , 2024.

According to general relativity, which states that the metric, g_{ab},and quantities derivable from it are the only spacetime quantities that are allowed to appear in the equations of physics. And that given a point P on a manifold M and a vector **V** tangent to M at point P, we determine the only geodesic line on the manifold. For example, any meridian starting from the north pole of a sphere is part of a geodesic line. However, according to the uncertainty principle of quantum mechanics, if a free particle is precisely located at the north pole at the initial moment, we can not determine which direction it moves. We can only infer the rate and direction of its motion at the initial moment by the particle's trajectory, that is, as long as the particle's movement draws an "observable" arc length, we can infer the initial velocity of the particle.

Although the principle of uncertainty does not violate the physical laws of the macroscopic motion of particles (the motion of free particles along geodesic lines),it is not easy to introduce the uncertainty principle of quantum mechanics into the curved space-time [2]. Still, we can find a basic principle that both theories have to follow.

II. A general priciple

As we know, the essence of the principle of general covariance is to exclude all human factors unrelated to the intrinsic geometry of space and time in the expression of physical laws. It's a natural idea that the uncertainty principle of quantum mechanics should also abide by this principle. It seems that if a physical process must be described by introducing a 'measurable set' independent of the intrinsic geometry of the background space, then the quantum effects of the process will disappear (or no longer apparent), which I will call principle No.1 in later text. Let's discuss a few examples first:

Example 1: In the Schrodinger's Cat experiment [3] [4], the whole physical process should be regarded as the interaction between two systems: one is the system of radium, the decay of which can be described without the need to introduce any measurable set (length, volume, etc.) and is therefore purely quantum mechanical; the other is a macroscopic system consisting of the box, the cat and the bottle containing cyanide. For the two systems to interact with each other, it is necessary to break the bottle or open a small hole in the side wall of it to release cyanide into the air, thus a measurable set (the diameter of the hole) must be introduced. According to principle No.1, the physical process will no longer have obvious quantum mechanical effects, the results are conclusive, and there is no superposition states of live and dead cats. If there is no intermediate (the cyanide-filled bottle), but rather direct interaction between the decay system and the cat, then there are also two cases: one is that the radiation produced by decay hits the cat for enough time to kill it, then a measurable set of "time interval" is introduced and the conclusion is definitive. The other case is that the radiation produced by decay acts immediately with the cat, without observable time interval, then the cat is no different from a microscopic particle, the states of cat and radium atoms are indeed entangled [5].

Example 2: In Young's double-slit interference experiment [6], let the photon pass through the slits one by one without making any measurements of its path, the physical background can be considered as pure quantum mechanical. Once we make measurements (in any way) and try to determine which slit the photon passes [7], the interference pattern disappears. The reason is that to determine which slit the photon passes through, a measurable set of "resolution" must be introduced to distinguish the two slits, then the quantum effect disappears.

Example 3: For the interpretation of ERP paradox [8] [9], the description of two entangled particles does not require the introduction of any measurable set, so it is a pure quantum mechanical effect. According to Einstein, the spins of two particles are determined at the time of separation (but we do not know which particle takes which spin direction before the measurement). From a macroscopic point of view, in order to measure the spin of two particles, we have to wait for them to separate for a distance (a measurable set), while a quantum mechanical description of the process require no concept of measurable sets, which is self-evident in the wave functions of entangled states:

$$|0\rangle_{\mathrm{C}} \to \frac{1}{\sqrt{2}}\left[|\uparrow\rangle_{\mathrm{A}}|\downarrow\rangle_{\mathrm{B}} \pm |\uparrow\rangle_{\mathrm{B}}|\downarrow\rangle_{\mathrm{A}}\right] \quad (1)$$

so we have to consider them as a whole. If we consider this problem in the framwork of field theory, we may have to acknowledge the existence of superluminal particles which are used to exchange information between the entangled particles.

III. Introduction of virtual potential fields and virtual particles

Acorrding to the discussion above, if we want to explore the root causes of the contradictions between general relativity and quantum mechanics, we should first focus on those constants independent of human factors, to see what the effect is when those constants were changed. As we all know, the speed of light is an invariant constant regardless of the state of its observer. But no one has ever answered the questions: Why is it right for being so? What happens if one exceeds the speed of light? Now let's take the wildest guess and look for some clues.Take Einstein's mass velocity relation $m_R = m_0/\sqrt{1-v^2/c^2} \equiv \gamma m_0$ for example, the mass becomes imaginary $m_R = \pm i m_0/\sqrt{v^2/c^2-1}$ when the particle velocity exceeds the speed of light (mathematically of course!). According to the law of gravitation $F = G\frac{Mm}{r^2}$, a particle with an imaginary mass will feel a virtual potential field.

Does the virtual potential field introduced in this way have any physical significance? For simplicity, a one-dimensional constant virtual potential field is introduced:

$$V(x) = \begin{cases} 0, & x < 0 \\ -iV, & x > 0 \end{cases}, \quad V > 0 \quad (2)$$

Let a particle with energy E enter the virtual potential field from $x = -\infty$ along the x direction, when $x < 0$ the wave function writes:

$$\psi_1(x) = e^{ik_0 x} + Be^{-ik_0 x},\ x < 0,\ k_0 = \sqrt{\frac{2\mu E}{\hbar^2}} \quad (3)$$

Where $Be^{-ik_0 x}$ is the reflected wave function generated by the virtual potential field, and the wave function in $x > 0$ region satisfies:

$$\frac{d^2\psi(x)}{dx^2} + k^2\psi(x) = 0,\ x > 0, k = \sqrt{\frac{2\mu(E+iV)}{\hbar^2}} \quad (4)$$

The general solution is:

$$\psi_2(x) = Ae^{ikx}, \ , x > 0 \tag{5}$$

By continuity condition $\psi_1(0) = \psi_2(0)$, ${\psi_1}'(0) = {\psi_2}'(0)$, and suppose $V \ll E$, then $B^2 \approx \frac{1}{16}\left(\frac{V}{E}\right)^2 \approx 0$. Take approximate value $B = 0, A = 1$, I get

$$\psi_1(x) = e^{ik_0x} \tag{6}$$

$$\psi_2(x) = e^{ikx} = e^{ik_0x}e^{-\left(\frac{k_0V}{2E}\right)x} \tag{7}$$

Substituted into the probability flow density formula, I arrive:

$$j_1 = \frac{\hbar k_0}{\mu}, \ , x < 0 \tag{8}$$

$$j_2 = \frac{\hbar k_0}{\mu}e^{-\left(\frac{k_0V}{E}\right)x}, \ , x > 0 \tag{9}$$

When a particle with $E > 0$ enters the virtual potential field, the probabilistic flow density of the particle decreases with the increase of the injection depth, indicating that the particle is absorbed by the virtual potential field. However, if I write $V(x) = \pm iV, \ x > 0, \ V > 0$ in the initial condition (5), then

$$j_2 = \frac{\hbar k_0}{\mu}e^{\pm\left(\frac{k_0V}{E}\right)x}, \ x > 0 \tag{10}$$

so the physical process corresponding to the absorption/generation of matters in the virtual potential field. This may explain why the velocity of a particle can not exceeds the speed of light: a particle with imaginary mass feels a virtual potential field according to the law of gravitation, thus a tachyon will be absorbed or give rise to a Big Bang instantly according to formula (10).

This can also be used as a simplified black hole model. The formation of black holes can be considered as the result of a special space-time coordinate transformation. I first write down the inertial system metric:

$$ds^2 = c^2dT^2 - dX^2 - dY^2 - dZ^2 \tag{11}$$

Now if I want to change the upper metric to the following form through a coordinate transformation:

$$ds^2 = -c^2\left[1 + \frac{\omega z\mu(t)}{c^2}\right]^2 dt^2 - dx^2 - dy^2 + \omega^2 dz^2 \tag{12}$$

Suppose the transformation I look for can be written as:

$$\begin{aligned} &Z^\nu = Z^\nu(z^\mu, z^\nu), \quad \mu,\nu = 0,3 \\ &X = x, \ \ Y = y \end{aligned} \tag{13}$$

substitute (13) into (11)and (12), I arrive:

$$\begin{aligned} &-c^2\left[1 + \tfrac{\omega z\mu(t)}{c^2}\right]^2 dt^2 + \omega^2 dz^2 \\ &= -\left[\tfrac{\partial Z(z,t)}{\partial z}dz + \tfrac{\partial Z(z,t)}{\partial t}dt\right]^2 \\ &+c^2\left[\tfrac{\partial T(z,t)}{\partial z}dz + \tfrac{\partial T(z,t)}{\partial t}dt\right]^2 \end{aligned} \tag{14}$$

Compare the coefficients at both ends of the formula, I obtain:

$$c^2\left[\frac{\partial T(z,t)}{\partial z}\right]^2 - \left[\frac{\partial Z(z,t)}{\partial z}\right]^2 = \omega^2 \tag{15}$$

$$c^2\left[\frac{\partial T(z,t)}{\partial t}\right]^2 - \left[\frac{\partial Z(z,t)}{\partial t}\right]^2 = -c^2\left[1 + \frac{\omega z\mu(t)}{c^2}\right]^2 \tag{16}$$

$$\frac{\partial Z(z,t)}{\partial z} \cdot \frac{\partial Z(z,t)}{\partial t} = c^2\frac{\partial T(z,t)}{\partial z} \cdot \frac{\partial T(z,t)}{\partial t} \tag{17}$$

Solving equation (15)-(17):

$$Z(z,t) = c\int_{t0'}^{t} ch\left[\int_{t0}^{t}\frac{\mu(t)}{c}dt\right]dt + \omega z sh\int_{t0}^{t}\frac{\mu(t)}{c}dt \tag{18}$$

$$T(z,t) = c\int_{t0''}^{t} sh\left[\int_{t0}^{t}\frac{\mu(t)}{c}dt\right]dt + \frac{\omega z}{c} ch\int_{t0}^{t}\frac{\mu(t)}{c}dt \tag{19}$$

looking back at (12), compared with:

$$g_{00} = 1 + \frac{\omega z\mu(t)}{c^2} = 1 + \frac{2U}{c^2} \tag{20}$$

I get:

$$U = \frac{1}{2}\omega z\mu(t) \tag{21}$$

if $\omega = \pm i$, then

$$ds^2 = -c^2\left[1 + \frac{\pm iz\mu(t)}{c^2}\right]^2 dt^2 - dx^2 - dy^2 - dz^2 \tag{22}$$

this is equivalent to introducing a virtual potential field:

$$U = \pm\frac{i}{2}z\mu(t) \tag{23}$$

If the probability flow density represents the information of matter, according to formula (9), as matter falls into the black hole and gets closer and closer to the center, the outside world (infinity viewer) will get less and less information about the matter. So a large amount of information is essentially left outside the black hole or on its route dropping to the center of the black hole, which provides a possible explanation for the black hole information paradox [10] [11] [12].

Besides, according to formula (10) and (23), the black hole not only consumes matter, but also produces matter, providing a possible explanation for the antimatter jet of the black hole. If it can be proved that this coordinate transformation leads to the transformation of matter/ antimatter, it will provide a new clue to the mystery of antimatter, which is also a subject worth further study.

As for the ERP parodox, we can assume that two entangled particles transmit information through superluminal virtual particles. When we measure one of the entangled particles, the superluminal virtual particles are absorbed by the potential field provided by the measurement instrument, so they can no longer transfer information between the two entangled particles, and the states of the two particles are subsequently determined.

A similar discussion can be made for the double-slit interference experiment. First, how does the photon know whether the travel path ahead is double slit or single slit? We can assume that the photon flash superluminal virtual particles to detect the path ahead, When the photon detect a double-slit, it will send a virtual photon through one of the slit, and itself go through the other, and then they interact with each other to produce interference fringes on the screen. Once we want to observe which slit the photon passes, whether by instant observation or delayed observation, the virtual photon will be absorbed by the potential field provided by the detector, and only one photon is left, which cannot produce interference fringes by itself. This expression can at least provide a self-consistent explanation for the delayed selection experiment. It should be particularly noted that:(1) The concept of "virtual photon" is only an equivalent description of the interaction between the particle and the background space in which it is located, and actually no "virtual photon" is emitted (otherwise it is a real photon). (2) When I say "observable" and "measurable" I mean the measurement process, in which the influence of the uncertainty principle of quantum mechanics should be considered. (3) The introduction of "superluminal virtual particles" and "virtual mass" are mathematical concepts. In fact, this paper does not support any superluminal phenomenon, but aims to discuss why the motion of macroscopic matter cannot exceeds the speed of light (a very simple reason is that the superluminal phenomenon violates the law of causality). But for microscopic particles, we can find a clever way that allows superluminal phenomenon without violating the law of causality, considering the amplitude of a free particle propagating from x_0 to x:

$$[U(t) =< x|e^{-iHt}|x_0 > \tag{24}$$

for relativistic particles:

$$U(t) =< x|e^{-it\sqrt{p^2+m^2}}|x_0 >\sim e^{-m\sqrt{x^2-t^2}} \tag{25}$$

the propagation amplitude outside the light cone is not zero, but we can argue that beyond the light cone, the probability of finding a particle is getting smaller and smaller. That is, it is possible to find particles in a thin layer outside the light cone, but according to the above discussion, such particles are quickly absorbed by vacuum, ensuring that there is no violation of causality at the macroscopic scale.

IV. VIRTUAL PARTICLES AND FIELD THEORY

The introduction of the virtual potential field may also provide a completely new renormalization method for the quantization of the gravitational field. Let's start with the quantization of the real scalar field. When there is only one real scalar field, I introduce a virtual potential in the Lagrangian:

$$\mathcal{L} = \frac{1}{2}\partial^\mu\varphi\partial_\mu\varphi - \frac{1}{2}m^2\varphi^2 + i\lambda\partial^0\varphi \tag{26}$$

where λ is a real constant, $\mu = 0, 1, 2, 3$, It's easy to see that $\varphi(x)$ obeys K-G equation:

$$({\partial_0}^2 - \nabla^2 + m^2)\varphi(x) = 0 \tag{27}$$

and conjugate momentum:

$$\pi(x) = \frac{\partial\mathcal{L}}{\partial\dot{\varphi}} = \dot{\varphi}(x) + i\lambda \tag{28}$$

Hamiltonian should be written as:

$$\begin{aligned} &\mathcal{H}\,(\pi,\varphi) = \pi\dot{\varphi} - \mathcal{L} \\ &= \tfrac{1}{2}\{\dot{\varphi}(\vec{x},t)^2 + [\nabla\varphi(\vec{x},t)]^2 + m^2\varphi(\vec{x},t)^2\} \end{aligned} \tag{29}$$

integral by parts and throw away the surface item, I arrive:

$$H = \frac{1}{2}\int d^3x\,[\dot{\varphi}^2 + \varphi(-\nabla^2 + m^2)\varphi] \tag{30}$$

The plane-wave expansion of $\varphi(\vec{x},t)$ writes:

$$\begin{aligned} \varphi(\vec{x},t) = \textstyle\int \tilde{d}k\{[a(k) + ib(k)]e^{-ikx} \\ + [a^+(k) + ib^+(k)]e^{ikx}\} \end{aligned} \tag{31}$$

where, the integral measure is:

$$\tilde{d}k = \frac{d^3k}{(2\pi)^3 2\omega_k} = \frac{d^4k}{(2\pi)^4}\delta(k^2 - m^2)\theta(k^0)2\pi \quad (32)$$

and $\omega_k = \sqrt{\vec{k}^2 + m^2}$. substitute (31) into equation(29) and after a lenthy calculation I get:

$$\begin{aligned} H = \tfrac{1}{2}\int \tilde{d}k\,\omega_k\{[a(k)a^+(k) + a^+(k)a(k)] \\ -[b(k)b^+(k) + b^+(k)b(k)]\} + iO(\vec{x}, t) \end{aligned} \quad (33)$$

abandon the virtual item (considered as unphysical terms arising from the virtual process) , and consider $[a, a^+] = 1$, if we introduce $\{b, b^+\} = 1$, then

$$H = \int \tilde{d}k\,\omega_k a^+(k)a(k) \quad (34)$$

divergent term no longer exists. But this does not mean that particle b is real, it is just an equivalent method to deal with the zero point energy.

Incidentally, when we evaluate the one-loop contribution to the electron vertex function in QED:

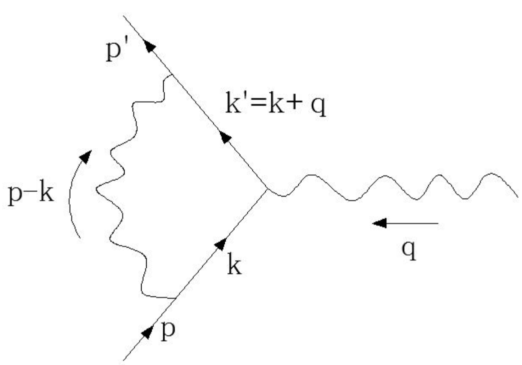

Fig. 1: vertex correction

in order to keep the Feynman integrals finite, we may introduce a fictitious heavy photon through Pauli-Villars regularization:

$$\frac{1}{(k-p)^2 + i\varepsilon} \to \frac{1}{(k-p)^2 + i\varepsilon} - \frac{1}{(k-p)^2 - \Lambda^2 + i\varepsilon} \quad (35)$$

but the physical significance of this practice is not clear, in order to explain the origin of the divergence term, we have to consider the following diagrams: when $R \to \infty$, diagram (a) can be divided into sub-diagrams (b)+(c): and diagram (c) will be cancelled by diagram (d), so we just need to subtract diagram (b), and consider it as the contribution of a superluminal virtual particle (emitted by infinite

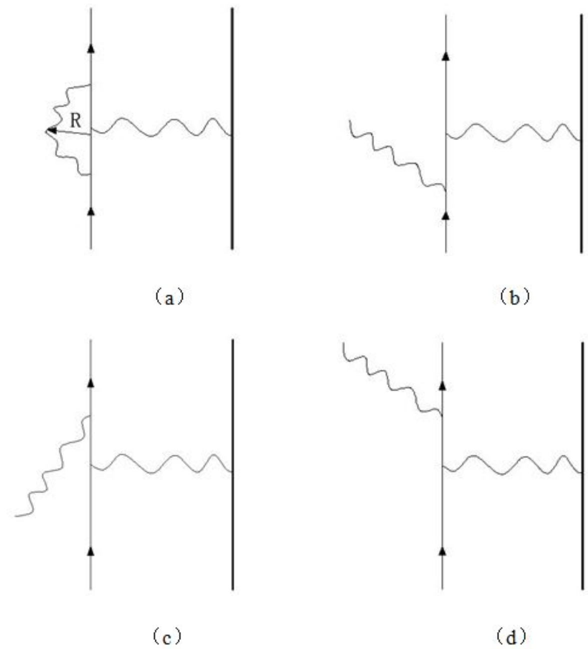

Fig. 2: corrections containing virtual particles

past electron and then absorbed by infinite future electron), we should write:

$$\frac{1}{(p - i\Lambda)^2} \to \frac{1}{p^2 - \Lambda^2 - i2p\Lambda} \to \frac{1}{(p-k)^2 - \Lambda^2 + i\varepsilon} \quad (36)$$

for $k \to 0$, this justified the Pauli-Villars regularization and provide the physical origin of the divergent term. To see this more clearly, consider the second-order Feynman diagram of the electronic self-energy:

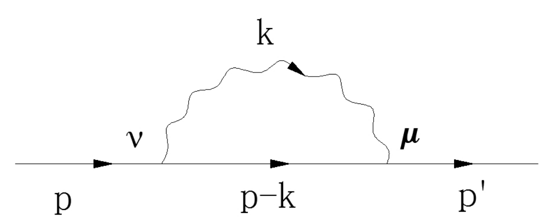

Fig. 3: electron self-energyn

the corresponding S matrix element can be written directly with Feynman rules, and the result is:

$$\langle f|S^{(2)}_{e.m.}|i\rangle = (2\pi)^4\delta^4(p' - p)\bar{u}^{(\alpha')}(p')\Sigma(p)u^{(\alpha)}(p) \quad (37)$$

where

$$\Sigma(p) = (-ie)^2\int \frac{d^4k}{(2\pi)^4}\gamma^\mu \frac{i}{\not{p} - \not{k} - m + i\varepsilon}\gamma^\nu \frac{-ig_{\mu\nu}}{k^2 + i\varepsilon} \quad (38)$$

the Hamiltonian of positronium can be written as:

$$H = H_0 + H_i \tag{39}$$

Where

$$H_0 = \int d^3x(H_{e.m.} + H_{Dirac}) \tag{40}$$

$$H_{e.m.} =: -\frac{1}{2}\dot{A}^{\mu}\dot{A}_{\mu} + \nabla A^{\mu} \cdot \nabla A_{\mu} : \tag{41}$$

$$H_{Dirac} =: \bar{\psi}(-i\vec{\gamma} \cdot \nabla + m)\psi : \tag{42}$$

$$H_i(x) = e : \bar{\psi}(x)\not{A}\psi(x) - \delta m\bar{\psi}(x)\psi(x) : \tag{43}$$

where m is the physical mass of the particle, m_0 is the bare mass, A is the electromagnetic vector, $\delta m = m - m_0$. The first-order transition matrix element produced by the additional term $-\delta m : \bar{\psi}(x)\psi(x) :$ is:

$$\begin{aligned}&\left\langle f|b_{\alpha'}(p')S^{(1)}_{\delta m}b^{+}_{\alpha}(p)|i\right\rangle \\ &= i\delta m(2\pi)^4\delta^4(p'-p)\bar{u}^{(\alpha')}(p')u^{(\alpha)}(p)\end{aligned} \tag{44}$$

compare equation (37) and (44), in order to cancel the infinity in $\Sigma(p)$, we should have$\Sigma(p) \sim i\delta m$, thus, the virtual mass corresponds to the pole of the integral in the one-circle diagram.

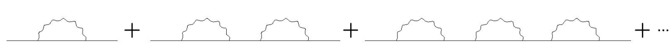

Fig. 4: corrections by absorptions of virtual particles

As an example of the application of virtual particles, here I present an estimate of Lamb movement. Suppose the interaction between the electron and the proton is an elastic collision, and the electron mass is m_e, the proton mass is m_p, initial velocity of the electron is v_e, initial kinetic energy of the electron is E_e, velocity of the electron after collision is v_e', kinetic energy of the electron after collision is E_e' , initial velocity of the proton is 0, velocity of the proton after collision velocity is v_p, kinetic energy of the proton after collision is E_p. According to the conservation law of energy and momentum:

$$v_e' = \frac{1-k}{2}v_p \tag{45}$$

$$E_e' = \frac{(1-k)^2}{4k}E_p \tag{46}$$

where

$$k = \frac{m_p}{m_e} \tag{47}$$

The energy loss of electrons after interaction, that is, the energy transfer efficiency (reflecting the energy change caused by electron emission or absorption of virtual photons) is:

$$\eta = \frac{E_p}{E_e} = \frac{4k}{(1-k)^2+4} \tag{48}$$

Now I equivalent the one-circle graph to the contribution of the virtual photon which is absorbed at one wavelength, the double-circle diagram to the contribution of the virtual photon absorbed at two wavelengths and so on, the contribution of the total energy of each circle is related to the coupling coefficient of the field, which for the electromagnetic field is $\alpha = \frac{\hbar}{m_e c r_0} \approx \frac{1}{137}$.

In Fig.4, the effect on the electron kinetic energy is shown as follow:

$$1 - (\alpha\eta+\alpha^2\eta^2+\alpha^3\eta^3+...) = 1 - \frac{\alpha\eta}{1-\alpha\eta} \approx 1 - \alpha\eta \tag{49}$$

The total 2S orbital energy is corrected to:

$$E_{2S} = -\frac{e^2}{4\pi\varepsilon r}+\mu c^2+\frac{1}{2\mu}(\frac{2h}{2\pi r})^2(1-\alpha\eta) =-\frac{1}{8}\alpha^2\mu c^2(1+\alpha\eta) \tag{50}$$

Same argument:

$$E_{2P} = -\frac{1}{8}\alpha^2\mu c^2(1+\alpha\eta') \tag{51}$$

$$\Delta E = E_{2S} - E_{2P} = \frac{1}{8}\alpha^2\mu c^2\alpha(\eta'-\eta) \tag{52}$$

Since 2P and 2S orbital electron clouds are significantly different, we can actually propose a formula for the energy transfer efficiency and then adopt a numerical integration method to calculate ΔE exactly. For example, we can assume that the energy transfer efficiency is proportional to cloud density, inversely proportional to r, and after a reasonable choice of the integral limit, we can get results similar to the lamb movement. However, in this paper I take a roughly estimation, and consider that the difference between the energy transfer efficiency of 2P orbital and 2S orbital is a higher order correction of α, and is related to the square of the orbital quantum number, i.e.

$$\eta' - \eta = n^2\alpha\eta \tag{53}$$

Substitute the relevant data, I get:

$$\Delta E \approx 0.0382cm^{-1} \tag{54}$$

consistent in order of magnitude with the observed spectral data.

The last consideration is the quantum theory of gravity, I first write out the Einstein-Hilbert action:

$$S = \frac{1}{16\pi G}\int d^4x\sqrt{-g}R \tag{55}$$

and when I write $g_{\mu\nu} = \eta_{\mu\nu}+h_{\mu\nu}$, where $\eta_{\mu\nu}$ denotes the flat Minkowski metric and $h_{\mu\nu}$ the deviation from the flat metric, then the expasion of the action in powers of $h_{\mu\nu}$ should take the schematic form:

$$S' = \frac{1}{16\pi G}\int d^4x(\partial h\partial h + h\partial h\partial h + h^2\partial h\partial h + ...) \tag{56}$$

after dropping total divergences. In order to cancel the various divergent terms, I have to introduce various virtual fields:

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} + i\kappa_{\mu\nu} + i\partial_\mu\varepsilon_\nu + i\partial_\nu\varepsilon_\mu + ... \tag{57}$$

where ε denotes an infinitesimal coordinate transformation, in fact,

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} + i\kappa_{\mu\nu} \tag{58}$$

is enough, consider the self energy correction to the graviton propagator as shown in Fig.4 and Fig.5:

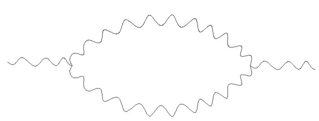

Fig. 5: 1-loop correction

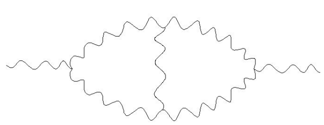

Fig. 6: 2-loop correction

we should write the 1-loop propagator corrections schematically as:

$$\frac{1}{{M_p}^2}\frac{1}{p^2}[\int d^4k\frac{kkkk}{k^2k^2}]\frac{1}{p^2} \tag{59}$$

so the overall tree+1-loop propagator is:

$$\frac{1}{p^2}(1+\frac{1}{{M_p}^2}[\int d^4k\frac{kkkk}{k^2k^2}]\frac{1}{p^2}) \tag{60}$$

so the correction to 1/G is quadratically divergent $\sim k^2$. In order to eliminate the divergent term, I introduce an overall counter term shown in Fig.5:

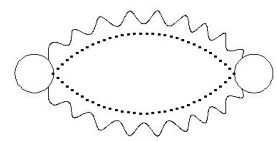

Fig. 7: counter term for loop correction

which is equavalent to offer an overall virtual momentum, so we get: $\sim (k+ik)^2 \sim i2k^2$, and abandon the virtual items, the 1-loop divergent term disappear. Or we can consider it another way, take the tranformation:

$$\partial h\partial h \rightarrow \partial(h_{\mu\nu} + i\kappa_{\mu\nu})\partial(h_{\mu\nu} + i\kappa_{\mu\nu}) \tag{61}$$

and dictate the commutation relations:

$${h_{\mu\nu}}^2 - {\kappa_{\mu\nu}}^2 = 0 \tag{62}$$

$$h_{\mu\nu}\kappa_{\mu\nu} + \kappa_{\mu\nu}h_{\mu\nu} = 0 \tag{63}$$

we can get the same conclution. For 2-loop corrections, 4-vertices contribute $\frac{k^8}{Mp^4}$, 5 internal propagators contribute $\frac{1}{k^{10}}$, two loop integrals contribute $d^4kd^4l \sim k^8$, plus an outside propagtor k^2, the overall contribution of 2-loop correction is $\frac{k^4}{Mp^4}$. One can easily check that by introducing proper anti/commutation relations for $h_{\mu\nu}$and $\kappa_{\mu\nu}$, and just abandon the virtual items, we can get S'=0. That's mean when we eliminate the effects of the vacuum background energy, the total energy of the system is only related to some formal integral of the curvature of the spacetime. From this point of view, it's no surprise to identify gravitation as the bend of spacetime. The method above also applies to the presence of a matter field, we can quantize the field by imposing appropriate anti/commutation rules according to the specific form of the expression, and abandon the virtual items and surface items when evaluating the integration.

V. Conclusions

In this paper I propose for the first time that imposing a spacetime coordinate transformation in the inertial system metric may introduce a virtual potential field, which corresponds to the absorption or generation of matters, thus providing a plausible explanation for the black hole antimatter jet and the imbalance of matter and antimatter in the universe. And I suggest a common approach for the renormalization of various quantum fields. The essence of this approach is that by introducing appropriate virtual potential field (and specify the required anti/commutation relation for the virtual particles), we can manage to eliminate some divergent terms and unecessary constants in the expression of the Hamiltonian. And I obtain some preliminary results on the quantization of the gravitational field.

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