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Cosmology constant and quantum mechanics equation based on the rotational gravitational field

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In this work, the gravitational field is investigated in detailed and the quantum mechanics equation under the gravitational field has been derived. Then, the Schrodinger and Dirac equations are accordantly solved under the gravitational field condition by separating variables. As a result, the Rydberg formula is deduced in such conditions, which proves that the change of the external gravitational field intensity will cause the overall spectral movement. Obviously, the partial redshift of quasar spectrum should assign to this effect. Furthermore, by applying this gravitational field together with the energy and mass concepts into the symmetry, gravity theory and gauge theory, it is deduced that the interaction of "gravity" between matter and anti-matter is repulsive force, which is the originator of the accelerated expansion phenomenon for dark energy in the universe. It is found that the calculated cosmological constant is a small variable related to the radial and angular direction of the universe, and the "spontaneous breaking of vacuum symmetry" is caused by this gravitational field. Further, the gravitational field lead to the non-conservation of weak action parity. The equal number of baryon and antibaryon as well as the energy conservation in the universe are confirmed. In this work, the gravitational field is introduced into quantum theory, which will promote the integrality of the quantum mechanics, and explain the dark energy phenomenon constitutionally. This study will push the astrophysical theory and the gauge theory of particle physics for the further study of energy level, basic particle structure, and quantum gravity theory.

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Cosmology constant and quantum mechanics equation based on the rotational gravitational field

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Key Points:

- The change of the external gravitational field intensity will cause the overall spectral movement
- The interaction of "gravity" between matter and anti-matter is repulsive force
- The equal number of baryon and antibaryon as well as the energy conservation in the universe are confirmed

Abstract

In this work, the gravitational field is investigated in detailed and the quantum mechanics equation under the gravitational field has been derived. Then, the Schrodinger and Dirac equations are accordantly solved under the gravitational field condition by separating variables. As a result, the Rydberg formula is deduced in such conditions, which proves that the change of the external gravitational field intensity will cause the overall spectral movement. Obviously, the partial redshift of quasar spectrum should assign to this effect. Furthermore, by applying this gravitational field together with the energy and mass concepts into the symmetry, gravity theory and gauge theory, it is deduced that the interaction of "gravity" between matter and anti-matter is repulsive force, which is the originator of the accelerated expansion phenomenon for dark energy in the universe. It is found that the calculated cosmological constant is a small variable related to the radial and angular direction of the universe, and the "spontaneous breaking of vacuum symmetry" is caused by this gravitational field. Further, the gravitational field lead to the non-conservation of weak action parity. The equal number of baryon and antibaryon as well as the energy conservation in the universe are confirmed. In this work, the gravitational field is introduced into quantum theory, which will promote the integrality of the quantum mechanics, and explain the dark energy phenomenon constitutionally. This study will push the astrophysical theory and the gauge theory of particle physics for the further study of energy level, basic particle structure, and quantum gravity theory.

1 Introduction

Dark energy phenomena [1-4], dark matter [5,6], neutrino mass, asymmetry of material and antimatter are the known experimental or observable facts, which cannot be explained or does not be included by either the standard particle physics model or the standard cosmic model. As we know, the electromagnetic interaction, the strong interaction, and the weak interaction have been unified as gauge theory interactions. However, it is the hot issue in the past 50 years or even nearly 100 years to explore a simple universal physical principle to unify all kinds of interaction forces. In order to explain the new phenomena such as those originated from the experiments and observations and also those cannot be explained by the above standard models, and as well in order to intergrade gravity theory with quantum theory, it is necessary to quantify the gravitational field. By such an approach, a quantum gravity theory is constructed which could response the completeness of quantum theory. Actually, it has encountered many insurmountable difficulties: 1) The quantum theory is different from the general relativity in the concept of time. For instance, the time corresponded to the instantaneous collapse of the quantum state is absolute whereas it is relative for the time of general relativity. 2) It is much more complicated for the quantal gravitational field than the quantization of electromagnetic field. The metric is a second order tensor, that is, it includes the gravitational information as well as the time and space geometry. This makes the change of gravitational field in space and the evolution of gravitational field with time being ambiguous. Further, it is ambiguous for the motion and evolution of gravitational field after the quantization. The perturbation method of quantization gravity has also been tried, but the problem of gravity non-renormalization is not perfectly solved. Later the attempts were tried to find solutions to gravitational field quantization from different views, such as the non-perturbed method is applied to the circle quantum gravitation (Loop Quantum Gravity) [7,8] of the gravitational quantization, the string theory, and superstring theory [9-16]. Horava-Lifshity theory have been proposed by modifying Einstein general relativity. All these theories formed by either replacing the metric tensor with nonlocal field operators, or considering particles as spatiotemporal nonlocal representations of strings and interactions in high dimensional supersymmetric space-time, or correction theory of Lorentz symmetry breaking at high energy. Therefore, although these theories could find solutions for several problems, most of them are locally questionable or imitative. For examples, the circle quantum gravitation theory has dynamic problems while string theory (superstring theory) has encountered serious difficulties in compacting to the real 4-dimensional space-time, and Horava-Lifshit [17] theory could not response the Lorentz symmetry at low energy. Recently, several quantum effective theories were proposed, such as, the double special relativity (DSR) model [18,19] which was constructed by modifying the energy momentum relationship of the relativistic quantum, the general uncertainty principle (GUP) [20-23] which was derived from the uncertain relationship in quantum mechanics, and the Lorentz symmetry breaking (SME)[24,25] which was based on the standard model extending. These theories have gained some valuable conclusions in the investigation of the high energy phase quantum gravity effect in Planck scale or black hole thermodynamics. Whereas, further research and exploration are significantly needed due to the limitative (or defective) parameters described the quantum gravity effect. There are also investigations on the scattering effects [26-28] and the Higgs push [29,30] of the cosmic inflation originated from the non-minimal coupling term $RH^{+}H$ (H is the Higgs field and R is the standard curvature of space time scalar) between Higgs field and the gravity in the framework of effective field theory. The spin value of the graviton and high-energy phases have been assumed to be 2 in this investigation. A colored Higgs field H_c^i was introduced to the SU(5) grand unity theory (GUT)[31-35] whereas the proton decay is synchronously caused. Consequently, the progress has been made in high energy and black hole processing by fitting the gravity into the standard model of the gauge theory. Nevertheless, the gravitational fields used are all the Einstein gravitational field with the plane wave solution, in which spin value is 2. It is not the ideal candidates for the interaction theory between Higgs and gravitational forth. Here, a complete theory of quantum gravity is still not established until now.

The Higgs mechanism of the gauge theory and its particle physics standard model is to assume that there naturally is a scalar field $\Phi(\chi)$. In the vacuum state of this scalar field, the interaction between the scalar field and the gauge field or the fermion field makes the gauge particles and fermions obtain excess mass. However, this is only a scalar field and the corresponding spontaneous breaking vacuum state assumed at the requirements of gauge theory. In one hand, it is not clear whether such a real scalar field and the required spontaneous breaking vacuum state exist. On the other hand, our understanding of the physical real vacuum is relatively vague. If the gravitational field is quantized and the physical vacuum is described on the basis of such quantum gravitational field, the physical vacuum contained the quantum gravitational field and its vacuum state will be more suitable for the gauge theory. As a result, not only the real physical field of the scalar field required by the gauge theory is determined, but also the physical reality of the real vacuum is correspondingly determined. Therefore, the theoretical vacuum and the real vacuum is equated, and the gravitational field could be introduced into the gauge theory, which will promote to specify the standard model of the particle physics and the gauge theory.

In the section 2 of this manuscript, we have defined the chiral energy, the chiral mass and the chiral gravitational field (the only one assumption in this manuscript), and then the CPT theorem is proved to be held in this gravitational field. After that, in the section 3, the 1/2 spinor gravity field is naturally introduced under the concept of chiral gravity field. After fully understanding the different expressions of microgravity field and macrogravity field and the original establishment of quantum mechanics, the quantum mechanics equation under the condition of gravitational field is established through Poisson's equation. The energy solution of this equation is the Rydberg formula under the condition of gravitational field. Moreover, the overall shift effect of the atomic characteristic spectrum can be derived. It is proposed the dense matter will appear if the external gravitational field tends to infinity but the mass matter is unstable and tends to decompose when the gravitational field become infinitesimal. In section 4, the repulsive gravitational interaction between positive and negative mass matter is established. Next, the scalar field of the gauge theory is namely identified as the scalar of the spinor gravitational field via the mass generation of the Higgs mechanism. Hence, there existed the transverse energy and the longitudinal gravitational field conditions for the generation of the mass. Because the different contributions from both the positive-anti particle spin in the term coupled the scalar field in Lagrange quantity with the fermion field and the different positive and negative masses, the positive and antiparticles will present the various lifetimes. It makes a positive matter stable and anti-matter unstable in the right-handed gravitational field. And the stronger the field strength, the greater the difference of the positive particle and anti-particle in the Lagrange quantity value. That is, the right-handed gravitational field is a positive matter stable field and the unstable field of the antimatter. Combining the CPT theorem with the limit case of the Rydberg formula in the gravitational field condition, it derives a conclusion that a microscopic chiral symmetric particle world is existed and also a macroscopic chiral-symmetric universe. The universe consists of the positive and antimatter sky, in which the positive and antimatter cannot mix together to form the universe. Based on this derivation, the cosmological constant is calculated under the positive matter sky and antimatter sky model, which is a quasi-constant associated with the cosmological radial and angular direction.

The cosmic model presented in this manuscript is obtained naturally based on the theory of particle physics and is an extension of the Standard Universe Model (Λ CDM), which is different from the Dirac-Milne universe [36]. The Λ solved in this manuscript is also simple in principle, and it will be better if it derived from the observations and n-body simulations [37-40] (our observations are limited to the positive sky, but the long-range effect of the anti-sky is still valid). However, the redshift caused by the change of matter structure in the gravitational field will have a big impact on cosmic observations and cosmic theory.

Nowadays, it is still inharmonic for the physics gauge theory and gravity field theory. Therefore, it is good choice for us to distinguish the representation and function of the microscopic gravitational field from the macroscopic classical gravitational field. Moreover, the microscopic gravitational field, the quantum mechanics, and the quantum field theory will be combined. It is truth that this combination of a series of interrelated conclusion can be identified by experiment, such as the spectral redshift and the existence of the dense matter (The white dwarf and the neutron star) have actually proved this theory.

2 Definition of chiral energy, mass and gravitational field， and the field quantization and the certification for CPT's Theorem

2.1 Definition of right-hand energy and left-hand energy

The propagation behavior of electromagnetic wave in medium is determined by the permittivity ε and permeability μ of medium. The relationship between wave vector K and electromagnetic vector E, and H can be deduced by Maxwell's equations:

$$K \times E = \omega \mu_0 \mu_r H \qquad (2.1)$$

$K \times H = -\omega\varepsilon_0\varepsilon_r E$ （2.2）

Where, w is the angular frequency, μ_r is the dielectric permeability, ε_μ is the dielectric permittivity. By equations (2.1) and (2.2), the following equations are obtained:

$K^2 = \left(\frac{\omega}{c}\right)^2 n^2$ （2.3）

Where the refractive index of medium $n^2 = \varepsilon_r\mu_r$. Then，

$K=\pm\frac{\omega}{c}n$ （2.4）

i) When ε> 0 and μ > 0，n is large than 0 and $K_R=\frac{\omega}{c}n$. In addition, E，H，K satisfy the right-hand relationship. The energy is thus defined as the right-hand energy ϵ_R or the nominal positive energy $\epsilon_R = \epsilon$.

ii) When ε< 0 and μ< 0, n is large than 0 and $K_L = -\frac{\omega}{c}n$ (negative value). In addition, E, H, K satisfy the left-hand relationship. Meanwhile, the direction of light propagation (e.g., direction of the K and it is also the phase velocity direction) is opposite to the energy propagation direction (S direction of the Poynting vector). The energy is thus defined as the left-hand energy ϵ_L or the negative energy: $\epsilon_L = -\epsilon,\ K_R = -K_L$.

2.2 Definition of chiral mass and chiral gravity field

Under the location-time four vectors x^μ（μ=0,1,2,3）：$x^0 = ct，x' = x，x^2 = y，x^3 = z$, the energy-momentum four-vectors is $P^\mu = （\frac{E}{c}，P_x，P_y，P_z）$.

According to the above definition of chiral energy and 4-momentum, the chiral mass and the chiral gravitational field are defined as the right-handed energy E_R (in order to distinguish the electric field vector energy E, the energy in section (2.1) is written as ϵ, and here E is also used to present the energy) and left-hand energy E_L. Then, $P_R^0 = \frac{E_R}{c} = \frac{E}{c}，P_L^0 = \frac{E_L}{c} = \frac{-E}{c}$. Accordingly, the right-hand mass (intrinsic property) is defined as m_R=m, that is, the mass of normal matter while the left-handed mass is defined as mL=-m, a antimatter mass. Furthermore, the corresponding gravitational potentials (take the single particle Newton potential as an example to illustrate the two kinds of the gravitational potentials) are defined as:

$$\varphi_R = -\frac{Km_R}{\gamma} = -\frac{Km}{\gamma}$$

$$\varphi_L = -\frac{Km_L}{\gamma} = \frac{Km}{\gamma}$$

The gravitational potential carried by the right-handed mass is right-handed whereas the left-handed mass is the left-handed gravitational potential.

2.3 CPT theorem under chiral energy and mass [41]

The CPT invariant representation of various spin fields is written by quantizing each quantity field under the definition of left-handed energy, right-handed energy, and chiral 4-momentum. Then, the CPT theorem $\oint \mathcal{L}(x)\oint^{-1} = \mathcal{L}^+(-x)$（$\oint$ = CPT）has been derived, and the detail is listed in Appendix 1. Thus, the following conclusions could be followed with the CPT theorem：

1) The existence of right-handed energy E_R and the chiral symmetrical left-handed energy E_L. It is set E_R=E during the calculation which is known as the positive energy while E_L=-E known as the negative energy.

2) There is right-handed mass matter (also called positive matter m_R=m) and left-handed mass matter (also called antimatter m_L=-m). This mass chirality is the intrinsic property of matter and does not change due to the selection of reference system.

3) The mass matter carries the gravitational field and the mass matter exhibits chiral symmetry. Then, the gravitational field accordingly presents chiral symmetry. That is, the positive matter carries a right-handed gravitational field and antimatter carries a left-handed gravitational field.

4) There is a microscopic world of chiral symmetric particles, and also there is a macroscopic chiral symmetry universe. Such universe consists of the positive matter sky and the antimatter sky (the matter and antimatter in the universe form their own positive and antimatter sky, respectively. But it cannot be a mixture of matter and anti-matter to form the universe which will be discussed in the Appendix 4 particle physics parts). In a physical vacuum in the sky of positive matter, it is $\varepsilon_0 > 0$， $\mu_0 > 0$. While, in a vacuum for an antimatter sky, it is $\varepsilon_0 < 0$， $\mu_0 < 0$. It means there are two gravitational field vacuums in the universe. The defined "positive sky" is actually what people now call the universe. In fact, the cosmic model in this manuscript doubles the original universe (a pair of positive and anti-sky).

3 Establishment of the quantum mechanics equation under gravitational field and its physical meaning

3.1 Establishment of the quantum mechanics equation under gravity field

Today, the superstring theory (or not yet the so-called M theory) is the hottest research by quantizing the gravity field or combining the gauge theory with the gravity theory. It is a more complicated mathematical process by introducing boundary conditions under the light cone specification, or repeating the classical string theory, gravity theory and quantum theory in string length (10^{-30} cm) regions. Whether or not is it correct (because we still cannot verify the authenticity of the string theory under Planck energy), it is truth that it can only study gravity in Planck length (10^{-33} cm) and explore the universe in Planck time (10^{-44} sec). For relatively low-energy quantum mechanics or quantum field theory, we are hardly able to consider the effects of gravity.

The expression and action of gravitational field in microscopic gauge theory and macroscopic gravity theory should be different, which is also a manifestation of the inconsistency of microscopic and macroscopic theories. The Eeinstain equation of the macroscopic gravitational field is suitable for the large-scale physics. For microscopic gravitational fields, we need to seek out from Schrodinger and the initial quantum mechanics of Dirac.

According to the definition of section 2, the natural introduction of spin 1/2 of the microscopic gravitational field, leads to its quantization, microscopic gravitational field quantum state, microscopic equation of motion, Lagrangian Hamiltonian are all 1/ 2 field.

The gravity is very weak than the other three interactions, so the quantum mechanics that describes the interaction of microscopic particles does not consider the gravitational field at all. However, the physical behavior is all occurred in the gravitational field, which forces us to consider the influence of the gravitational field. Thus, a complete quantum mechanical system has to include gravity in it.

Here, on the basis of fully understanding the concept of primitive quantization, the quantization mechanics equation under gravitational field is obtained by using the classical 3D gravitational field Poisson equation.

First of all, it is clear that the following properties of the gravitational field are included: a) The gravitational field is a form of energy (the other form of energy is electromagnetic wave), a spin field, and a helical field of spin 1/2, with a component of 1/2 or -1/2. b) As a form of energy existence, the gravitational field can exchange energy momentum directly with mass matter, which does not require the intermediate particles. Unlike the electromagnetic energy transfer, gravitational fields do not need to be exchanged with gravitons in the concept of gravitational waves (radiation). For example, neutrinos produced in particle decay are the direct exchange of energy momentum and angular momentum between mass matter and gravitational field. That is to say, the energy and momentum transfer between the gravitational field and the mass matter is not carried out in the form of radiation, but by the gravitational field itself, which is a function of the gravitational field and different from the electromagnetic field. It is also the most essential difference between the present quantization of gravitational field and the previous quantized gravitational field. c) All the executable physical experiments and observations are going in the gravitational field of the positive sky space, and the vacuum state is the lowest energy state of the gravitational field.

The second quantization of spin 1/2 field is listed detailed in section 3 of Appendix 1. Here only the quantization process is simply written. The description of 0 mass spin 1/2 field can be described by a single spin ψ, which satisfies the Dirac equation:

$$(\hat{p}_0+\hat{p}\cdot\sigma)\,\psi=0 \qquad (1)$$

where $\hat{p}_\mu = i\partial\mu$ is a four-momentum operator, σ is a Pauli matrix. Between the energy and momentum of the zero mass fields, it is

$E=|p|$ (here, the light velocity is C=1)， For plane waves $\psi_p = \frac{1}{\sqrt{2\varepsilon}}U_p e^{-ipx}$ and $\psi_{-p} = \frac{1}{\sqrt{2\varepsilon}}U_{-p} e^{ipx}$

By equation (1) $(n\cdot\sigma)\psi_p = -\psi_p$ （2）

$n = \frac{p}{|p|}$ is the unit vector of vector P. For the negative energy of the waves, it has

$$(n\cdot\sigma)\psi_{-p} = -\psi_{-p} \qquad (3)$$

Quadratic quantization for the gravitational field:

$$\psi=\sum_p(\psi_p\hat{a}_p+\psi_{-p}b_p^+) = \frac{1}{\sqrt{2\varepsilon}}\sum_p \hat{a}_p U_p e^{-ipx} + \hat{b}_p^+ U_{-p} e^{ipx}),$$

$$\psi^*=\sum_p(\psi_p^* a_p^+ + \psi_{-p}^*\hat{b}_p) = \frac{1}{\sqrt{2\varepsilon}}\sum_p \hat{a}_p^+ U_p^* e^{ipx} + \hat{b}_p U_{-p}^* e^{-ipx})$$

Here $\frac{1}{2}(n\cdot\sigma)$ is the projection operator of the spin in the direction of motion. By the equation (2) and (3), the state of a " particle " with a certain momentum is necessarily helical.

Based on the above concepts of gravitational field properties and quantization, a classical three-dimensional gravitational field Poisson equation ($\Delta\varphi=4\pi G\rho$) is used to establish a quantization mechanics equation under the gravitational field. As it is known, the classical Poisson equation is about mass flux. In view of microcosmic quantum mechanics, the unit volume mass substance (ρ) converted into energy substance ($E=mc^2$) can be divided into two parts: one is in the form of transverse polarization energy of the electromagnetic radiation, and the other part is the existence of energy in the form of longitudinal polarization gravitational field (the Higgs mechanism in the following sections will show the existence of energy during analyzing the formation of mass). Or in other words, the quantum form of mass matter per unit volume is composed of two parts: one is corresponding to the transverse polarization energy part and the other is the longitudinal polarization energy. The quantum understanding of a classical Φ gravitational potential is a scalar quantity of the spinning gravitational field where the quantum form is ($\bar{\psi}\psi$), $\varphi \sim \bar{\psi}\psi$, that is the gravitational potential varies according to the the scalar of the spinning gravitational field. It can be defined as:

$$\varphi = k\bar{\psi}\psi \quad (4)$$

Here κ is the quantity associated with the strength of the macroscopic gravitational field and can be considered as C constant in the equation.

Mass density per unit volume：

$$\rho = \frac{E}{C^2} \quad (5)$$

The energy E in quantum mechanics can be replaced by $E \to i\hbar \frac{\partial}{\partial t}$.

The quantum substitutions of equation (4), (5) and energy E were placed into the classical Poisson equation. Meanwhile, the longitudinal polarization energy part is added into the equation. The longitudinal energy is expressed as $\gamma \cdot \hat{p}$ with the zero mass Dirac field (space 3D). The corresponding Dirac matrix is introduced and applied to the wave function to obtain the equation:

$$(\gamma^0 \Delta k\bar{\psi}\psi + k\gamma \cdot \hat{p})\psi(r,t,\sigma) = \frac{4\pi G}{C^2} i\hbar\gamma^0 \frac{\partial}{\partial t}\psi(r,t,\sigma)$$

Or represented as:

$$\mathrm{k}(\gamma^0 \nabla^2 \bar{\psi}\psi + \gamma \cdot \hat{p})\ \psi(r,t,\sigma) = \frac{4\pi G}{C^2} i\hbar\gamma^0 \frac{\partial}{\partial t}\psi(r,t,\sigma)$$

An infinite small volume element is taken, and in which the scalar of the curl field $\bar{\psi}\psi$ can be regarded as a constant. Moreover, only the wave function ψ(r,t,σ) changes with the quadratic derivative. Compared with the Schrodinger equation of the fundamental wave equation of quantum mechanics, the "normalized" transverse energy is partially obtained as $\bar{\psi}\psi = -\frac{\hbar^2}{2m}$, and finally a quantization mechanics equation under the quantization gravitational field is obtained as following:

$$\mathrm{k}(-\frac{\hbar^2}{2m}\gamma^0 \nabla^2 + \gamma \cdot \hat{p})\psi(r,t,\sigma) = \frac{4\pi G}{C^2} i\hbar\gamma^0 \frac{\partial}{\partial t}\psi(r,t,\sigma) \quad (6)$$

Several conclusions are derived by analyzing the physical meaning of equation (6):

1) when all unit mass matter is converted into the transverse energy without forming longitudinal gravitational field energy, or when the unit mass matter exists in the form of the mass matter particles and the transverse energy, but not the longitudinal energy, there is no rotation field in equation (6). In this case, the equation（6）becomes the Schrodinger of the free particles in the context of gravitational field: $(-\frac{\mathrm{k}\hbar^2}{2m}\nabla^2)\psi(\mathrm{r},t) = \frac{4\pi G}{C^2} i\hbar \frac{\partial}{\partial t}\psi(r,t)$

Clearer after adjusting:

$$\frac{\mathrm{kC}^2}{4\pi G}(-\frac{\hbar^2}{2m}\nabla^2)\psi(\mathrm{r},t) = i\hbar\frac{\partial}{\partial t}\psi(r,t) \qquad (7)$$

Let $C_M = \frac{kC^2}{4\pi G}$, now, the equation (3.7) is transformed into:

$$\mathrm{C}_M(-\frac{\hbar^2}{2m}\nabla^2)\psi(r,t) = i\hbar\frac{\partial}{\partial t}\psi(r,t) \qquad (8)$$

General form of the Schrodinger equation:

$$i\hbar\frac{\partial}{\partial t}\psi(\mathrm{r},t) = H'\psi \qquad (9)$$

$$H' = C_M H = C_M(-\frac{\hbar^2}{2m}\nabla^2)$$

The coefficient κ is a constant variable related to the strength of the macroscopic gravitational field, and the corresponding C_M is also a quantity related to the strength of the gravitational field. Therefore, it is dominated as the quantum conditional coefficient of the gravitational field. The stronger the gravitational field is, the smaller the κ and C_M are. Therefore, the different quantum mechanical equations possess the different gravitational field strengths and the earth region is the quantum conditional region of $C_M = \frac{kC^2}{4\pi G} = 1$.

2) The equation (6) will become the equation of 0 mass field Dirac equation when the unit mass is completely converted to the longitudinal gravitational field energy and there is no transverse electromagnetic field energy.

$$\mathrm{k}\gamma\cdot\hat{\mathrm{p}}\psi(\mathrm{r},t,\sigma) = \frac{4\pi G}{C^2}i\hbar\gamma^0\frac{\partial}{\partial t}\psi(r,t,\sigma) \qquad (10)$$

Equation (2.10) is the 0-mass spin field Dirac equation under the gravitational field conditions. This equation could be deformed as follows:

$$\mathrm{C}_M\gamma\cdot\hat{\mathrm{p}}\psi(r,t,\sigma) = i\hbar\gamma^0\frac{\partial}{\partial t}\psi(r,t,\sigma)$$

Or a similar form of Schrodinger equation:

$$i\hbar\frac{\partial}{\partial t}\psi = H'\psi \qquad (11)$$

Here, the Hamiltonian is:

$$H' = C_M H = C_M\gamma\cdot p = C_M(-i\hbar\gamma\cdot\nabla),\ \hat{p} = -i\hbar\nabla$$

Actually, the Schrodinger equation and the Dirac equation can be obtained by separating the variables from equation (6) under the condition of gravitational field.

3) the quantum of the microcosmic gravitational field satisfies the longitudinal energy polarization condition. Here, the neutrino is regarded as the quantum of the gravitational field, and three kinds of neutrinos have been discovered so far.

The gravitational field quantum defined in this work is the Neutrinos. There are three kind of the Neutrinos which are all classified into energy levels of a 0-mass particles. It contradicts with the neutrino mass required in the Neutrino oscillation theory, in which the Neutrinos are not equal and cannot be all zero mass. But it does not contradict with the oscillation phenomenon itself. The reason is that the Neutrino mass in the weak electric unified standard model of SU(2) × U(1) is strictly equal to zero. Whereas, the right-handed Neutrino component of the SU(2) singlet state and the coupling of the Yukawa are introduced to form the Dirac mass term in the extended standard model. Then, Neutrinos is sure to have the theoretical mass. In addition, in the mixing theory of Neutrino quantum mechanics, the Dirac mass shall be of the same order as the other lepton e, μ, τ mass. But the Neutrino mass is very small, and the "seesaw mechanism" was introduced to give a small mass to the Neutrinos. It shows that the Neutrino theory is debatable. Furthermore, the cosmological observations of the Neutrino mass are $m_e + m_\mu + m_\tau < 0.28$ eV (2010 year). Generally, the mass of Neutrino is not exceeding 1 eV and its controversial mass is indeed very small. As it is reported the mass of Neutrino is zero or very small in several theories. Finally, if we confirm the Neutrino to be a gravitational field quantum, then it is certain to be affected by the gravitational field during the transmission process. Consequently, the specially change appears, that is, Neutrino oscillation, which is the nature of the gravitational field, to be further studied. Based on the above discussions, there is no specific explanation between the 0-mass definition in the gravity field quantum and the neutrino oscillation theory.

3.2 The solution of the quantization mechanics equation under the gravitation field and its physical significance

Energy solutions of the Schrodinger and Dirac equations in the gravitational field background and the energy solutions of hydrogen atoms are described in detail in Appendix 2. As an example, the hydrogen atoms are discussed concretely below.

The energy level difference of hydrogen atoms is: $\Delta E = C_M\left[\frac{\mu e^4}{2\hbar^2}\left(\frac{1}{m^2}-\frac{1}{n^2}\right)\right]$ （12）

Take the wave number as: $\bar{\nu} = C_M R\left(\frac{1}{m^2}-\frac{1}{n^2}\right)$ （13）

Where $R = \frac{2\pi^2\mu e^4}{h^3 c}$ is the constant of Rydberg.

In the Earth's quantum condition region, the C_M=1， and the formula (13) becomes Rydberg formul $\bar{\nu} = R\left(\frac{1}{m^2}-\frac{1}{n^2}\right)$.

In terms of the spectral formula (13), when C_M takes different values, that is, the differently external gravitational field strength, the overall shifts of the hydrogen characteristic spectrum occur. Unlike the energy level splitting of the Stark effect in the external electric field and the Zeeman effect in the external magnetic field, the atomic characteristic spectrum in the external gravitational field has the overall shift effects with the various strength of the gravitational field, such as the quasar spectral redshift. The results here is the greater the field strength changes, the greater the spectral moves.

Using the data and conclusions in the literature [42], the formula (13) can be solved: firstly, defining $C_M = \frac{1}{Z+1}$， for instance, for QSO Q1442+231 the red shift of the emission line α in the Lyman spectrum is Z=3.625. At this point, C_M=0.2162, then the solution of (13) is $\bar{\nu}$=1/5622 Å, that is, λ=5622 Å.

On the one hand, it shows that the quantization mechanics equation under the gravitational field is suitable for different gravitational field under the strong backgrounds. The energy solution of the spectral formula is the observed wavelength (the intrinsic wavelength of the hydrogen Lyman α spectrum or the Earth zone wavelength that is 1216 Å). On the other hand, it is confirmed that the external strong gravitational field changes the atomic structure, making the electron "orbital" energy reduce, the energy level difference decrease, and the spectral shift to red, which explains the spectral red shift from the perspective of the matter structure.

The number of quasars reaches a peak when the redshift value Z=0.3, 0.6, 0.96, 1.41, 1.96, corresponding to the peak value of the quasars when C_M value is 0.77, 0.63, 0.51, 0.41, 0.33. That is, a more stable quantum conditional region is formed when the difference of C_M value is about 0.1. It indicates that the gravitational field condition is quantized and discontinuous. Although there is only one set of data, it can be concluded that there are several stable quantum conditional regions in the universe（A large amount of astronomical observation data should be able to determine the stable quantum conditions. The Doppler redshift is the rest of the redshift that excludes theC_M effect ones in the large redshift of the quasar spectrum）. The quantum mechanics in Earth region (C_M= 1) is the quantum mechanics that we have not considered the background conditions of the gravitational field in the past hundred years, or that it does not walk out of the Earth. The detailed data and analysis of the quasar spectral redshift are listed in our previous investigation [42].

According to the formula (12), when $C_M \to 0$, the strength of the gravitational field tends to infinity. At this point, $\Delta E \to 0$, and the energy difference of “atomic orbit” is zero. The density of matter is enormous and then to form the dense material that does not interact with the electromagnetic fields. This dense matter is so called dark matter. Therefore, in terms of the material structure, the dark matter is a very dense ordinary matter. As the C_M changes from 0 to 1, there are atoms with different structures, and the material structures varies with the different densities. From the spectral red shift of the atomic structure, the atomic structure of the white dwarf or neutron star is gradually formed. If $C_M > 1$, the spectral blue shift. When $C_M \to \infty$ and $\Delta E \to \infty$, the energy levels tend to be infinite. Consistently, the atomic structure is instable and it is disintegrated. When $C_M \to \infty$ and the strength of the gravitational field tends to zero, the material is instable. It indicates in view of the energy solution quantization mechanics equation that the gravitational field is a condition for the existence of the mass matter and it is an indispensable condition. There is no the mass material if without the external gravitational field.

Based on the above discussion, it infers Einstein's equivalence principle is not suitable for the material structure or the quantum mechanics. Since the effect of the gravitational mass m_g on the material structure in the field is not available for the inertial mass m_i, it is difficult to combine the general relativity under space-time background with the quantum mechanics related to space-time background. Therefore, the quantum of the gravitational field in this investigation does not adopt the metric field, and the superposition principle is applied to the vacuum gravitational potential.

4 The application of the chiral and quantum gravitational fields

4.1 The application in gravitation theory

4.1.1 The interactions between mass matter derived by Newton's law

Taking the Newtonian potential of single particle as an example to show the gravity interaction between the mass matter and anti-mass matter.

Newtonian potential: $\varphi_\alpha = -\frac{Km_\alpha}{\gamma}$ （$\alpha = \begin{cases} R & right-hand\ mass \\ L & left-hand\ mass \end{cases}$）

Force F that acts on another particle m_β in the m_α field is::

$$F = -m_\beta \frac{\partial\varphi}{\partial\gamma} = -\frac{Km_\alpha m_\beta}{\gamma^2}$$

If $\alpha = \beta$, （$\beta = \begin{cases} R \\ L \end{cases}$）（$m_R = m, m_L = -m$）

$$F = -m_\beta \frac{\partial \varphi}{\partial \gamma} = -\frac{k m_\alpha m_\beta}{\gamma^2} = \begin{cases} -\dfrac{kmm}{\gamma^2}\left(m_\alpha = m_\beta = m_R = m\right) \\ -\dfrac{k(-m)(-m)}{\gamma^2} = -\dfrac{kmm}{\gamma^2}\left(m_\alpha = m_\beta = m_L = -m\right) \end{cases} \quad F < 0,$$

that is, the "gravity" between matter and matter, or antimatter and antimatter is mutually attractive, a gravity force.

If $\alpha \neq \beta$,

$$F = -\frac{k m_\alpha m_\beta}{\gamma^2} = \begin{cases} -\dfrac{km(-m)}{\gamma^2} = \dfrac{kmm}{\gamma^2}\begin{pmatrix} m_\alpha = m_R = m \\ m_\beta = m_L = -m \end{pmatrix} \\ -\dfrac{k(-m)(m)}{\gamma^2} = \dfrac{kmm}{\gamma^2}\begin{pmatrix} m_\alpha = m_L = -m \\ m_\beta = m_R = m \end{pmatrix} \end{cases}$$

$F > 0$, the "gravity" between matter and antimatter is mutually exclusive, a repulsion force.

4.1.2 The interaction between mass materials in view of the symmetry

The gravitation between the normal matters is mutually attractive, that is, it is mutually attractive between the right-handed mass or the gravitational fields. In view of the symmetry, the gravity between the two left-handed gravitational fields should also be mutually attractive. It is namely mutually attractive between the antimatters. Then, it had to be mutually exclusive between the right-hand and the left-hand gravitational field. That is, the "gravity" between matter and antimatter is the repulsion as well.

Summarily, by deriving and analyzing of the parts 4.1.1 and 4.1.2, it can be proved that the "gravity" between the matter and antimatter is mutually exclusive. As expected, the repulsion of the antimatter to the matter causes the accelerated expansion of cosmic galaxies, which is the real originating of the dark energy phenomenon.

4.1.3 Einstein cosmological constant derived by the "gravitation" repulsion between the matter and anti-matter

According to CPT theory, there exists a positive-antimatter sky in the universe. It is the cooperation between the repulsion action of the anti-sky to the positive sky galaxies and the gravity effect of the positive sky on its internal galaxies that can accelerate the expansion of galaxies in the positive sky in the universe, manifested as a dark energy phenomenon.

Under the cosmological assumption, the positive sky (M) and the anti-sky (-M) are applied to the physical laws of FRW (Friedmann-Robertson-Walker), respectively. However, the geometry influence cannot be clearly determined due to the large scale, the selection of coordinates and direction of action. Moreover, the positive sky metric tensor under anti-sky action cannot be determined. Therefore, the 4-dimensional space-time tensor equation cannot be applied to the connection between the positive sky and the anti-sky. On one hand, this paper focuses on clarifying the physical principle and does not pay special attention to the calculative details. On the other hand, in considering the role of the mass center in the anti-sky on galaxies in the positive sky, it can be regarded as the role of the Newtonian potential at t moments in a very large-scale space. It is applicable the positive sky evolution under the FRW metric at 1-dimensional time and 3-dimensional Euclidean space with the same time horizon. The detailed calculation can be seen in Appendix 3 and here the evolution equation of the positive sky under the anti-sky directly describes as:

$$\ddot{a} = \frac{4\pi G}{3}\left(\rho + \frac{3P}{c^2}\right)a + \frac{GM}{a^2(4+\gamma^2-4\gamma cos\theta)}(\hat{e}_{-}) \qquad (13)$$

$$a\ddot{a} + 2\dot{a}^2 = 4\pi G\left(\rho - \frac{P}{c^2}\right)a^2 - 2kc^2 + \frac{3GM}{a^2(4+\gamma^2-4\gamma cos\theta)}(\hat{e}_{-}) \qquad (14)$$

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8}{3}\pi G\rho + \frac{GM}{a^3(4+\gamma^2-4\gamma cos\theta)}(\hat{e}_{-}) - \frac{kc^2}{a^2} \qquad (15)$$

$$\frac{d\rho}{d\tau} + 3\left(\frac{\dot{a}}{a}\right)\left(\rho + \frac{P}{c^2}\right) = 0 \qquad (16)$$

The cosmological constant $\Lambda = \frac{3GM}{a^3c^2(4+\gamma^2-4\gamma cos\theta)} = \frac{3GM}{a^3c^2}\frac{1}{4sin^2\theta+(\gamma-2cos\theta)^2}$ （17）

Here，M is the total mass in anti-sky, and it is a definite and invariant value when acts on m.

m: the mass of galaxy in the positive sky.

θ：It is the approximation clip angle between the anti-sky center of mass action on the positive sky galaxy m and the positive sky center of mass action on the m. It is also the spherical coordinate θ angle, θϵ[0,2π].

$\hat{e}_{-}$: The direction of the anti-sky on galaxy m and it cannot be determined. It is only showed the difference from the metric.

a: It is the radius of the positive sky, which is also a radius in anti-sky.

G: The Newton's gravitational constant.

P: The fluid pressure in the positive sky.

ρ: The energy density of the positive sky.

K: The curvature of the three-dimensional cosmic space.

γa: Total motion distance from m to the center of mass in the positive sky. γ is the proportional constant, $0 < \gamma < 1$.

Any two combination of the equation (13), (14), (15), (16) can be called as the Lemaitre equation under the antimatter sky. It is the instantaneous Newtonian potential introduced the anti-sky at a very large scale which is obtained by Lemaitre's Λ equation. Here, the cosmic constant $\Lambda = \frac{3GM}{a^3c^2}\frac{1}{4sin^2\theta+(\gamma-2cos\theta)^2}$，and Λ is a positive value.

At the fixed moment with a constant a, the value of Λ is only related to the common coordinate γ and the direction angle of the galaxy. When θ takes a fixed value (certain spatial orientation), Δγ change of γ has little influence on the change of Λ value. When γ takes fixed value (certain spatial radius), the Δθ change of θ also has very small influence on Λ. That is, the radial and angular changes have a small impact on the Λ value, manifested as "quasi-constant". It is physically manifested as constant negative energy acting on the cosmic positive sky galaxies. However, the radial and angular variations of the Λ make the cosmic space inhomogeneous, producing a small anisotropy.

Considering the cosmological evolution of the cosmic age greater than the moment T_0 (the entry of the non-relativistic time), e.g., $T>T_0$, the equations (13) and (16) are approximately written as:

$$\ddot{a} = -\frac{4\pi G}{3}(\rho a) + \frac{GM}{a^2(4+\gamma^2-4\gamma cos\theta)}(\hat{e}_{-}) \qquad (18)$$

$$\dot{\rho} = -3\left(\frac{\dot{a}}{a}\right)\rho \qquad (19)$$

The Solution of the equation (19) is $\rho = \frac{\rho_0}{a^3}$，and ρ_0 is the density of $a = 1$. Then substitute $\rho = \frac{\rho_0}{a^3}$ into the equation（18）

It is：$\ddot{a} = -\frac{4\pi G}{3a^2}\rho_0 + \frac{GM}{a^2(4+\gamma^2-4\gamma cos\theta)}(\hat{e}_{-})$ （20）

Let $\ddot{a} = 0$, we obtained $4 + \gamma^2 - 4\gamma cos\theta = \frac{3M}{4\pi\rho_0}$(the fixed value)（21）

That is, when the co-dynamic coordinates γ and θ satisfy the equation (21), the FRW sky transforms from the deceleration expansion to the accelerated expansion. Equation (21) is the transformation point of the FRW accelerated expansion, which is not only radial but also angular. Also, the solution can be get $\cos\theta = \frac{1}{\gamma}\left(1 - \frac{3M}{16\pi\rho}\right) + \frac{\gamma}{4}$.

Therefore, the following conclusions can be inferred for the positive sky FRW cosmology under the anti-sky (-FRW) repulsion:

1） The physical reason for the accelerated expansion of the universe is due to the chiral symmetry positive and anti-sky. It is the repulsion of the anti-sky that accelerates the expansion of galaxies of the positive sky, manifested as a dark energy phenomenon. The change in the Λ value caused the inflation disturbance is only originated form the term of（$\frac{1}{4sin^2\theta+(\gamma-2cos\theta)^2}$）, which is small in radial, angular changes and appears as constant.

2) A specific critical radius of cosmic accelerated or deceleration expansion is no longer existed. There are different acceleration or deceleration expansion turning points at different points in space. The universe is non-spherically symmetric with the small spatial anisotropy.

3) When t → ∞， then $a \to \infty$， thus ρ → 0.The equation (15) then transformed to

$$\dot{a}^2 = \frac{GM}{a(4+\gamma^2-4\gamma cos\theta)}\widehat{e_-} - Kc^2$$

When K=0， $a^{\frac{3}{2}}(t) = \frac{3}{2}\left(\frac{GM}{a(4+\gamma^2-4\gamma cos\theta)}\right)^{\frac{1}{2}} t + \text{constant}$

When K=1， $a^{\frac{3}{2}}(t) = \frac{3}{2}\left(\frac{GM}{a(4+\gamma^2-4\gamma cos\theta)} - c^2\right)^{\frac{1}{2}} t + \text{constant}$

When K=-1， $a^{\frac{3}{2}}(t) = \frac{3}{2}\left(\frac{GM}{a(4+\gamma^2-4\gamma cos\theta)} + c^2\right)^{\frac{1}{2}} t + \text{constant}$

Whether FRW positive sky is flat, open, or closed, the radius$a$varies is substantially same with the time t.

4) The total kinetic energy of the positive sky (FRW) in the universe.

$\mathrm{E} = \frac{1}{2}M\dot{a}^2 = \frac{4M\pi G\rho_0}{3a} + \frac{GM^2}{2a(4+\gamma^2-4\gamma cos\theta)} - \frac{1}{2}\mathrm{MK}c^2$

The total kinetic energy of the FRW space with the antimatter sky model equation is one more than that of the Friedmann total kinetic energy, $\frac{GM^2}{2a(4+\gamma^2-4\gamma cos\theta)}$， which enables the FRW space to accelerated expansion if it matches with $\cos\theta > \frac{1}{\gamma}\left(1 - \frac{1}{16\pi\rho_0}\right) + \frac{\gamma}{4}$. Otherwise, it will be a decreased expansion. Since the action of the positive and anti-sky is mutual, the energy in the total universe remains conservation, namely, the law of energy conservation is also held on large scales.

4.2 Application in symmetry and Higgs Mechanism

Now, due to the the limitation of space only the significant conclusions are summarized here (others like the discussion of vacuum symmetry breaking caused by gravitational field and the detailed Higgs mechanism have listed in Appendix 4). Based on the analysis of the Higgs mechanism and the energy solution of the quantization equation of section 3.2, it can be concluded that the mass matter generated by energy matter must have transverse electromagnetic field conditions and longitudinal gravitational field conditions. The stronger region of the positive sky gravitational field is, the matter will be more stable in this region. Meanwhile, the antimatter is obviously more unstable. Similarly, in the strong region of the anti-sky gravitational field, the antimatter is more stable while the matter is more unstable. So, the matter and antimatter cannot be intermingled, and they can only form a chiral symmetric positive-antimatter sky to construct the universe.

5 Discussion

The boundaries of the positive and antimatter sky will not be areas of extremely intense activity. The mass particles cannot reach the boundary because the positive and anti-sky is far away and the boundary area is broad. Thus, the mass particles in the positive material sky side cannot have enough kinetic energy to overcome the continuous force towards the center of the sky to reach the boundary. It is similarly for the mass particles in the anti-material sky. So, the extreme violent phenomenon of the positive and anti-particle annihilation in the positive and anti-sky boundary will not occur. In addition, one kind of the 0 mass energy particles, such as electromagnetic wave, can converse the right-hand light to left hand light if they enter the gravitational field from the right-hand side into the left-hand area. The boundary of the energy conversion from the positive sky to anti-sky is equal to the conversion from anti-sky to positive sky due to CPT conservation. There will be no violent energy fluctuations but only the weak energy exchange. Another energy particle, such as neutrinos, have the nature of the gravitational field, let alone a violent energy conversion.

This work cannot completely solve the understanding problem of the gravitational field. In different theories (such as Newtonian gravity theory, the general relativity, the symmetry, the gravitational field under quantum mechanics, the gauge theory of the "scalar field", etc.), there are different performances and mathematical expression in the gravitational field. It results in no unified and ineffective integration of gauge theory and gravitational theory.

The cosmological observations are related to the location of the universe we are in, and a large amount of data should be able to determine the general direction of the line of the centroid between the positive sky and anti-sky_which can be understood as the "magic axis" of the microwave background of K. Land and T. Magueijo[43]. If so, the credibility of the cosmic model of the positive-antisky is also increased.

After all, the gravity is relatively weak, and its effect is not very obvious. However, at least three experiments can be used to confirm or falsify the present theory: (1) anti-hydrogen atomic experiments. Synthetic anti-hydrogen atoms should drift upward in the earth's gravitational field. But the antihydrogen atoms trace is a problem. (2) the positive-antiparticle lifetime experiments or half-life experiments. The positive-antiparticle life is different in the gravity field. The stronger the gravitational field, the greater the positive-antiparticle life difference is. The similar experiments are the half-life of the radioactive matter changes with the strength of the gravitational field. The stronger the gravitational field, the longer the half-life of the radioactive matter in it is. However, it is unlike the difference in positive and antiparticle life, the strength of the gravitational field that could affect the half-life needs to change greatly with the earth's gravitational field due to the more inert Half-life. (3) the parity breaking experiment. Like C_0^{60} , the gravitational field condition changes while the degree of breaking changes. We do not know whether the experiment can be tested for the weak change of the parity breaking caused by the change of the very small gravitational field strength such as the tide-induced force.

Finally, it should be pointed out that we only define dark matter as ordinary dense matter when the quantum condition factor $C_M \to 0$ (gravitational field strength is infinite) in term of mater structure, which infers that the dark matter only exists in the center of the galaxy. But this work does not consider the relative movement of the dark matter found in the literatures [5,6].

5 Conclusions

The following a set of the interrelated conclusions are derived based on the forementioned analysis:

1) We have quantized the gravitational field, and obtained the quantization equation of the gravitational field. Furthermore, the Schrodinger equation and Dirac equation under a variable-gravitational field condition have been obtained by variables separation method.

2) The following conclusions have been derived from the quantization equation of the gravitational field: a) The strong change of an external gravitational field will introduce the change of the atomic structure and then result in the spectral shift effect. The redshift of quasar spectrum is just this effect. b) the dark matter is an ordinary dense matter when the gravitational field quantum condition coefficient $C_M \rightarrow 0$, that is, the gravitational field tends to be infinite. It is recognized to be the essence of the dark matter in view of the matter structure. c) Due to the different gravitational field strength (e.g., the different C_M values), there are several discrete stable quantum condition regions in the universe, and the Earth region is only that of the gravitational field quantum condition factor C_M=1.

3) The universe is composed of the chiral symmetric positive matter sky and antimatter sky. The "gravitational" interaction between the positive and anti-sky is exclusive. It is the repulsion that accelerates the expansion of galaxies in the positive sky and appears as a dark energy phenomenon, which is the physical essence of dark energy.

4) The cosmological constant is obtained by this calculation, which has small changes in both the radial and angular directions, producing a small anisotropy of the cosmic space.

5）The positive-anti baryon number in the universe is equal and the total energy of the positive-anti sky is conserving.

6) Not only a vacuum symmetry breaking but also a parity breaking could be caused by the gravitational field. The stronger the gravitational field will lead to the greater breaking degree.

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Appendix 1. Evidence of the CPT theorems under the definition of manual performance energy and mass

This appendix defines various fields in the presence of CPT invariance, and then proves the CPT theorem:

1.1 The quantization of the free electromagnetic field (spin is 1 and m=0)

From the invariance of CPT, there are two kinds of vacuum: one is the positive matter vacuum ($\varepsilon_0 > 0$, $\mu_0 > 0$), and the right-hand energy is in it, K_R =K. The other one is antimatter vacuum ($\varepsilon_0 < 0$, $\mu_0 < 0$), and there is the left-hand energy in it, K_L = -K.

Let A (t, r) to be the vector potential of the free electromagnetic field, and satisfy the "transverse condition" divA = 0, then scalar potential $\phi = 0$. Whereas, field E and H are for:

$$E = -\dot{A},\quad H = \text{rot } A \qquad (1)$$

Maxwell's equations can be transformed into wave equations of A: $\Delta A - \frac{\partial^2 A}{\partial t^2} = 0$

In classical electrodynamics, the localized fields can be expanded into the plane waves, and their potentials can be represented as a series (Fourier expansion)：

$$A = \sum_K (a_K e^{iK\cdot\gamma} + a_K e^{-iK\cdot r}) \qquad (2)$$

Where a_K is a function of time,

$$a_K \sim e^{-i\omega K},\quad \omega = |K| \qquad (3)$$

Define the regular variable for the field: $Q_K = \frac{1}{\sqrt{4\pi}}(a_K + a_K^*)$, $P_K = \frac{i\omega}{\sqrt{4\pi}}(a_K - a_K^*) = \dot{Q}_K$

Each vector of P_K and Q_K is perpendicular to the wave vector K, that is, there is two independent components. The direction of the vector determines the polarization direction of the corresponding wave, which the two components are represented by using $Q_{K\alpha}$ and $P_{K\alpha}$ (α = 1, 2).

Now, quantizing the free field, and then the classical description of the above field could be transited to the quantum theory. Meanwhile, the regular variables could be treated as operators that satisfy the commutation relations: $\hat{P}_{K\alpha}\hat{Q}_{K\alpha} - \hat{Q}_{K\alpha}\hat{P}_{K\alpha} = -i$. All operators with the different K and α can be commutative with each other. The potential A and the fields E and H（by formula (1)） also form the Hermitian operators.

Define the operators $\hat{C}_{K\alpha} = \frac{1}{\sqrt{z\omega}}\left(\omega\hat{Q}_{K\alpha} + i\hat{P}_{K\alpha}\right)$, $C_{K\alpha}^{+} = \frac{1}{\sqrt{z\omega}}\left(\omega\hat{Q}_{K\alpha} - i\hat{P}_{K\alpha}\right)$

$\hat{C}_{K\alpha}$ and $\hat{C}_{K\alpha}^{+}$ meet the commutation relationship $\hat{C}_{K\alpha}\hat{C}_{K\alpha}^{+} - C_{K\alpha}^{+}\hat{C}_{K\alpha} = 1$

The operator of the potential A is (see formula (2))

$$\hat{A} = \sum_K\left(\hat{C}_{K\alpha}A_{K\alpha} + C_{K\alpha}^{+}A_{K\alpha}^{*}\right) \qquad (4)$$

where

$$A_{K\alpha} = \sqrt{4\pi}\frac{e^{(\alpha)}}{\sqrt{2\omega}}e^{iK\cdot r} \qquad (5)$$

The symbol $e^{(\alpha)}$ is the unit vector of the oscillator polarization direction, and it is perpendicular to the wave vector K. Also, it has two independent polarization directions for each K, similarly to write the operator

$$\hat{E} = \sum_{K.\alpha}\left(\hat{C}_{K\alpha}E_{K\alpha} + \hat{C}_{K\alpha}^{+}E_{K\alpha}^{*}\right)$$

$$\hat{H} = \sum_{K\alpha}\left(\hat{C}_{K\alpha}H_{K\alpha} + \hat{C}_{K\alpha}^{+}H_{K\alpha}^{*}\right) \qquad (6)$$

Where $E_{K\alpha} = i\omega A_{K\alpha}$, $H_{K\alpha} = n \times E_{K\alpha}$

$$E_{K\alpha}^{*} = -i\omega A_{K\alpha}^{*}, \quad H_{K\alpha}^{*} = n \times E_{K\alpha}^{*} \qquad (7)$$

In the vacuum of $\varepsilon_0 < 0$, $\mu_0 < 0$, the left-hand energy is running. The three vectors of electric magnetic field strength vector E, the magnetic field strength vector H, and the wave vector K form the left-hand system, thus $K_L = -K_R = -K$. Then, the a_K, Q_K, P_K, $\hat{P}_{K\alpha}$, $\hat{C}_{K\alpha}$, $\hat{E}$, $\hat{H}$, $A_{K\alpha}$ and their corresponding conjugators are defined as the right hand energy. Then, define each quantity in the left-hand energy as a complex vector (comparison with the formula (3)) $a_{-K} \sim e^{i\omega K} = a_K^*$

Thus, let

$$a_{-K} = a_K^*, \quad a_{-K}^* = a_K \qquad (8)$$

Then, $Q_{-K} = \frac{1}{\sqrt{4\pi}}(a_{-K} + a_{-K}^*) = \frac{1}{\sqrt{4\pi}}(a_K^* + a_K) = Q_K = Q_K^*$（Hermit quantity）

$$P_{-K} = \frac{i\omega}{\sqrt{4\pi}}(a_{-K} - a_{-K}^*) = \frac{1}{\sqrt{4\pi}}(a_K^* - a_K) = -P_K$$

After the operation of $Q_{-K} = Q_K$, $P_{-K} = -P_K$, it can be defined similarly:

$$\hat{C}_{-K\alpha} = \frac{1}{\sqrt{2\omega}}\left(\omega\hat{Q}_{-K\alpha} + i\hat{P}_{-K\alpha}\right) = \frac{1}{\sqrt{2\omega}}\left(\omega\hat{Q}_{-K\alpha} - i\hat{P}_{-K\alpha}\right) = C_{K\alpha}^{+}$$

$$\hat{C}_{K\alpha}^{+} = \frac{1}{\sqrt{2\omega}}\left(\omega\hat{Q}_{-K\alpha} - i\hat{P}_{-K\alpha}\right) = \frac{1}{\sqrt{2\omega}}\left(\omega\hat{Q}_{K\alpha} + i\hat{P}_{K\alpha}\right) = \hat{C}_{K\alpha} \qquad (9)$$

$$\hat{A}_L = \sum_{-K\alpha}\left(\hat{C}_{-K\alpha}A_{-K\alpha} + \hat{C}_{-K\alpha}^{+}A_{-K\alpha}^{+}\right)$$

$$A_{-K\alpha} = -\sqrt{4\pi}\frac{e^{(\alpha)}}{\sqrt{2\omega}}e^{-iK\cdot r} = -A_{K\alpha}^{*},$$

With the left-hand energy, the vector A takes negative values,

$$A^*_{-K\alpha} = -\sqrt{4\pi}\frac{e^{(\alpha)}}{\sqrt{2\omega}}e^{iK\cdot r} = -A_{K\alpha}$$

$$E_{-K\alpha} = i\omega A_{-K\alpha} = -i\omega A^*_{K\alpha} = E^*_{K\alpha}$$

$$E^*_{-K\alpha} = -i\omega A^*_{-K\alpha} = -i\omega(-A_{K\alpha}) = i\omega A_{K\alpha} = E_{K\alpha}$$

$$H_{-K\alpha} = n_L \times E_{-K\alpha} = \frac{-K}{\omega} \times E^*_{K\alpha} = -n \times E^*_{K\alpha} = -H^*_{K\alpha}$$

$$H^*_{-K\alpha} = n_L \times E^*_{-K\alpha} = (-n) \times E_{K\alpha} = -H_{K\alpha} \qquad (10)$$

Then it can be derived:

$$\hat{E}_L = \sum_{-K\alpha}\left(\hat{C}_{-K\alpha}E_{-K\alpha} + \hat{C}^+_{-K\alpha}E^*_{-K\alpha}\right) = \sum_{K\alpha}\left(\hat{C}^+_{K\alpha}E^*_{K\alpha} + \hat{C}_{K\alpha}E_{K\alpha}\right) = \hat{E} = \hat{E}_R$$

$$\hat{H}_L = \sum_{-K\alpha}\left(\hat{C}_{-K\alpha}H_{-K\alpha} + \hat{C}^+_{-K\alpha}H^*_{-K\alpha}\right) = \sum_{K\alpha}\left[\hat{C}^+_{K\alpha}(-H^*_{K\alpha}) + \hat{C}_{K\alpha}(-H_{K\alpha})\right]$$

$$= -\sum_{K\alpha}\left(C^+_{K\alpha}H^*_{K\alpha} + \hat{C}_{K\alpha}H_{K\alpha}\right) = -\hat{H} = -\hat{H}_R$$

$$A_L = \sum_{-K\alpha}\left(\hat{C}_{-K\alpha}A_{-K\alpha} + \hat{C}^+_{-K\alpha}A^*_{-K\alpha}\right) = \sum_{K\alpha}\left[\hat{C}^+_{K\alpha}(-A^*_{K\alpha}) + \hat{C}_{K\alpha}(-A_{K\alpha})\right]$$

$$= -\sum_{K\alpha}\left(\hat{C}^+_{K\alpha}A^*_{K\alpha} + \hat{C}_{K\alpha}A_{K\alpha}\right) = -\hat{A} = -\hat{A}_R \qquad (11)$$

Since the above quantization of the electromagnetic field start from the classical definition, the production and annihilation operators of the electromagnetic field are expressed by $\hat{C}_{K\alpha}$ to avoid confusion with the classical plane wave expansion. Then, when the spin is defined as 0 or 1/2 field, both *a or* α are used to represent the generation and annihilation operators.

The plane wave is defined as spin is 1 and mass m of particles does not require to be 0, similarly with the electromagnetic field with 0 mass and spin =1. Corresponding to the right-hand plane wave $A_R = \frac{1}{\sqrt{2\omega\Omega}}e^{iK_R\cdot r}$is the left-hand plane wave. By referencing to 0 mass definition, it has $A_L = \frac{1}{-\sqrt{2\omega\Omega}}e^{iK_L\cdot r}$, here, $K_R = K = -K_L$, and the Fourier expansion is:

$$A_R(t,r) = \sum_{KR}\frac{1}{\sqrt{2\omega\Omega}}\left[a_{K_R}(t)e^{iK_R\cdot r} + a^+_{K_R}(t)e^{-iK_R\cdot r}\right]$$

$$= \sum_{K}\frac{1}{\sqrt{2\omega\Omega}}\left[a_K(t)e^{iK\cdot r} + a^+_K(t)e^{-iK\cdot r}\right]$$

(12)

$$A_L(t,r) = \sum_{K_L}\frac{1}{\sqrt{2\omega\Omega}}\left[a_{K_L}(t)e^{iK_L\cdot r} + a^+_{K_L}(t)e^{-iK_L\cdot r}\right]$$

$$= -\sum_{-K}\frac{1}{\sqrt{2\omega\Omega}}\left[a_{-K}(t)e^{-iK\cdot r} + a^+_{-K}(t)e^{iK\cdot r}\right]$$

$$= -\sum_{K}\frac{1}{\sqrt{2\omega\Omega}}\left[a^+_K(t)e^{-iK\cdot r} + a_K(t)e^{iK\cdot r}\right] = -A_R(t,r)$$

(13)

Such as the transformation of $C_{K\alpha}$ in the electromagnetic field with 0 mass and spin 1, here $a^+_K = a_{-K}$, $a_K = a^+_{-K}$

1.2 Secondary quantization of the field where spin is 0

Following the quadratic quantization methods, the arbitrary wave functions unfold by an eigen function of a complete set of possible states, such as the plane waves could be represent as:

$$\phi = \sum_P a_P \phi_P\,,\quad \phi^* = \sum_P a_P^* \phi_P^*$$

$\phi_P = \frac{1}{\sqrt{2\omega\Omega}} e^{-iPx}$, ϕ^* could be viewed as the plane wave of –P: $\phi_{-P}^* = \frac{1}{\sqrt{2\omega\Omega}} e^{iPx}$。

As defined by the four-momentum momentum, $\phi_{P_R} = \frac{1}{\sqrt{2\omega\Omega}} e^{-iP_R x} = \frac{1}{\sqrt{2\omega\Omega}} e^{-iPx}$

$\phi_{P_L} = \frac{1}{\sqrt{2\omega\Omega}} e^{-iP_L x} = \frac{1}{\sqrt{2\omega\Omega}} e^{iPx}$, ϕ_R and $\phi_L$conjugate each other

Corresponding to the annihilation operator a_P of the particle, the antiparticle production operator b^+ constitutes a complete set.

$$\phi(t,r) = \sum_P \frac{1}{\sqrt{2\omega\Omega}}\left[a_P(t)e^{-iP_R\cdot r} + b_P^+(t)e^{iP_L\cdot r}\right]$$

$$= \sum_P \frac{1}{\sqrt{2\omega\Omega}}\left[a_P(t)e^{-iP\cdot r} + b_P^+(t)e^{-iP\cdot r}\right]$$

(14)

The Hermit conjugation:

$$\phi_{(t,r)}^+ = \sum_P \left[a_P^+(t)e^{iP\cdot r} + b_P(t)e^{-iP\cdot r}\right]$$

1.3 The secondary quantization of the spin-1/2 field

In the four-vectors, $P^\mu = \begin{pmatrix} P_R^\mu \\ P_L^\mu \end{pmatrix}$, the right-hand plane wave $\psi_R(x)$ and the left-hand plane wave could be introduced:

$$\psi_R(x) = \frac{1}{\sqrt{\Omega}} u_{P_R,S} e^{-iP_R x} = \frac{1}{\sqrt{\Omega}} u_{P,S} e^{-iPx}$$

$$\psi_L(x) = \frac{1}{\sqrt{\Omega}} \upsilon_{P_L,S} e^{-iP_L x} = \frac{1}{\sqrt{\Omega}} \upsilon_{-P,S} e^{iPx}$$

Here the spinor transformation follows the agreement of the phase factor:

(i) $\upsilon_{P,S} = \gamma_2 u_{P,S}^*$, $u_{-P,S} = \gamma_2 \upsilon_{P,S}^*$

(ii) $\gamma_o u_{P,S} = u_{-P,-S}$, $\gamma_o \upsilon_{P,S} = -\upsilon_{-P,-S}$

(iii) $\sigma_2 u_{P,S}^* = e^{i\theta_{P,S}} u_{-P,S}$, $\sigma_2 \upsilon_{P,S}^* = e^{-i\theta_{-P,S}} \upsilon_{-P,S}$, 其中$e^{i\theta_{P,S}} = -e^{i\theta_{-P,-S}}$

Here, γ is the Dirac matrix.

At any given moment t, like the original-spin 1/2 field, the spin 1/2 field operator under the left-handed four-momentum is introduced and $\psi(x) = \psi(t,r)$could be extended with the Fourier series:

$$\psi(t,r) = \sum_P S_P(t) \frac{e^{iP\cdot r}}{\sqrt{\Omega}}$$

(15)

Where, $S_P(t)$ is 4×1 matrix which is not relative with γ, and Ω is the volume taken. It also takes *C-number base* vetors, like $u_{P_R,S} = u_{P,S}$, $\upsilon_{P_L,S} = \upsilon_{-P,S}$ in the spinor space and all meet with the Dirac equation $(\gamma^\mu P_\mu + m)u = 0$ that is, $(\alpha \cdot P_i + m)u = E_P u$.

Here $m = \begin{cases} m_R \\ m_L \end{cases} = \begin{cases} m \\ -m \end{cases}$, $E_P = \begin{cases} E_R \\ E_L \end{cases} = \begin{cases} E_P \\ -E_P \end{cases}$, $u = \begin{cases} u_{P_R,S} \\ \upsilon_{P_L,S} \end{cases} = \begin{cases} u_{P,S} \\ \upsilon_{-P,S} \end{cases}$

In above formula, substitute a group E_R， P_R(including three vectors) simultaneously, m_R or E_L， P_L, m_L：

$$(\sigma \cdot P + m)u_{P,S} = E_P u_{P,S}$$

$$(\sigma \cdot P - m)\upsilon_{-P,S} = -E_P \upsilon_{-P,S}$$

To normalizing the vector, let $u^+_{P,S} u_{P,S} = \upsilon^+_{-P,S}\upsilon_{-P,S} = 1$

$u_{P,S}$ and $\upsilon_{-P,S}$ form a complete set of the orthogonal base vectors in spinor space, $S_P(t)$ could be deployable by this set of base vectors:

$$S_P(t) = \sum_{S=\pm\frac{1}{2}}\left[a_{P,S}(t)u_{P,S} + b^+_{-P,S}(t)\upsilon_{-P,S}\right] \quad (16)$$

In the formula, $a_{P,S}(t)$ and $b^+_{-P,S}(t)$ is the Operator in the Hilbert space, and combining (15) and (16), we have

$$\psi(x) = \psi(t,r) = \frac{1}{\sqrt{\Omega}}\sum_{P.S}\left[a_{P,S}(t)u_{P,S}e^{iP\cdot r} + b^+_{P,S}(t)\upsilon_{P,S}e^{-iP\cdot r}\right] \quad (17)$$

$$\psi^+(x) = \psi^+(t,r) = \frac{1}{\sqrt{\Omega}}\sum_{P.S}\left[a^+_{P,S}(t)u^+_{P,S}e^{-iP\cdot r} + b_{P,S}(t)\upsilon^+_{P,S}e^{iP\cdot r}\right] \quad (18)$$

Below is a proof of CPT's theorem under the definition of a chiral field.

Considering the localized field theory, where there is N_i the field of the Spin j and it is represented as:

Spin 0： $\phi_1(x)$、$\phi_2(x)$ ... $\phi_{N_0}(x)$

Spin $\frac{1}{2}$： $\psi_1(x)$、$\psi_2(x)$ ... $\psi_{N_{\frac{1}{2}}}(x)$

Spin 1： $[A_1(x)]_\mu$、$[A_2(x)]_\mu$ ... $\left[A_{N_1}(x)\right]_\mu$ (19)

Under the Lorentz group or the C.P.T transformation, in terms of transformation properties,

Field is available a symmetric tensor representation with the spin j as an integer: $T_{\mu_1\dots\mu_j}(x)$ (20)

A field with a spin j as a half-integer is represented as $S_{\mu_1\dots\mu_{j-\frac{1}{2}},\alpha}(x) \sim T_{\mu_1\dots\mu_{j-\frac{1}{2}}}\psi_\alpha(x)$ (21)

It can be seen as transforming as the direct product like the order symmetric tensor of $T_{\mu_1\dots\mu_{j-\frac{1}{2}}}$ with a spin j as a half-integer and Dirac spinor.

Assuming the Lagrangian density

$\mathcal{L}(x) = \left(\frac{\partial}{\partial x_\lambda}, \phi_a, \phi^+_a, \psi_b, \psi^+_b, (A_c)_\mu, (A^+_c)_\mu \dots\right)$ sum of the formal products.

All of the fields are taken at the same space time point x, $x_\mu = (it, r)$

Operator $\oint \equiv \mathrm{CPT}$ (or the other arrangement and combination forms of the CPT) （22）

The theorems can be Introduced: Any the Lorentz-invariant $\mathcal{L}(x)$ meets with $\oint \mathcal{L}(x) \oint^{-1} = \mathcal{L}^+(-x)$

If we make the following choices

For all $a = 1,2,\dots N_0$， $\oint \phi_a(x)\oint^{-1} = \phi^+_a(-x)$ (23)

For all $b = 1,2,\dots N_{\frac{1}{2}}$， $\oint \left(\psi_b(x)\right)_\alpha \oint^{-1} = i(\gamma_5)_{\alpha\beta}\left(\psi^+_b(-x)\right)_\beta$ (24)

For all $c = 1,2,\dots N_1$， $\oint \left(A_c(x)\right)_\mu \oint^{-1} = -\left(A^+_c(-x)\right)_\mu$ (25)

For all integer j field (20), $\oint T_{\mu_1\dots\mu_j}(x)\oint^{-1} = (-1)^j T^+_{\mu_1\dots\mu_j}(-x)$ (26)

For all semi-integer j fields (21),

$$\oint S_{\mu_1\ldots\mu_{j-\frac{1}{2}},\alpha}(x)\oint^{-1} = (-1)^j (i\gamma_5)_{\alpha\beta} S^{+}_{\mu_1\ldots\mu_{j-\frac{1}{2}},\beta}(-x) \qquad (27)$$

Proof：

（1）Consider the field with the spin 1/2

under the introduction of the defined spin 1/2 field of the left-hand energy, the final Fourier expansion is formula 17.

$$\psi(x) = \frac{1}{\sqrt{\Omega}}\sum_{P,S}\left[a_{P,S}(t)u_{P,S}e^{iP\cdot r} + b^{+}_{P,S}(t)\upsilon_{P,S}e^{-iP\cdot r}\right]$$

① if $Ca_{P,S}C^{+} = \eta_c b_{P,S}$

$Cb^{+}_{P,S}C^{+} = \eta_c a^{+}_{P,S}$

the conjugated $Ca^{+}_{P,S}C^{+} = \eta^{+}_c b^{+}_{P,S}$

and under the spinor transformation convention of the formula (19), it has $C\psi(x)C^{+} = \eta_c \varphi^{c}(x)$ (28)

② if $Pb^{+}_{P,S}P^{+} = -\eta_P b^{+}_{-P,-S}$

$Pa_{P,S}P^{+} = \eta_P a_{-P,-S}$

the conjugated $Pa^{+}_{P,S}P^{+} = \eta^{*}_P a^{+}_{-P,-S}$

And formula (19) , it has $P\psi(t,r)P^{+} = \eta_P\gamma_0\psi(t,-r)$ (29)

③ if $Ta_{P,S}T^{-1} = e^{-i\theta_{-P,S}}a_{-P,S}$

$Tb^{+}_{P,S}T^{-1} = e^{i\theta_{-P,S}}b_{-P,S}$

the conjugated $Ta^{+}_{P,S}T^{-1} = e^{i\theta_{-P,S}}a^{+}_{-P,S}$

$Tb_{P,S}T^{-1} = e^{-i\theta_{-P,S}}b_{-P,S}$

and formula (19) , it has $T\psi(t,r)T^{-1} = \eta_t\sigma_2\psi(-t,r)$ (30)

by formula (28), (29) and (30)

$$\oint \psi(x)\oint^{-1} = CPT\psi(t,r)T^{-1}P^{-1}C^{-1} = CP\eta_t\sigma_2\psi(-t,r)P^{-1}C^{-1}$$
$$= C\eta_t\eta_P\sigma_2\gamma_0\psi(-t,-r)C^{-1} = \eta_t\eta_P\eta_c\sigma_2\gamma_0\psi^{c}(-x) = \eta(ir_5)\psi^{+}(-x)$$

Here, $\psi^{c} = \gamma_2\psi^{+}$, $\sigma_2\gamma_0\gamma_2 = \sigma_2\rho_2\rho_3\sigma_2 = -i\rho = i\gamma_5$, let $\eta_t\eta_P\eta_c = 1$

It matches with the conditions of CPT invariance (24)

（2）Consider a field with a spin=0

The final Fourier expansion is formula (14） by defining the spin as 0 field with left-hand energy

$$\phi(t,r) = \sum_{P}\frac{1}{\sqrt{2\omega\Omega}}\left[a_P(t)e^{-iP\cdot r} + b^{+}_P(t)e^{-iP\cdot r}\right]$$

Under the transform of $Ca_PC^{+} = \eta_c b_P$， $Pa_PP^{+} = \eta_P a_{-P}$， $Ta_PT^{-1} = \eta_T a_{-P}$

$Ca^{+}_PC^{+} = \eta^{*}_c b^{+}_P$， $Pa^{+}_PP^{+} = \eta^{*}_P a^{+}_{-P}$， $Ta^{+}_PT^{-1} = \eta^{*}_T a^{+}_{-P}$

It has $C\phi(x)C^{+} = \eta_c\phi^{+}(x)$

$P\phi(t,r)P^{+} = \eta_P\phi(t,-r)$

$T\phi(t,r)T^{-1} = \eta_t\phi(-t,-r)$

That is, $\oint \phi(x)\oint^{-1} = \phi^{+}(-x)$, and it matches with the conditions of CPT invariance (23)

（3）Consider a field with a spin=1

The final Fourier expansion is formula （12） and （13） by defining the spin as 1 field with left-hand energy.

$$A(t,r)=\sum_K \frac{1}{\sqrt{2\omega\Omega}}\left[a_K(t)e^{iK\cdot r}+a_K^{+}(t)e^{-iK\cdot r}\right]$$

under the transform of $Pa_K^{+}P^{+}=-a_K^{+}$, $Ca_K^{+}C^{+}=-a_K^{+}$, $Ta_K^{+}T^{-1}=-a_{-K}^{+}$

$Pa_KP^{+}=-a_{-K}$, $Ca_KC^{+}=-a_K$, $Ta_KT^{-1}=-a_{-K}^{+}$ it has

$PA(x)P^{+}=PA(t,r)P^{+}=-A(t,-r)$, $CA(x)C^{+}=-A(x)$,

$TA(t,r)T^{-1}=-A(-t,r)$

That is, $\oint\left(A_C(x)\right)_\mu\oint^{-1}=-\left(A_C^{+}(-x)\right)_\mu$

Here $A_\mu=(iA_0,A)$, and $A=A^{+}$ is Hermitian. Whereas, $A_0=-A^{+}$ is anti- Hermitian. However, i becomes -i under the time inversion. So $A_\mu=A_\mu^{+}$ will meet with the conditions for CPT invariance of the formula（25）.

The spin 0,1 and 1/2 fields based on the definition of the above right hand or the left-hand energy meet with the conditions of CPT invariance under CPT joint operation, where the proof of the CPT theorem $\oint\mathcal{L}(x)\oint^{-1}=\mathcal{L}^{+}(-x)$ is consistent with any textbook on particle physics, and thus here it is no longer repeated discussed.

From the CPT's theorem, the following conclusions are drawn:

1）The existence of right-handed energy E_R and the chiral symmetrical left-handed energy E_L. It is set E_R=E during the calculation which is known as the positive energy while E_L=-E known as the negative energy.

2) There is right-handed mass matter (also called normal matter m_R=m) and left-handed mass matter (also called antimatter m_L=-m). This mass chirality is the intrinsic property of matter and does not change due to the selection of reference system.

3) The mass matter carries the gravitational field and the mass matter exhibits chiral symmetry. Then, the gravitational field accordingly presents chiral symmetry. That is, the normal matter carries a right-handed gravitational field and antimatter carries a left-handed gravitational field.

4) There is a microscopic world of chiral symmetric particles, and also there is a macroscopic chiral symmetry universe. Such universe consists of the positive matter sky and the antimatter sky with the chiral symmetry (the matter and antimatter in the universe form their own positive and antimatter sky, respectively. But it cannot be a mixture of matter and anti-matter to form the universe which will be discussed in the Appendix4 particle physics parts). In a physical vacuum in the sky of matter, it is $\varepsilon_0>0$, $\mu_0>0$. While, in a vacuum for an antimatter sky, it is $\varepsilon_0<0$, $\mu_0<0$. It means there are two gravitational field vacuums in the universe. The defined "positive sky" is actually what people now call the universe. In fact, the cosmic model in this manuscript doubles the original universe (a pair of positive and anti-sky).

Appendix 2. Analysis of the quantum mechanics equation under the gravitational field

Under the energy scale nucleon mass m=1GeV condition, the strengths of the four interactions are divided into the strong 1, electromagnetic 10^{-2}, weak 10^{-5}, gravitational 10^{-38}, respectively. The gravitational interaction is extremely weak than the other three interactions, so the quantum mechanics described the microscopic particle interactions does not consider the gravitational field at all. However, all the physical behavior occurs in the gravitational field and thus it is inseparable from the gravitational field, which forces us to consider the influence of the gravitational field. Meanwhile, the gravitational field is also a longitudinal condition for the generation of mass matter, so a complete quantum mechanical system must include gravity.

3.1 Quantum mechanics equation of the gravitation field (3.6)

$$k(-\frac{\hbar^2}{2m}\gamma^0\nabla^2 + \gamma\hat{p})\psi(r,t,\sigma) = \frac{4\pi G}{c^2} i\hbar\gamma^0 \frac{\partial}{\partial t}\psi(r,t,\sigma) \quad (1)$$

When the mass matter exists at a mass particle and the transverse energy without the longitudinal energy, the equation (3.6) transforms into the Schrodinger equation:

$$C_M(-\frac{\hbar^2}{2m}\nabla^2)\psi(r,t) = i\hbar\frac{\partial}{\partial t}\psi(r,t) \quad (2)$$

Equation (2) is the Schrodinger equation on the background of the gravitational field.

When all the mass material is converted into the longitudinal gravitational field energy, there is no transverse electromagnetic field energy, and thus the equation (3.6) becomes a massless spinor field Dirac equation:

$$C_M\gamma\cdot\hat{p}\psi(r,t,\sigma) = i\hbar\gamma^0\frac{\partial}{\partial t}\psi(r,t,\sigma) \quad (3)$$

Equation (3) is the Dirac equation in the context of a gravitational field. Equations (2) and (3) can also be seen as the equation obtained by separating variables from equations (1).

The energy solutions to the Schrodinger equation and Dirac equation in the context of the gravitational field are explained as follows:

(1) One-dimensional fixed state

The Schrodinger equation is $H'\psi(x) = E\psi(x)$

$$H' = C_M H = C_M\left[-\frac{\hbar^2}{2m}\nabla^2 + V(x)\right]$$

One-dimensional square potential trap $V(x) = \begin{cases} 0, & 0 < x < a \\ \infty, & x < 0 \text{ or } x > a \end{cases}$

The Schrodinger equation in the one-dimensional fixed situation well is: $-C_M\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\psi = E\psi$

Let $K = \sqrt{\frac{2mE}{C_M\hbar^2}}$, we obtain:

$\psi(x) = A\sin(Kx+\sigma)$, $\sin Ka = 0$, $Ka = n\pi$, n = 1,2,3…

$\frac{n\pi}{a} = \sqrt{\frac{2mE}{C_M\hbar^2}}$, $E = \frac{C_M\hbar^2\pi^2 n^2}{2ma^2}$

The level distance between the adjacent energy levels:

$$\Delta E_n = \frac{C_M\hbar^2\pi^2}{2ma^2}[(n+1)^2 - n^2] = \frac{C_M\hbar^2\pi^2}{ma^2}n \quad (4)$$

Known from the formula （4), if the gravitational field strength coefficient C_M changes, the energy level ΔE_n also changes. When the gravitational field increases, C_M decreases, and ΔE_n decreases. That is, the the energy level difference decreases with the external gravitational field strength increases. Therefore, the change of the field strength of the external gravitational field (or background gravitational field) will alter the atomic structure of the material.

(2) Hydrogen atoms

The energy eigen equation is $H'\psi = E\psi$

$$H' = C_M H = C_M\left[-\frac{\hbar^2}{2\mu}\nabla^2 + V(\gamma)\right]$$

μ**:** electronic quality, $V(\gamma) = -\frac{e^2}{\gamma}$, The Coulomb action energy.

Substitute the H' to the eigen equation, it gets

$$C_M\left[-\frac{\hbar^2}{2\mu}\nabla^2 + V(\gamma)\right]\psi = E\psi \quad (5)$$

Take the ball coordinates, now

$$\nabla^2 = \frac{1}{\gamma^2}\frac{\partial}{\partial\gamma}\gamma^2\frac{\partial}{\partial\gamma} - \frac{l^2}{\hbar^2\gamma^2} = \frac{1}{\gamma}\frac{\partial^2}{\partial\gamma^2}\gamma - \frac{l^2}{\hbar^2\gamma^2} \qquad (6)$$

The formula (6) is replaced into (5) and the equation (5) is:

$$\left[-\frac{\hbar^2}{2\mu}\frac{1}{\gamma}\frac{\partial^2}{\partial\gamma^2}\gamma + \frac{l^2}{2\mu\gamma^2} + \mathrm{V}(\gamma)\right]\psi = \frac{E}{C_M}\psi \qquad (7)$$

From the separation of the variables $\psi(\gamma,\theta,\psi) = R_l Y_{lm}(\theta,\psi)$, the radial equations are available

$$\left[\frac{1}{\gamma}\frac{d^2}{d\gamma^2}\gamma + \frac{2\mu}{\hbar^2}\left(\frac{E}{C_M} - \mathrm{V}(\gamma) - \frac{l(l+1)}{\gamma^2}\right)\right]R_l = 0 \qquad (8)$$

Divided the singularity $\gamma = 0$, let $R_l(\gamma) = X_l(\gamma)/\gamma$, and then substitute it into equation (8):

$$X_l'' + \left[\frac{2\mu}{\hbar^2}\left(\frac{E}{C_M} - \mathrm{V}(\gamma)\right) - \frac{l(l+1)}{\gamma^2}\right]X_l = 0 \qquad (9)$$

Coulomb energy is substituted into equation (9)

$$X_l'' + \left[\frac{2\mu}{\hbar^2}\left(\frac{E}{C_M} + \frac{e^2}{\gamma}\right) - \frac{l(l+1)}{\gamma^2}\right]X_l = 0$$

Considering $\gamma \to 0$, $\gamma \to \infty$ and the boundary conditions, the physically allowed solutions can be get by the application of the confluence super geometric equation:

$$E = E_n = -\frac{C_M\mu e^4}{2\hbar^2}\frac{1}{n^2} = -\frac{C_M e^2}{2a}\frac{1}{n^2} \qquad \mathrm{n} = 1, 2, 3, \ldots \qquad (10)$$

$$a = \frac{\hbar^2}{\mu e^2}$$

The energy difference $\Delta E = h\nu = h\frac{\bar{\nu}}{c} = E_n - E_m = C_M\left[\frac{\mu e^4}{2\hbar^2}\left(\frac{1}{m^2} - \frac{1}{n^2}\right)\right]$, $(n > m)$

$$\bar{\nu} = C_M\left[\frac{2\pi^2\mu e^4}{\hbar^3 c}\left(\frac{1}{m^2} - \frac{1}{n^2}\right)\right] = C_M R\left(\frac{1}{m^2} - \frac{1}{n^2}\right) \qquad (11)$$

$R = \frac{2\pi^2\mu e^4}{\hbar^3 c}$ 为 Rydberg constant。

In the gravitational field quantum condition in the Earth region C_M=1, $\bar{\nu} = R\left(\frac{1}{m^2} - \frac{1}{n^2}\right)$ is converted into the Rydberg formula.

According to the spectral formula (11), when C_M take different values, e.g., the various external gravitational field strength, the hydrogen characteristic spectrum moves as an whole. Unlike the energy level splitting of the Stark effectin in the external electric field and the Zeeman effect in the external magnetic field, the atomic characteristic spectra in the external gravitational field have the effect to move with the strength of the gravitational field overall. Such as, the quasar spectral redshift is this effect (after all, the big red shift of the mass matter almost the speed of light is difficult to be widely accepted). The greater the field strength will lead to the greater the spectral movement.

In the strong gravitational field region, $\bar{\nu} = C_M R\left(\frac{1}{m^2} - \frac{1}{n^2}\right)$, $C_M < 1$, a red shift is produced. Therefore, it could explain the quasar big red shift, which is a spectral redshift caused by the external gravitational field (or the gravitational field in the background) changing the atomic structure. See the literature [18] for more details.

Referring to the literature [18], the presence of n stable quantum condition regions in the universe is defined by the redshift distribution of the number of quasars. It is only one of n stable quantum condition regions for Earth.

The number of quasars reaches its peak at the redshift values of Z = 0.3, 0.6, 0.96, 1.41, 1.96, respectively.

If we define $C_M = \frac{1}{Z+1}$, the peak values are corresponding to C_M = 0.77, 0.63, 0.51，0.41, 0.33.

That is, when the C_M difference is about 0.1, there is a stable quantum condition region, and the gravitational field quantum condition is also a gradient, non-continuous.

(3) The Dirac equation

The Dirac equation for free electrons

$$i\hbar \frac{\partial}{\partial t}\psi = H'\psi \qquad (12)$$

$$H' = C_M H = C_M(-i\hbar c\alpha \cdot \nabla + mc^2\beta) = C_M(c\alpha \cdot P + mc^2\beta)$$

$$\psi_{P,E}(r,t) = U(P)exp\left[{}^{i(P\cdot r - Et)}/_{\hbar}\right]$$

Replacing the upper 2 formula into equation (12), it gets:

$$C_M(c\alpha P + mc^2\beta)u = Eu \qquad (13)$$

Then, it is obtained: $\mathrm{E} = \pm C_M\sqrt{m^2c^4 + c^2\hbar^2K^2}$, here $P = \hbar K$, α *and* β are the matrix formula.

It is learned that the energy "content" is still related to the background gravitational field strength. When the gravitational field increases the C_M decreases and the particle energy decreases.

Appendix 3. The Einstein cosmological constant derived from the "gravitational" repulsion between the positive-sky and anti-sky

According to CPT invariance, there exists a chiral symmetrically positive matter sky and anti-matter sky in the universe (it will explain in the section of the particle physics part that the matter and anti-matter will form the positive and anti-matter sky, respectively, but not the matter and anti-mater mixed together to form the universe). It is the cooperation between the repulsion action of the anti-sky to the positive sky galaxies and the gravity effect of the positive sky on its internal galaxies that can accelerate the expansion of galaxies in the positive sky in the universe, manifested as a dark energy phenomenon. The following calculation is the evolution of the positive sky under anti-sky repulsion.

Under the cosmological assumption, the positive sky (M) and the anti-sky (-M) are applied to the physical laws of FRW (Friedmann-Robertson-Walker), respectively. However, the geometry influence cannot be clearly determined due to the large scale, the selection of coordinates and direction of action. Moreover, the positive sky metric tensor under anti-sky action cannot be determined. Therefore, the 4-dimensional space-time tensor equation cannot be applied to the connection between the positive sky and the anti-sky. In considering the role of the mass center in the anti-sky on galaxies in the positive sky, it can be regarded as the role of the Newtonian potential at t moments in a very large-scale space. It is applicable the positive sky evolution under the FRW metric at 1-dimensional time and 3-dimensional Euclidean space with the same time horizon (FRW represents the positive matter sky, and -FRW represents the anti-matter sky in the followed descriptions).

The universe consists of the chiral symmetric positive sky (FRW) and anti-sky(-FRW) and begins to expand in the two directions after explosion, forming the today's universe (see Fig. 3.1).

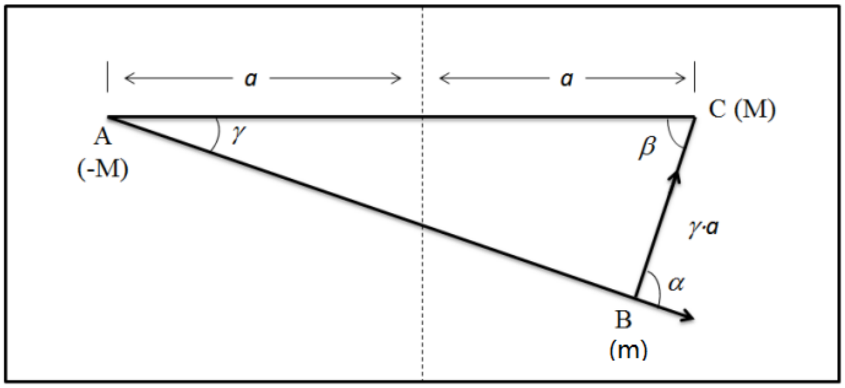

Figure 3.1 a cosmic model formed by the explosion of the positive and anti-sky. A: anti-center of sky, M is total mass. B: the positive sky galaxy m position, a is the radius of the positive and anti-sky， ra is the co-moving distance of m from the positive center of mass, α is the angle between the positive and anti-sky on m force. C: the positive center of mass, and M is total mass.

In Fig. 3.1, $AC = 2a$， $BC = ra$

$$(AB)^2 = (2a)^2 + (ra)^2 - 2(2a)(ra)\cos\beta$$
$$= 4a^2 + (ra)^2 - 4a^2 r\cos\beta$$

Here, we do not know the centroid of mass position of-FRW and FRW and angle (α-γ) cannot be measured.

When the galaxy is selected as the coordinate origin, and the spherical coordinates is taken, the angle β = α-γ is 0~2π if θ is 0~2π and φ is fixed. Accordingly in this way, we can always let the angle of θ and (α-γ) is roughly the same by selecting the coordinate system. If the angle difference is θ_1, θ=$(\alpha - \gamma)$-θ_1， $\alpha \in [0,2\pi]$， $\theta \in [0,2\pi]$. Then, we can replace the (α-γ) value with θ. Thus, when θ value takes 0~2π, (α-γ) also takes the corresponding values. Consequently, the cos values for θ and $(\alpha - \gamma)$ are always in the same region, only the order of the taken value is different. Therefore, the instead (α-γ) with θ does not affect the calculation of the cos value. Furthermore, the impact is even less for our astronomical observations due to the Δθ values from the two galaxies.

Therefore, $(AB)^2 \approx 4a^2 + (\gamma a)^2 - 4a^2\gamma\cos\theta$

We can only use the Einstein tensor equations of four-dimensional space time in observing and computing cosmological evolution. But at a very large scales, the role of the-FRW sky on galaxies in the FRW sky can only use the Newtonian potential and the interaction on m is in case at an invariant mass (-M) center of mass:

$$\mathrm{F} = -\frac{G(-M)m}{(AB)^2} = \frac{GMm}{a^2(4+r^2-4r\cos\theta)}(\hat{e}_-)$$

The acceleration of the Newtonian potential due to the interaction of anti-sky on galaxy m in FRW (Euclidean space)

$$\frac{\mathrm{d}^2(AB)}{\mathrm{d}t^2} = \frac{GM}{a^2(4+r^2-4r\cos\theta)}(\hat{e}_-)$$

$\hat{e}_-$**:** it is the interaction direction of the anti- sky on the galaxy, which cannot be determined now, and it is only shows the difference from the later metric.

In the positive sky, the spherical coordinate system and the FRW metric are taken, and the m point is defined as the coordinate origin:

$$\mathrm{d}s^2 = -c^2\mathrm{d}t^2 + a^2\left[\frac{\mathrm{d}r^2}{1-Kr^2} + r^2(\mathrm{d}\theta^2 + \sin^2\theta\,\mathrm{d}\varphi^2)\right] \qquad (1)$$

Let (x^0, x^1, x^2, x^3) represents (ct, r, θ, φ), and thus this metric tensor component is:

$$g_{00} = -1,\ g_{11} = \frac{a^2}{1-Kr^2},\ g_{22} = a^2r^2,\ g_{33} = a^2r^2\sin^2\theta,\ g_{\mu\nu} = 0,\ \forall\mu \neq \nu \quad (2)$$

Under the symmetry conditions, the FRW medium energy momentum tensor in the universe takes the following form:

$$T_{\mu\nu} = \begin{pmatrix} \rho C^2 & 0 & 0 & 0 \\ 0 & g_{11}P & 0 & 0 \\ 0 & 0 & g_{22}P & 0 \\ 0 & 0 & 0 & g_{33}P \end{pmatrix} \quad (3)$$

The connection formula by diagonalization $\Gamma_{ij}^{K} = 0$, when i, j, K is not equal to each other

$$\Gamma_{ii}^{K} = -\frac{1}{2}\frac{1}{g_{KK}}\frac{\partial g_{ii}}{\partial x^K},\ i \neq K,\ 1 \leq i$$

$$\Gamma_{Ki}^{K} = \Gamma_{iK}^{K} = \frac{1}{2}\frac{1}{g_{kk}}\frac{\partial g_{K\mu}}{\partial x^i},\ 1 \leq i$$

For (1), All$\Gamma_{\mu\nu}^{\alpha}$ (not equal to zero) are listed as below:

$$\begin{aligned}
&\Gamma_{KK}^{0} = \frac{1}{2c}\frac{\partial g_{kk}}{\partial t},\ K=1,\ 2,\ 3 \\
&\Gamma_{11}^{1} = \frac{Kr}{1-Kr^2},\ \Gamma_{22}^{1} = -r(1-Kr^2) \\
&\Gamma_{33}^{1} = -r\sin^2\theta\,(1-Kr^2),\ \Gamma_{10}^{1} = \frac{1}{ca}\frac{\partial a}{\partial t} \\
&\Gamma_{20}^{2} = \frac{1}{ca}\frac{\partial a}{\partial t},\ \Gamma_{21}^{2} = \frac{1}{r},\ \Gamma_{33}^{2} = -\sin\theta\cos\theta \\
&\Gamma_{30}^{3} = \frac{1}{ca}\frac{\partial a}{\partial t},\ \Gamma_{31}^{3} = \frac{1}{r},\ \Gamma_{32}^{3} = \frac{\cos\theta}{\sin\theta}
\end{aligned} \quad (4)$$

According to the formula of the Ricci tensor $R_{\mu\nu}$:

$$R_{\mu\nu} = \frac{\partial\Gamma_{\mu\lambda}^{\lambda}}{\partial x^{\nu}} - \frac{\partial\Gamma_{\mu\nu}^{\lambda}}{\partial x^{\lambda}} + \Gamma_{\mu\lambda}^{\alpha}\Gamma_{\nu\alpha}^{\lambda} - \Gamma_{\mu\nu}^{\lambda}\Gamma_{\lambda\alpha}^{\alpha}$$

Calculated by the formula (3):

$$\begin{aligned}
R_{00} &= \frac{1}{c}\frac{\partial}{\partial t}\Gamma_{K0}^{K} + \Gamma_{0\lambda}^{\alpha}\Gamma_{0\alpha}^{\lambda} = \frac{3}{c^2}\frac{1}{a}\frac{\partial^2 a}{\partial t^2} \\
R_{11} &= \frac{\partial\Gamma_{\lambda 1}^{\lambda}}{\partial r} - \frac{\partial\Gamma_{11}^{1}}{\partial r} - \frac{\partial\Gamma_{11}^{0}}{c\partial t} - \Gamma_{\lambda 1}^{\alpha}\Gamma_{\alpha 1}^{\lambda} - \Gamma_{11}^{1}\Gamma_{\alpha 1}^{\alpha} - \Gamma_{11}^{0}\Gamma_{\alpha 0}^{\alpha} \\
&= -\frac{1}{c^2(1-Kr^2)}\left[a\frac{\partial^2 a}{\partial t^2} + 2\left(\frac{\partial a}{\partial t}\right)^2 + 2Kc^2\right] \\
R_{22} &= \frac{\partial\Gamma_{\lambda 2}^{\lambda}}{\partial\theta} - \frac{\partial\Gamma_{22}^{0}}{c\partial t} - \frac{\partial\Gamma_{22}^{1}}{\partial r} + \Gamma_{2\lambda}^{\alpha}\Gamma_{2\alpha}^{\lambda} - \Gamma_{22}^{\lambda}\Gamma_{\lambda\alpha}^{\alpha} \\
&= -\frac{1}{c^2}\left[a\frac{\partial^2 a}{\partial t^2} + 2\left(\frac{\partial a}{\partial t}\right)^2 + 2Kc^2\right] \quad (5) \\
R_{33} &= -\frac{\partial\Gamma_{33}^{\lambda}}{\partial x^{\lambda}} + \Gamma_{3\lambda}^{\alpha}\Gamma_{3\alpha}^{\lambda} - \Gamma_{33}^{\lambda}\Gamma_{\lambda\alpha}^{\alpha} \\
&= -\frac{r^2}{c^2}\sin^2\theta\left[a\frac{\partial^2 a}{\partial t^2} + 2\left(\frac{\partial a}{\partial t}\right)^2 + 2Kc^2\right]
\end{aligned}$$

$$R_{\mu\nu} = 0,\ \forall\mu \neq \nu$$

For $T_{\mu\nu} - \frac{1}{2}g_{\mu\nu}T$, it has

$$T = g_{\mu\nu}T_{\mu\nu} = -\rho c^2 + 3P$$

$$T_{00} - \frac{1}{2}g_{00}T = \frac{c^2}{2}\left(\rho + \frac{3P}{c^2}\right)$$

$$T_{11} - \frac{1}{2}g_{11}T = \frac{1}{2}\frac{a^2c^2}{1-Kc^2}\left(\rho - \frac{P}{c^2}\right)$$

$$T_{22}-\frac{1}{2}g_{22}T=\frac{1}{2}r^2a^2c^2\left(\rho-\frac{P}{c^2}\right)$$

$$T_{33}-\frac{1}{2}g_{22}T=\frac{1}{2}\gamma^2a^2\sin^2\theta\, c^2\left(\rho-\frac{P}{c^2}\right) \qquad (6)$$

$$T_{\mu\nu}-\frac{1}{2}g_{\mu\nu}T=0.\ \forall\ \mu\neq\nu$$

Here, the Λ equation for Lemaitre of the FRW metric is applied

$$R_{\mu\nu}=-\frac{8\pi G}{c^4}\left(T_{\mu\nu}-\frac{1}{2}g_{\mu\nu}T\right)+\Lambda g_{ij} \qquad (7)$$

Now, $g_{ij}=-g_{\mu\nu}$

Replace formula (5) and (6) into formula (7), then by equation R_{00}, it can derive:

$$\ddot{a}=-\frac{4\pi G}{3}\left(\rho+\frac{3P}{c^2}\right)a+\frac{\Lambda c^2}{3}a \qquad (8)$$

The acceleration of the Newtonian potential from the action of the cosmic anti-sky on the m galaxy in the positive sky

$$\frac{d_{AB}^2}{\mathrm{d}t^2}=\frac{GM}{a^2(4+r^2-4r\cos\theta)}(\hat{e}_-)$$

Comparing to formula (8) and the Friedmann universe model, there is an extra term $\frac{\Lambda c^2}{3}a$. It is the physical effect of anti-sky action on the positive sky galaxies. Thus, at the determined moment, the galaxies moving in FRW can be treated as the instantaneous cooperation of -FRW and FRW. Replacing the item containing Λ in formula (8) with $\frac{\mathrm{d}^2AB}{\mathrm{d}t^2}$, it will derive:

$$\ddot{a}=-\frac{4\pi G}{3}\left(\rho+\frac{3P}{c^2}\right)a+\frac{GM}{a^2(4+r^2-4r\cos\theta)}(\hat{e}_-) \qquad (9)$$

Comparing formula (8) and (9)

$$\Lambda=\frac{3GM}{a^3c^2(4+r^2-4r\cos\theta)}=\frac{3GM}{a^3c^2}\frac{1}{[4\sin^2\theta+(r-2\cos\theta)^2]}$$

It obtains by equation R_{11}:

$$a\ddot{a}+2\dot{a}^2=4\pi G\left(\rho-\frac{P}{c^2}\right)a^2-2Kc^2+\Lambda c^2a^2$$

Substituting the Λ value into the above formula:

$$a\ddot{a}+2\dot{a}^2=4\pi G\left(\rho-\frac{P}{c^2}\right)a^2-2Kc^2+\frac{3GM}{a[4\sin^2\theta+(r-2\cos\theta)^2]} \qquad (10)$$

By equation (9) and (10), to eliminate the $\ddot{a}$:

$$\left(\frac{\dot{a}}{a}\right)^2=\frac{8}{3}\pi G\rho+\frac{GM}{a^3(4+r^2-4r\cos\theta)}(\hat{e}_-)-\frac{Kc^2}{a^2} \qquad (11)$$

By the divergence equation $D^\mu T_{\mu\nu}=0$, it derives:

$$\frac{\mathrm{d}\rho}{\mathrm{d}t}+3\left(\frac{\dot{a}}{a}\right)\left(\rho+\frac{P}{c^2}\right)=0 \qquad (12)$$

Any two combination of the equation (9), (10), (11), and (12) could be called the improved Lemaitre equation, which is a cosmic model composed of the positive and anti-sky. By applying the Newtonian potential and Euclidean space on a very large scale, the evolution equation of the positive sky in Universe could be derived. This time, the FRW metric and the Lemaitre four-dimensional tensor equation in the positive matter sky should be adopted.

Appendix 4. Application in symmetry and Higgs Mechanism

1. Vacuum symmetry breaking

The universe is composed of the positive and anti-sky. Taking any point x ($x_\mu=(x_0, x)$) in the positive sky, where the effective gravitational field at this space time point is the summing field of the positive and anti-sky gravitational field (the general relativity curved space time is not considered here, and it is stated in the part 2.2 that the equivalence principles are not suitable for quantum mechanics). It is traditionally represented as：

$$\varphi = \varphi_R + \varphi_L = -\frac{Km_R}{\gamma_R} - \frac{KM_L}{\gamma_L} \qquad (1)$$

m_R is the positive sky effective material mass that produces the gravitational field at the fixed point of the positive sky while M_L is the total mass of the anti-sky. The difference is small for them. However, because the taken point is in the positive sky, thus, $\gamma_R \ll \gamma_L$, and $\varphi_R \gg \varphi_L$. As a result, the physical vacuum in the positive sky appears as a right-hand gravitational field. In order to adopt the quantum theory, the classical gravitational field can be phenomenally defined as a spinor field ψ with a spin value of 1/2 according to the definition of some chiral gravitational field in sections 1 and 2 of this paper. In the quantum mechanics equation under gravitational field (2.6), the Newton scalar potential of the macroscopic gravitational field can be understood as a quantum hierarchical spinor field scalar $\bar{\psi}\psi$. The physical process observed and experiment test is always occurred in the "vacuum" of the positive sky, which always exists a gravitational field, e.g., the summing field of the positive and anti-sky.

$$\varphi = k\bar{\psi}_R\psi_R + k\bar{\psi}_L\psi_L \qquad (2)$$

As mentioned above, the right-hand field is far larger than the left-hand field. Thus, the physical effect is manifested as the right-hand gravitational field vacuum, and this vacuum is invariant under any the parity transformation. It always represents as the right-hand gravitational field vacuum. In the (2) formula, if $k\bar{\psi}_R\psi_R = -k\bar{\psi}_L\psi_L$ (here φ=0), it is the symmetry point of the cosmic space in the positive and anti-sky, at which the symmetry of the vacuum remains constant. It is $k\bar{\psi}_R\psi_R \gg k\bar{\psi}_L\psi_L$ and $\varphi = k\bar{\psi}_R\psi_R + k\bar{\psi}_L\psi_L \neq 0$ at an any point in the positive sky vacuum. Therefore, the vacuum gravitational field involved in the interaction is actually symmetry breaking, and this breaking is caused by the asymmetry of the positive and anti-sky gravity field at any point in the positive sky space, which is the physical interpretation of the "vacuum symmetry spontaneous breaking" of the real physical vacuum. The breaking increases if the gravitational field is enhanced at x point, that is, the strong difference between the right-hand gravitational field and the left-hand gravitational field increases (The variety of the left-hand gravitational field in the positive sky is very small). Further, the parity transformation cannot change gravitational field of our experimental environment in the positive sky (our experiment or observation phenomenon is always in the positive sky gravitational field, and the positive sky gravitational field can be mathematically transformed into the anti-sky gravitational field, which is so-called mathematical parity conservation). The parity breaking caused in this case is assigned to the intensity of the gravitational field. The difference of the parity breaking degree is found originated from the gravitation field different from the earth region. A more detailed study is the observable parity breaking arising from the action difference between the right-handed gravitational field in the positive sky vacuum and the positive-antiparticle or the differences in spatial orientation, such as the C_0^{60} experiment. It is the topic of replacing the scalar field with the spinor field in gauge theory.

2. Analysis of the quality generation using Higgs mechanism

In the Higgs mechanism of the standard model in the particle physics, it is assumed there is a scalar field Φ(χ) in nature. It interacts with the gauge and fermionic fields by maintaining the localized gauge symmetry, and the scalar field strength is not the lowest energy state of the system by assuming a suitable scalar potential. However, the vacuum state of the system in the quantum theory is the lowest energy state of the system, causing the spontaneous breaking of vacuum symmetry. The vacuum state of the scalar field interacted with the gauge and fermionic fields gives a mass to the gauge particles and fermions. However, it is only a guessed scalar field and the corresponding spontaneous breaking vacuum state under the requirements of gauge theory. On one hand, we are still not clear whether such a physical scalar field and its required spontaneous breaking vacuum state exists. On the other hand, our understanding of the physical real vacuum is still vague, and we can contact only one physical real vacuum state if regardless of the varies of the vacuum gravitational field strength. Whereas, it had to be the different vacuum or vacuum states, which is required by different physical theories. In fact, we can create countless vacuum states mathematically. It is known that there must be a gravitational field in the physical vacuum. All physical experiments or phenomena are performed in a vacuum contained a gravitational field. The gravitational field in the vacuum, especially at a relatively low energy, has still not been introduced into the gauge theory. If the gravitational field is quantized and the physical vacuum is described on the basis of the quantum gravity field, the physical vacuum and its vacuum state contained the quantum gravitational field are very suitable for the gauge theory. Therefore, it determines the real physical field required by the scalar field and determines the physical reality of the real vacuum (the vacuum is a gravitational field medium). Then, the theoretical vacuum and the real field have been equated and finally the gravity field is introduced into the gauge theory, promoting to build the gauge theory and the standard model of particle physics.

As for the analysis in the section 1, the gravitational field may be represented as：

$$\varphi=\begin{pmatrix} \bar{\psi}_L\psi_L \\ \bar{\psi}_R\psi_R \end{pmatrix} \qquad (3)$$

The formula (3) is the scalar field required by the standard model gauge theory, so that the gravitational field existed in the positive sky space (the gravitational summary field caused in positive and antisky) corresponds to the scalar field required by the gauge theory. Then the gravitational field vacuum state in the positive sky corresponds to the scalar field vacuum state, and the scalar field and vacuum state in the gauge theory present the physical reality. In considering of the different requirements, such as for the convenient calculation and analysis for the Unitary gauge and the renormalizable non-unitary gauge contained Goldstone particles, the Scalar fields of unitary or other specifications will be used. For example, to match with the Weinberg-Salam-Glashow weak electro-uniform gauge theory, the scalar field is:

$$\Phi(x)=\begin{pmatrix} \phi^{+}(x) \\ \phi^{0}(x) \end{pmatrix} or \Phi(x)=\begin{pmatrix} \phi^{+}(x) \\ [v + H(x) + i\chi(x)] / \sqrt{2} \end{pmatrix} \qquad (4)$$

The potential energy term is

$$V(\Phi) = -\mu^2\Phi^{+}\Phi + \lambda(\Phi^{+}\Phi)^2 \qquad (5)$$

The breaking of vacuum symmetry will spontaneously appear and it will lead the gauge particles to have mass and then Higgs particles will presence. All this will not be repeated here. This work will focus on two inseparable aspects of the same topic: one is to explain the dark energy phenomenon and calculate the cosmological constant with the interaction between macroscopic mass matter. On the other hand, the microscopic gravitational field is quantized and then the real vacuum and vacuum states of physics are defined based on this gravitational quantization and mass generation, to derive parity breaking and confirm the scalar field vacuum in the Higgs mechanism of the standard model without further Feynman rules and cross-section calculations. As we know, the interaction between macroscopic mass matter needs to recognize and define gravitational fields. The gravitational field quantization, the generation and the stability of mass matter all need to analyze the microscopic particle mass generation and interaction information. In order to obtain the particle mass generation and interaction information, the gravitational field vacuum physics reality is not considering here. Then, the non-abelian group Su(2) gauge symmetry spontaneous breaking is used as an example and the U(1) gauge transformation of QED is directly analyzed.

The real scalar field φ is transformed in 3 dimensions of the Su (2) group. The matrix generated from Su (2) denoted as $L_j(j = 1,2,3)$. Let $A_\mu \equiv A_{j\mu} L_j$, the covariant differential quotient $\left[\left(\partial_\mu + igA_\mu\right)\varphi\right]_i = \partial_\mu \varphi_i - gA_{j\mu}\varepsilon_{ijk}\varphi_k$, and the partial of φ was included in the Lagrangian density.

$$\mathcal{L} = \frac{1}{2}\left(\partial_\mu \varphi_i - gA_{j\mu}\varepsilon_{ijk}\varphi_k\right)\left(\partial^\mu \varphi_i - gA_l^\mu \varepsilon_{ilm}\varphi_m\right) - V(\varphi^T \cdot \varphi) \quad (6)$$

Let SU (2) has symmetry spontaneous breaking, that is, $V(\varphi^T \cdot \varphi)$ has non-zero minimal points, thus it is always $\langle\varphi\rangle_0 = \begin{pmatrix} 0 \\ 0 \\ v \end{pmatrix}$ by rotating SU (2). Thus, the nonzero vacuum expectation appears only in the third component of $\langle\varphi\rangle_0$.

The 3 D representation matrix of SU (2) is $L_1 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{bmatrix}$, $L_2 = \begin{bmatrix} 0 & 0 & i \\ 0 & 0 & 0 \\ -i & 0 & 0 \end{bmatrix}$, and $L_3 = \begin{bmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$, respectively. Therefore, there is $L_1\langle\varphi\rangle_0 = \begin{bmatrix} 0 \\ -iv \\ 0 \end{bmatrix} \neq 0$, $L_{,2}\langle\varphi\rangle_0 = \begin{bmatrix} iv \\ 0 \\ 0 \end{bmatrix} \neq 0$, $L_3\langle\varphi\rangle_0 = 0$.

It suggests that the vacuum is no longer invariant under L_1 and L_2, whereas it is still invariant under L_3. By parameterizingφ, it could obtain $\varphi = \exp\left[-\frac{i}{2}(\zeta_1 L_1 + \zeta_2 L_2)\right]\begin{bmatrix} 0 \\ 0 \\ v + \eta \end{bmatrix} = \langle\varphi\rangle_0 + \begin{bmatrix} \zeta_2 \\ -\zeta_1 \\ \eta \end{bmatrix}$ + high-secondary term of the field.

ζ_1 and ζ_2 are two Goldstone bosons associated with the breaking generation $L_1$and L_2.

Make the domain Su(2) specification transformation: $\varphi(x) \to \varphi'(x) = U(x)\varphi(x) = exp\left\{\frac{i}{v}\left[\zeta_1(x)L_1 + \zeta_2(x)L_2\right]\right\}\varphi(x) = \begin{pmatrix} 0 \\ 0 \\ v + \eta \end{pmatrix}$

$$A_{\mu j}(x)L_j \to A'_{\mu j}(x)L_j = U(x)\left[A_{ij}(x)L_j - \frac{1}{g}\partial_\mu\right]U^+(x)$$

Substituting the upper binary formula into the equation (6), we obtained:

$$\mathcal{L}(\varphi,\ A_\mu) = \mathcal{L}(\varphi',\ A'_\mu) = \frac{1}{2}\left(\partial_\mu \eta\right)(\partial^\mu \eta) + \frac{1}{2}g^2 v^2\left(A'_{1\mu}A_1'^{\mu} + A'_{2\mu}A_2'^{\mu}\right) + \cdots$$

It is noteworthy that in $\mathcal{L}$ the scalar field ζ_1、ζ_2 corresponding L_1 and L_2 vanishes. However, the gauge fields $A'_{1\mu}$ and $A'_{2\mu}$ corresponding L_1, L_2 gain the mass. Known by the infinitesimal transform $\mathrm{U}(x) = 1 + \frac{i}{2}(\zeta_1 L_1 + \zeta_2 L_2)$,

$$A'_{j\mu}(x) = A_{j\mu}(x) - \frac{1}{gv}\left(\partial_\mu \zeta_j(x) + o(\zeta^2,\ \zeta\mathrm{A})\right),\ \ j=1,2 \quad (7)$$

Thus, the vanishing scalar fields ζ_1 and ζ_2 are absorbed into the longitudinal components of the gauge fields $A'_{1\mu}$ and $A'_{2\mu}$, respectively, making them massive fields.

For the gauge transformation of u(1) in QED, in the invariant L-quantity after gauge transformation, $A'_{\mu}(x) = A_{\mu}(x) - \frac{1}{ev}\partial_{\mu}\zeta(x)$。 The vanishing scalar field ζ enters the longitudinal component of the A'_{μ}, making the massless vector field A_{μ} a massive vector field.

In terms of the mass production of the Higgs mechanism of the above Su(2), u(1) gauge fields, the scalar field is necessarily required both in the electromagnetic gauge theory or the standard model gauge theory (containing U(1) gauge). Moreover, the gauge particles could obtain mass only when the vanishing scalar fields such as ζ_1 and ζ_2 in SU(2), become longitudinal components of the gauge field. In the previous discussion, it is clear that the scalar field required by the standard model gauge theory of the particle physics is the scalar of the gravitational spinor field in the real physical vacuum. The mathematical formula of the scalar field introduced to the theory is represented as formula (4) and its potential energy terms is showed as formula (5), which gives the gauge particle mass during the symmetry breaking. Therefore, the generation of mass can be understood as: although the gravitational field is weak, the longitudinal polarized gravitational field is one of the conditions for the generation of mass matter (that is "mass matter"). The other is the transverse condition and it is the transverse polarized electromagnetic field for electrons. The two conditions are indispensable, neither deficiency can constitute a stable mass matter (particles). Furthermore, it is concluded that the mass material generated by the energy levels must have transverse electromagnetic field conditions and longitudinal gravitational field conditions. Consequently, the stronger the gravitational field in the positive sky is, the more stable the particle is, and the more unstable the anti-particle is. Obviously, this particle stability conclusion is related to the Yukawa coupling of the fermions and scalar field ($\mathcal{L}_{Yukawa} = -g_i^L \bar{l}_{iR}\overline{\Phi}^+ l_L^i + g_{ij}^d \bar{d}'_{ik}\Phi^+ q_L^j - g_i^u \bar{u}_{iR}\tilde{\Phi}^+ q_L^i + h.c$).Due to the positive and antiparticle spin in the coupling term between the scalar field (gravitational field) in the Lagrange quantity and the fermion field, the different positive and negative masses make different contributions to the Lagrange quantity values. Thus, the positive and antiparticle show the different lifetimes. Consequently, a positive matter is stable and antimatter is unstable in the right-handed gravitational field. And the stronger the field strength, the greater the difference between the Lagrange quantity value of the positive and antiparticles is. That is, the stronger the right-hand field strength, the more stable the positive matter is, and the more unstable the antimatter is. Therefore, the right-handed gravitational field is a stable field for the positive matter and the unstable field for the antimatter. It derives there existed a microscopic chiral symmetric particle world and also a macroscopic chiral-symmetric universe via combining the CPT theorem and the limit case of the Rydberg formula in the gravitational field condition. The universe consists of the positive and antimatter sky, in which the positive and antimatter cannot mix together to form the universe. We do analysis by above approaches but not to calculate particle lifetime through the Green's function, because it is a real new physics by introducing the gravitational field scalar into gauge theory. It is involving into the gravitational field (scalar field) and gauge field, fermion field, Faddeev-Popov ghost field. The issues to select the scalar gravitational field or spinor is still existence, and it is the problem we will continue to solve in future.

Based on the analysis of the Higgs mechanism and the energy solution of the quantization equation of section 3.2, we can conclude that the mass matter generated by energy matter must have transverse electromagnetic field conditions and longitudinal gravitational field conditions. The stronger region of the positive sky gravitational field is, the positive matter will be more stable in this region. Meanwhile, the antimatter is more unstable. Similarly, in the strong region of the anti-sky gravitational field, the antimatter is more stable while the positive matter is more unstable.

So, the positive and antimatter cannot be intermingled, and they can only form a chiral symmetric positive-antimaterter sky.

In terms of the micromatter structure, the synthetic particles should have two conditions: one is the transverse energy and the other is the longitudinal gravitational field. Under a fixed gravity field condition of C_M=1 in the earth area, we cannot synthesize the big massive particles even if we promote the energy conditions. If you need to synthesize the big massive particles, it is necessary to reduce C_M, that is, to improve the gravitational field strength. Therefore, to synthesize the big massive particles, you have to find a larger field strength zone (by the way, I therefore don't advocate building a large high-energy collider on earth, it is firmed not get any experimental results). With the enhancement of the gravitational field, it performs in macroscopic as a spectroscopy red-shifted of the atomic structure, the atomic structure of the white dwarf, and the dense material structure of the neutron stars. In fact, these macroscopic phenomena themselves are proof that the external gravitational field will change the matter structure.