

Unified Field Equation Generated by Longitudinal Electromagnetic (LEM) Waves

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Abstract: According to special relativity, the relationship of electromagnetic conversion in a linear moving vacuum and the relationship formula between the magnetic vector potential/scalar potential and the LEM (Longitudinal Electromagnetic) waves, it is inferred that the spherical vacuum space we are in undergoes outward helical motion at the speed of light following the right-hand screw rule, accompanied by a radial space expansion motion far less than the speed of light. Based on this space basis, we derive a unified field equation indicating that the gravitational field might be equivalent to the acceleration field of the radial expansion motion of our vacuum space, the strong nuclear force field presumably is generated by the light-rotation angular velocity of our space, the weak nuclear force field is most probably produced by its radial expansion motion and the electromagnetic field is undoubtedly produced by the radial linear motion of our space at the speed of light. We have also demonstrated both theoretically and experimentally that the LEM waves can generate artificial gravitational fields, and the LEM waves are the material basis of the unified field theory. Essentially, on Earth, time is the result of the relativistic length contraction effect caused by the radial space expansion speed, which leads to the rate of change of distance in the radial dimension on the unit radial space expansion speed. Moreover, based on the length contraction effect in special relativity, the time and space generated by the outward helical motion of space at the speed of light can be expressed as zero. This indicates that such motion not only does not affect the seemingly perpetually stationary space that we can constantly perceive but also enables the gravitational field formula to remain unchanged in our space. They constitute the spatio-temporal basis of the unified field theory. Based on our unified field theory, we have also discussed some forward-looking perspectives, such as motion at the speed of light, anti-gravitation fields, and interstellar travel.

Key words: QED (quantum electrodynamics), LEM wave, electromagnetic induction, unified field equation, artificial gravitation field.

1. Preface

General relativity is a doctrine that discusses cosmic gravitation, while quantum theory is a doctrine that deliberates on the characteristics of particles. These two doctrines are the theoretical underpinnings of contemporary science and technology [1, 2]. Quantum mechanics posits that forces arise from the exchange of particles. The electromagnetic force is engendered by the exchange of photons, the weak nuclear force is produced by the exchange of bosons, and the strong nuclear force is generated by the exchange of gluons. Nevertheless, gravity cannot be "quantized". The gravitational equation of general relativity asserts that the mass of celestial bodies in the universe leads to the

curvature of spacetime, and the curvature of spacetime gives rise to gravitation [3, 4]. Currently, the weak nuclear force and electromagnetic force have been unified [5], and the unification of the strong nuclear force is on the verge of realization [5], yet gravity is excluded. The hypothesized "graviton" by scientists has not been discovered. At present, string theory is regarded as the most likely grand unified theory [6-8]. However, string theory lacks the support of experimental evidence [9]. General relativity is unable to incorporate the strong nuclear force, electromagnetic force, and weak nuclear force into the gravitational equation. This disparity between general relativity and quantum theory is both mathematical and physical. The

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fundamental reason lies in that traditional mainstream physics has not determined the common material and spacetime basis of relativity and quantum theory. Therefore, tracing to the source and understanding the common material and spacetime basis of relativity and quantum theory becomes the key to resolving this disparity. The wave model and particle model of the LEM (Longitudinal Electromagnetic) waves [10, 11] have opened up novel ideas and directions for addressing the fundamental issues in the unified field theory.

The LEM wave possesses characteristics such as transmitting energy and drug information [12-14], being stably absorbed by water [10], having non-destructive penetrability for the human body, potential superluminality, absorbing free energy, and lossless energy transmission [11], and it holds immense potential and practical value in the fields of medicine and energy, attracting extensive attention [15-23]. However, current Maxwell's equations neglect the LEM wave term, rendering them incompatible with the LEM wave. Hence, establishing a rigorous mathematical model for the LEM wave and incorporating it into the theoretical framework of current Maxwell's equations [11] is of utmost urgency. Simultaneously, exploring the electromagnetic essence of the LEM wave is conducive to revealing the underlying mechanisms of its applications in medicine and energy, facilitating the discovery of the common material and spacetime basis for the unification of relativity and quantum theory, and aiding in uncovering some fundamental problems in the unified field theory [24].

2. Relativistic Effect of Electromagnetic Conversion

2.1 Electromagnetic Conversion in a Moving Vacuum

In Fig. 1, in our vacuum a stationary coordinate system S and an observer coordinate system (moving coordinate system) S' coinciding with the origin of S at $t = 0$ are established. S' is moving negatively toward the z-axis at \vec{V}_R , which is equivalent to that the vacuum moves forward uniformly towards the z axis at

\vec{V}_R while S' is static. In accordance with the principle of special relativity, the covariant form of each fundamental law governing electromagnetic phenomena can be expressed for any inertial coordinate system. Thus, when transitioning a vacuum electromagnetic field from S to S' in Fig. 1, by using the electromagnetic tensor $F_{\mu\nu}$ [25], current Maxwell's equations can be written as $\partial F_{\mu\nu}/\partial X_\mu = \mu_0 J_\nu$ and $\frac{\partial F_{\mu\nu}}{\partial X_\lambda} + \frac{\partial F_{\nu\lambda}}{\partial X_\mu} + \frac{\partial F_{\lambda\mu}}{\partial X_\nu} = 0$. Here, X_μ is a four-dimensional coordinate vector and J_μ is a four-dimensional current vector. When S' undergoes negative displacement with velocity V_R along the z-axis, it is equivalent to S' being considered as stationary, while our vacuum medium undergoing positive displacement with velocity V_R along z-axis. By applying Lorentz covariant transformation principle [26], we can express $F'_{\mu\nu}$, which represents the electromagnetic tensor in S', as:

$$F'_{\mu\nu} = a_{\mu\lambda} a_{\nu\tau} F_{\lambda\tau} = a_{\mu\lambda} F_{\lambda\tau} \widetilde{a}_{\nu\tau} \quad (1)$$

Here, $F_{\lambda\tau}$ represents the electromagnetic tensor in S and $a_{\mu\lambda}$ and $\widetilde{a}_{\nu\tau}$ are respectively the transformation matrix from S to S' and its transpose matrix. Therefore, according to Eq. (1), under vacuum condition, we can express LEM wave \vec{E}'_θ and \vec{B}'_z [11, 27, 28] in S', as:

$$\vec{E}'_\theta = \gamma(\vec{E}_\theta - V_R \vec{e}_R \times \vec{B}_z) \quad (2)$$

$$\vec{B}'_z/\mu_0 \varepsilon_0 = \gamma(\vec{B}_z/\mu_0 \varepsilon_0 + V_R \vec{e}_R \times \vec{E}_\theta) \quad (3)$$

Here, γ is the vacuum Lorentz factor; \vec{E}_θ and \vec{B}_z are the electromagnetic fields in S; \vec{E}'_θ and \vec{B}'_z are the electromagnetic fields in S'; \vec{V}_R is the motion velocity of the moving vacuum medium. From Eqs. (2) and (3), it can be given that:

$$\vec{E}'_r = \gamma \vec{V}_R \times \vec{B} = \vec{V}_R \times \vec{B}'_r \quad (4)$$

$$\frac{1}{\mu_0 \varepsilon_0} \vec{B}'_r = \gamma \vec{V}_R \times \vec{E} = \vec{V}_R \times \vec{E}'_r \quad (5)$$

where, μ_0 and ε_0 are the absolute permeability and dielectric constant of vacuum, \vec{E}'_r , \vec{B}'_r are the additional electromagnetic fields generated by the relativistic scaling effect of \vec{V}_R . Eq. (4) indicates that

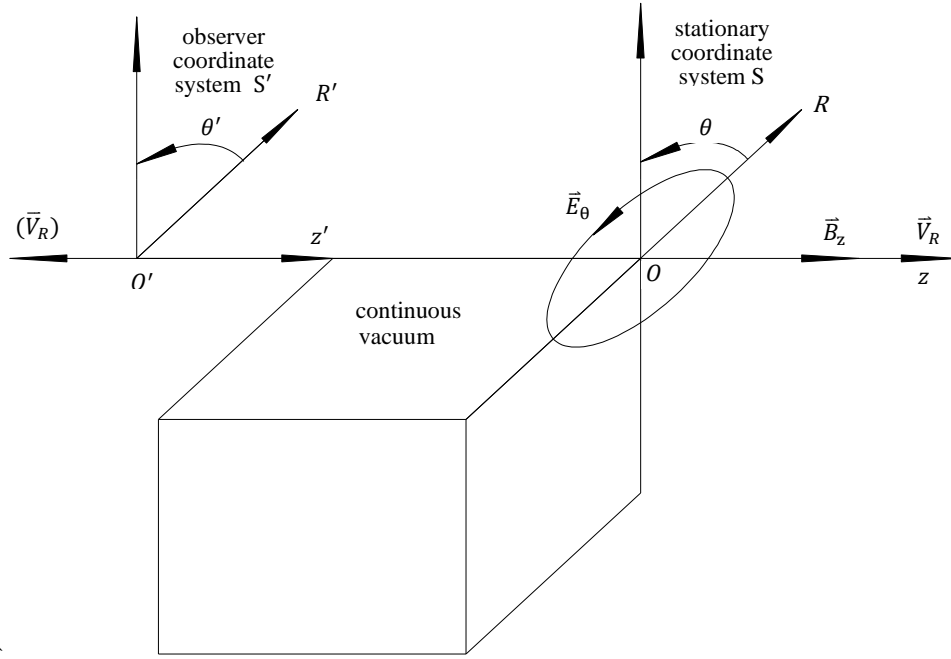


Fig. 1 LEM electromagnetic fields in a moving vacuum.

\vec{B} in S can be converted into \vec{B}'_r in S' through the relativistic effect of \vec{V}_R and is applicable to the process of generating electricity from magnetism, while Eq. (5) indicates that \vec{E} in S is converted into \vec{B}'_r in S' through the relativistic effect of \vec{V}_R and is applicable to the process of generating magnetism from electricity. Eqs. (4) and (5) unveil the essential relationships of electromagnetic conversion in a vacuum medium moving linearly at a speed \vec{V}_R .

2.2 Electromagnetic Conversion in a Static Vacuum

According to the relations of \vec{E} with φ and \vec{A} [29], it is obtained in a static vacuum that:

$$\begin{aligned}\vec{E}_\theta &= -\frac{\partial \vec{A}_\theta}{\partial t} = j \omega_p \vec{A}_\theta \\ &= -C \vec{e}_R \times j \frac{\omega_p}{C} (\vec{e}_R \times \vec{A}_\theta) \quad (6) \\ &= -C \vec{e}_R \times (\nabla \times \vec{A}_\theta) \\ &= -C \vec{e}_R \times \vec{B}_z\end{aligned}$$

In accordance with Faraday's law of electromagnetic induction [29],

$$\nabla \times \vec{E}_\theta = -\frac{\partial \vec{B}_z}{\partial t} = j \omega_p \vec{B}_z, \text{ i.e., } \vec{B}_z = \frac{1}{j \omega_p} \nabla \times \vec{E}_\theta = \frac{1}{\omega_p} \vec{k} \times \vec{E}_\theta$$

Substituting Eq. (6) into the above equation gives:

$$\frac{1}{\mu_0 \epsilon_0} \vec{B}_z = C \vec{e}_R \times \vec{E}_\theta \quad (7)$$

Eqs. (6) and (7) are the mutual conversion formulas of electromagnetic fields of the LEM waves propagating at light speed in a static vacuum.

3. Two Kinds of Motions of Our Vacuum

Substituting Eqs. (6) and (7) into Eqs. (2) and (3) gives that:

$$\vec{E}'_\theta = -\gamma(C + V_R) \vec{e}_R \times \vec{B}_z \quad (8)$$

$$\vec{B}'_z / \mu_0 \epsilon_0 = \gamma(C + V_R) \vec{e}_R \times \vec{E}_\theta \quad (9)$$

If V_R is significantly lower than the speed of light, we can obtain that $\vec{B}'_z \approx \vec{B}_z$, $\vec{E}'_\theta \approx \vec{E}_\theta$, $\gamma \approx 1$, and then Eqs. (8) and (9) can be simplified as:

$$\vec{E}_\theta \approx -(C + V_R) \vec{e}_R \times \vec{B}_z \approx -C \vec{e}_R \times \vec{B}_z \quad (8.1)$$

$$\vec{B}_z / \mu_0 \epsilon_0 \approx (C + V_R) \vec{e}_R \times \vec{E}_\theta \approx C \vec{e}_R \times \vec{E}_\theta \quad (9.1)$$

which means that the wave equations for $\vec{E}_\theta / \vec{B}_z$ [11] propagating at the speed of light $(C + V_R) \vec{e}_z$ in a static vacuum space is equivalent to the additional electromagnetic field equations produced by the relativistic scaling effect of the speed of light motion

$(C + V_R)\vec{e}_z$, where V_R is negligible compared with C .

By using Eqs. (8.1) and (9.1), we can obtain that the basic equations of the LEM waves \vec{E}_θ/\vec{B}_z with a wave speed C and a frequency ω_P in a static vacuum are shown as:

$$\nabla \times \vec{E}_\theta = -\frac{\partial \vec{B}_z}{\partial t} \quad (8.2)$$

$$\frac{1}{\mu_0 \varepsilon_0} \nabla \times \vec{B}_z = \frac{\partial \vec{E}_\theta}{\partial t} \quad (9.2)$$

which gives that:

$$\vec{E}_\theta = E_{\theta 0} \exp \left[j \left(\frac{\omega_P}{C} z - \omega_P t \right) \right] \vec{e}_\theta \quad (8.3)$$

$$\begin{aligned} \vec{B}_z &= B_{z0} \exp \left[j \left(\frac{\omega_P}{C} z - \omega_P t \right) \right] \vec{e}_z \\ &= \frac{E_{\theta 0}}{C} \exp \left[j \left(\frac{\omega_P}{C} z - \omega_P t \right) \right] \vec{e}_z \end{aligned} \quad (9.3)$$

where ω_P is presented as [11]:

$$\omega_P = j \frac{1}{\tau_2} = j \frac{\omega^2 \varepsilon_0}{\sigma_0} \sim 10^{29} \text{ Hz} \quad (10)$$

Here, τ_2 is the vortex attenuation period of the vacuum vortex electric field \vec{E}_θ [11], ω is the frequency of the source light waves generating it [11], σ_0 and ε_0 are the vacuum conductivity and vacuum dielectric constant. Substituting Eqs. (10) into (8.2) and (9.2), we can obtain:

$$\nabla \times \vec{E}_\theta = -\frac{\partial \vec{B}_z}{\partial t} = j\omega_P \vec{B}_z = -\vec{B}_z/\tau_2 \quad (11)$$

$$\frac{1}{\mu_0 \varepsilon_0} \nabla \times \vec{B}_z = \frac{\partial \vec{E}_\theta}{\partial t} = -j\omega_P \vec{E}_\theta = \vec{E}_\theta/\tau_2. \quad (12)$$

Eqs. (8.3) and (9.3) can be rewritten as:

$$\begin{aligned} \vec{E}_\theta &= \vec{B}_{z0} \exp(-j\omega_P t) \cdot \exp \left(j \frac{\omega_P}{C} z \right) \\ &= \vec{E}_{\theta 0} [\cos(-\omega_P t) \\ &\quad + j \sin(-\omega_P t)] \cdot \exp \left(j \frac{\omega_P}{C} z \right) \end{aligned} \quad (13)$$

$$\begin{aligned} \vec{B}_z &= \vec{B}_{z0} \exp(-j\omega_P t) \cdot \exp \left(j \frac{\omega_P}{C} z \right) \\ &= \vec{B}_{z0} [\cos(-\omega_P t) \\ &\quad + j \sin(-\omega_P t)] \cdot \exp \left(j \frac{\omega_P}{C} z \right) \end{aligned} \quad (14)$$

Mathematically, Eqs. (13) and (14) signify that the LEM waves \vec{E}_θ/\vec{B}_z , which propagates in a static

vacuum with a wave velocity of $C\vec{e}_z$ and a frequency of ω_P , are equivalent to a clockwise spiral with $E_{\theta 0}/B_{z0}$ as the helical radius, $2\pi\omega_P$ as the angular velocity, and moving along the positive z -axis at the speed of light C (viewed from the arrowhead to the arrow tail of the z -axis, see Fig.2). Moreover, in accordance with our LEM wave propagation particle model [10, 11], \vec{B}_z in Figs. 2 and 3 consists of two neutrinos with the same orbital rotation direction and the same spin direction. The orbital linear velocity \vec{V}_θ of the neutrinos revolving around the center of \vec{B}_z and the spiral radius R_z are equal to the speed of light C and the wavelength λ_z of \vec{B}_z . Supposing that the spiral radius $E_{\theta 0}/B_{z0}$ of \vec{E}_θ/\vec{B}_z is equal to the radius λ_z of the neutrino's revolution around the central axis of \vec{B}_z , the pitch λ and the spiral linear velocity V_θ of the clockwise spiral motion equivalent to the LEM wave \vec{E}_θ/\vec{B}_z can be represented as

$$\lambda = C\tau_2 = 3 \times 10^{-21} \text{ m} = \lambda_z, \quad (13.1)$$

$$V_\theta = 2\pi\omega_P R_z = 2\pi\omega_P \lambda_z = 2\pi C = C. \quad (14.1)$$

Consequently, in accordance with the principle of relativity of motion, the LEM waves \vec{E}_θ/\vec{B}_z propagating in a static vacuum along the \vec{R} direction at the speed of light (equivalent to a clockwise light-speed helical motion along the \vec{R} direction) can be equated to the LEM waves formed by the fluctuation of a vacuum ($\vec{V}_z = C\vec{e}_R$, $\vec{V}_\theta = C\vec{e}_\theta$, accompanied by the radial space expansion motion $\vec{V}_R = V_R\vec{e}_R \ll C$ [24], see Fig.4) that moves outward in a counter-clockwise direction at the speed of light along the \vec{R} direction with the stationary electromagnetic field $\vec{E}_{\theta 0}/\vec{B}_{z0}$. Thus, it can thus be observed that the reference frame of Maxwell's equations for the electromagnetic field can be a hypothetically absolutely stationary vacuum where the particles constituting the electromagnetic field perform a clockwise light-speed helical motion along the \vec{R} direction; or equivalently it can be assumed that the particles constituting the electromagnetic field are in an absolute stationary coordinate system, while the vacuum undergoes a counter-clockwise light-speed helical motion along the \vec{R} direction.

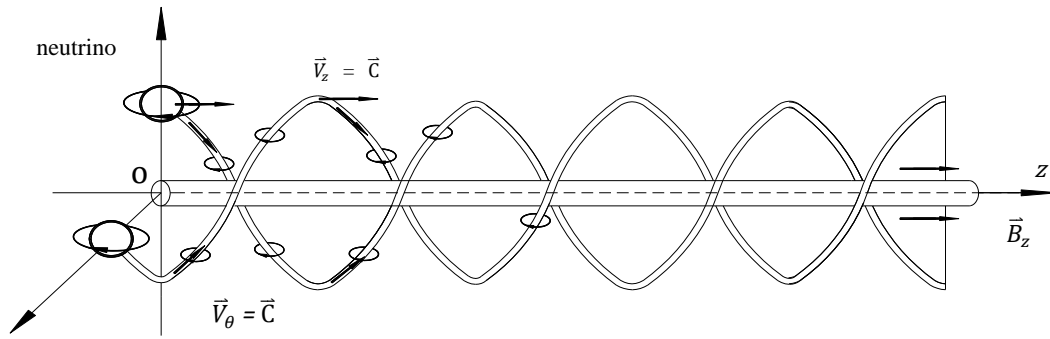


Fig. 2 Particle model of LEM wave \vec{B}_z .

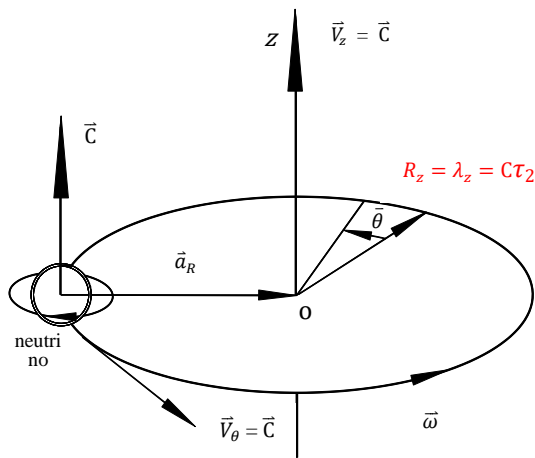


Fig. 3 Neutrinos' revolution around the center core of LEM wave.

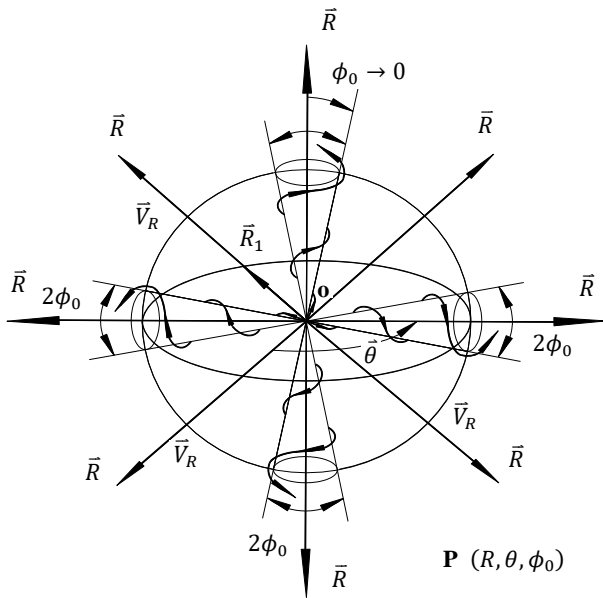


Fig. 4 Two kinds of motions of our vacuum.

4. Unified Field Equation Generated by Vacuum LEM Waves

As depicted in Fig. 5, in the source region V' (centered at point O') adjacent to the zero point O_B known as the singularity formed at the inception of the Big Bang that gives rise to our vacuum space V (field point region centered at point O on the center of our Earth), there exist some continuous-static charges $\rho(\vec{r}', t)$ and a static current source $\vec{J}(\vec{r}', t)$ producing the stationary electromagnetic field $\vec{E}_{\theta 0}$ and $\vec{B}_{z 0}$ in V . Moreover, in Fig. 6, a stationary cylindrical coordinate system $O_B(R, \theta, z)$ with an origin O_B is established, where the coordinate of source point P' is (R', θ', z') and the coordinate of the field point P is (R, θ, z) . \vec{r}'_0 and \vec{r}' are the vectors from the zero point O_B to O and O' ; \vec{R} is the vector from O' to O , which is equal to $\vec{r}'_0 - \vec{r}'$. What is more, a stationary spherical coordinate system $O(R_1, \theta_1, \phi_1)$ with an origin O on the center of our Earth is established to describe the motions of space V , where ϕ_1 is keeping a constant $\phi_0 \rightarrow 0$.

When the source point region V' approaches zero and zero point O_B coincides with source point O' which results in $\vec{R} = \vec{r}'_0$. Meanwhile, it is assumed that our vacuum V can be discretized into a series of micro-cones with cone angles $2\phi_0$ not zero but tending to zero and spiraling outward counterclockwise at the speed of light centered at point O along the positive direction of R_1 axis. Due to $\phi_0 \rightarrow 0$, based on Eqs. (13.1) and (14.1), these micro-cones can be approximated as individual counterclockwise micro-helical cylinders

with a radius of $\lambda_z = c\tau_2 \sim 10^{-21} \text{m} \rightarrow 0$. Their motions are a counterclockwise helical motion at the speed of light centered at point O and outward along the positive direction of R_1 axis (a combined motion of the light-speed motion $\vec{V}_z = C\vec{e}_{R1}$ in positive R_1 -direction and the light-speed rotational motion $\vec{V}_\theta = C\vec{e}_{\theta1}$ in positive θ_1 -direction, whose directions comply with the right-hand screw rule, with a helical radius of $\lambda_z \sim 10^{-21} \text{m}$) accompanied by a spatial expansional motion $\vec{V}_R = V_R\vec{e}_{R1} \ll \vec{C}$ along positive R_1 -axis (see Fig. 5). From Ref. [29], we can obtain in vacuum \mathbf{V} that as $\vec{R}_1 = \vec{R} \ll \vec{C}$, the magnetic vector potential \vec{A} and the scalar potential φ in the electromagnetic fields \vec{E}_θ/\vec{B}_z produced by $\vec{E}_{\theta0}/\vec{B}_{z0}$ and the outward light-speed spiral motion of \mathbf{V} are shown as

$$\vec{A}(\vec{R}, t) = \frac{\mu_0}{4\pi} \int_{V'} \frac{\vec{J}(\vec{r}', t)}{R} dV' \quad (15)$$

$$\varphi(\vec{R}, t) = \frac{1}{4\pi\epsilon_0} \int_{V'} \frac{\rho(\vec{r}', t)}{R} dV' = CA_z \quad (16)$$

which gives that when:

$$R_1 = R \ll C/\omega_p \sim 10^{-21} \text{m} \rightarrow 0 \ll C \quad [11] \quad (17)$$

we can obtain that $\vec{r} = \vec{r}_p + \vec{r}_o \rightarrow \vec{R}, \frac{\partial R}{\partial t} = \frac{\partial r}{\partial t} = \frac{\partial r_p}{\partial t}$,

$$\begin{aligned} \vec{B}_z = \nabla \times \vec{A}_\theta &= \frac{\mu_0}{4\pi} \int_{V'} -R^{-2}(\vec{e}_R \times \vec{J}_\theta) dV' \\ &= \vec{e}_R \times \frac{\mu_0}{4\pi} \int_{V'} -R^{-2} \vec{J}_\theta dV' \end{aligned} \quad (18)$$

and

$$\begin{aligned} \vec{E}_\theta = -\nabla\varphi_\theta - \frac{\partial \vec{A}_\theta}{\partial t} &= -\frac{\partial \vec{A}_\theta}{\partial t} \\ &= \frac{\mu_0}{4\pi} \int_{V'} R^{-2} \frac{\partial R}{\partial t} \vec{J}_\theta dV' \\ &= -\frac{\partial r_p}{\partial t} \frac{\mu_0}{4\pi} \int_{V'} -R^{-2} \vec{J}_\theta dV' \\ &= -\left(\frac{\partial r_p}{\partial R_1} \frac{\partial R_1}{\partial t} + \frac{\partial r_p}{\partial \theta_1} \frac{\partial \theta_1}{\partial t} \right. \\ &\quad \left. + \frac{\partial r_p}{\partial \phi_1} \frac{\partial \phi_1}{\partial t} \right) \vec{e}_R \times \vec{B}_z \\ &= -\left(\frac{\partial R_1}{\partial t} + \frac{1}{R_1} V_\theta \right. \\ &\quad \left. + \frac{1}{R_1 \sin \theta_1} V_\phi \right) \vec{e}_R \times \vec{B}_z \\ &= -(V_R + C + C/R_1) \vec{e}_R \times \vec{B}_z \end{aligned} \quad (19)$$

Here, \vec{E}_θ/\vec{B}_z are the LEM waves produced by $\vec{E}_{\theta0}/\vec{B}_{z0}$ and the outward light-speed spiral motion of \mathbf{V} , i.e., that are propagating at light speed in a static vacuum [11].

According to Eq. (19), when $R_1 \ll 10^{-21} \text{m} \rightarrow 0$ and the spatial expansion motion $V_R \ll C$, we are able to obtain that:

$$\begin{aligned} \frac{\partial \vec{E}_\theta}{\partial t} &= -a\vec{e}_R \times \vec{B}_z - (C/R_1)\vec{e}_R \times \frac{\partial \vec{B}_z}{\partial t} \\ &\quad - C\vec{e}_R \times \frac{\partial \vec{B}_z}{\partial t} - V_R\vec{e}_R \times \frac{\partial \vec{B}_z}{\partial t} \\ &= -a\vec{e}_R \times \vec{B}_z \\ &\quad - (C/R_1)\vec{e}_R \times \vec{B}_z/\tau_2 \\ &\quad - C\vec{e}_R \times \vec{B}_z/\tau_2 \\ &\quad - V_R\vec{e}_R \times \vec{B}_z/\tau_2 \end{aligned} \quad (20)$$

In Eq. (20), the first term presumably represents the portion where the vacuum LEM waves generate the gravitational field a equivalent to the acceleration field produced by the spatial expansion motion \vec{V}_R of our vacuum \mathbf{V} , the second term is most probably the part that gives rise to the strong nuclear force field, the third term is undoubtedly the component that generates the electromagnetic field and the last term might be the component that generates the weak nuclear force. Based on Eq. (20), it is obtained that:

$$\frac{\partial \vec{E}_\theta}{\partial t} = -a\vec{e}_R \times \vec{B}_z = \vec{E}_\theta/\tau_2 \quad (21)$$

which are called as the Maxwell's equation of the gravitational field generated by vacuum LEM waves. From Eq. (21), it is given that:

$$\begin{aligned} \vec{a} = -a\vec{e}_R &= \frac{\vec{B}_z}{B_z^2 \tau_2} \times \vec{E}_\theta = -\frac{C}{\tau_2} \vec{e}_R = -C\omega_p \vec{e}_R \\ &= -\frac{C^2}{\lambda_z} \vec{e}_R = \vec{a}_R \end{aligned} \quad (22)$$

which is defined as the artificial gravitation field formula generated by vacuum LEM waves \vec{E}_θ/\vec{B}_z , where \vec{a}_R is the centripetal acceleration of the neutrinos' revolution around the center core of B_z , C is the neutrinos' revolution line velocity and λ_z representing the orbital radius is the wavelength of B_z in our particle model [10, 11] of the LEM wave in Figs. 3 and 4.

In Eq. (20), taking $R_1 = 10^{-3}\lambda_z \ll \lambda_z$ gives that:

$$\begin{aligned} \frac{\partial \vec{E}_\theta}{\partial t} = & -a\vec{e}_R \times \vec{B}_z - (10^3 C/\lambda_z)\vec{e}_R \times \vec{E}_\theta/\tau_2 \\ & - C\vec{e}_R \times \vec{B}_z/\tau_2 \\ & - V_R\vec{e}_R \times \vec{B}_z/\tau_2 \end{aligned} \quad (23)$$

According to Eq. (23), we can obtain that:

$$\frac{1}{B_z} \frac{\partial E_\theta}{\partial t} = a + 10^3/\tau_2^2 + C/\tau_2 + V_R/\tau_2 \quad (24)$$

where, the first term a might represent gravitational field caused by the expanding motion $\vec{V}_R = V_R\vec{e}_R$ of our vacuum space \mathbf{V} , the second term presumably corresponds the strong nuclear force field produced by

$$\vec{r}_P = (R_1, \theta_1, \phi_0)$$

$$\vec{r}_O = (R_0, \theta_0, z_0)$$

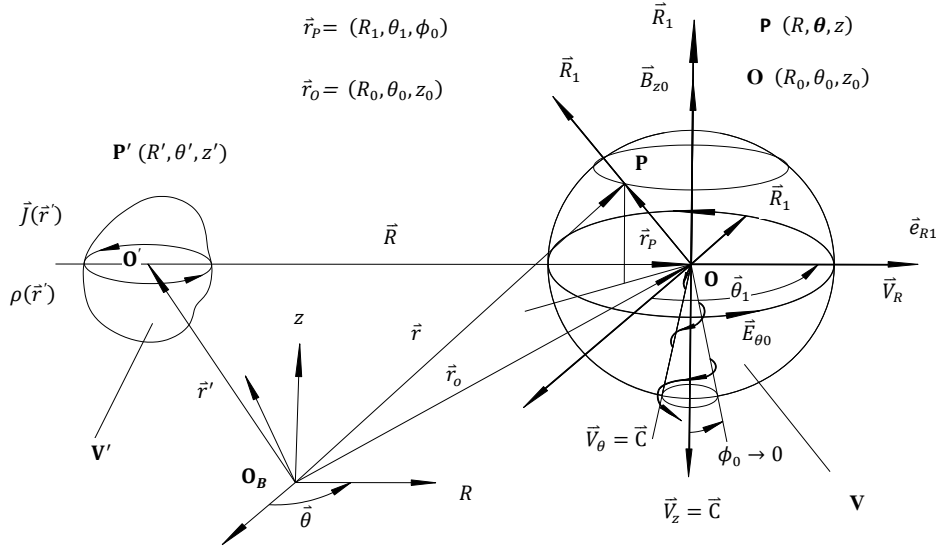


Fig. 5 Distribution diagram of source points and field points in a moving vacuum.

Analyzing Eq. (24) on the Earth's surface, we can gain $a = V_0^2/r_D = 7.9 \times 7.9 \times 10^6 / 6.371 \times 10^6 = 9.8 \text{ m/s}^2$ and $V_R = r_D H = 6.371 \times 10^6 \times 67.8 \times 10^3 / (3.08 \times 10^{22}) = 1.4 \times 10^{-11} \text{ m/s} \ll C$, which gives that $10^3/\tau_2^2 = 1 \times 10^{61} \text{ m/s}^2$, $C/\tau_2 = 3 \times 10^{37} \text{ m/s}^2$ and $V_R/\tau_2 = 1.4 \times 10^{18} \text{ m/s}^2$. Here, V_0 is the first cosmic velocity, r_D is the radius of the Earth and H is Hubble constant [31]. Evidently, at this circumstance, strong nuclear force field : electromagnetic field : weak nuclear force field : gravitational field = $10^{61} : 10^{36} : 10^{18} : 1$. From the viewpoint of LEM waves, the nuclear force field, gravitational field and electromagnetic field seem to be unified. It can be concluded from above analysis that

the revolution motion $C\vec{e}_\theta$ of \mathbf{V} , the third term undoubtedly stands for the electromagnetic field generated by the line motion $C\vec{e}_z$ of \mathbf{V} and the last term most probably is the weak nuclear force. Eq. (24) is famous as the unified field equation in which the gravitation, nuclear and electromagnetic fields are unified on the level of LEM waves in a vacuum space \mathbf{V} which is moving spirally outward at a speed of light along positive- z and θ directions while expanding along positive- R direction at the speed of $V_R \ll C$ (see Fig. 5). This is the cosmic space basis of unification of relativity and quantum theory.

vacuum LEM waves and spatial motions of \mathbf{V} can generate gravitational field, electromagnetic field and nuclear force field. LEM waves are the material basis of unified field theory, while \mathbf{V} with the spatial motions including $C\vec{e}_R, C\vec{e}_\theta$ and $V_R\vec{e}_R$ is the space basis of it. Naturally, this conclusion still requires a large number of experiments for verification and sustainment.

5. Experimental Validation of the Generation of Artificial Gravitational Field by Using Vacuum LEM Waves

The working principle diagram of the experimental device for generating artificial gravitational fields [30] is shown in Fig. 6. In a horizontally placed vacuum tank

with a diameter of 10 cm, a red polyethylene pellet with a mass of 0.35 g is suspended. During the experiment, the vacuum tank is evacuated to prevent the electrostatic motor effect and the ion wind effect from causing the pellet to rotate. Two coils wound with silicone wires are placed at the top and bottom of the vacuum tank, respectively. (The coil diameter is 8 cm, the coil height is 12 cm; the diameter of the wire wound into a coil is 10 mm, and at the center of the wire is a copper core with a diameter of 1.5 mm.) The two coils are isolated by the vacuum tank, and their other ends are respectively connected to the positive and negative electrodes of a pulsed direct current with a frequency of 30,000 Hz and a voltage of 70-100,000 volts. Since the electric field can easily pass through the thick glass of the vacuum tank, the polarization effect of the electric field cannot be completely avoided. However, in the coil structure of our experiment, the center line of the coil is parallel to the line on which the polyethylene pellet is suspended, and the force generated by the polarization effect is along the parallel direction of the line, while the polyethylene pellet rotates around the axis of the wire. Therefore, the polarization effect has no influence on its rotation. When the experiment starts, the power switch is pressed, and the pellet in the vacuum tank begins to rotate counterclockwise (viewed from the arrow tail of \vec{B}_z to its arrow head, see Fig.6). When the power is turned off, the rotation of the pellet accelerates but maintains the same rotation direction.

According to the principle of electromagnetic induction, the quasi-vortex electric field \vec{E}_θ and the quasi-scalar magnetic field \vec{B}_z generated by the coils conform to the right-hand screw rule [29]. As shown in Eq. (30), the quasi-electromagnetic longitudinal wave \vec{E}_θ/\vec{B}_z and the generated gravitational field \vec{a}_R are shown in Fig.6, indicating that \vec{E}_θ/\vec{B}_z can produce a centripetal acceleration \vec{a}_R for the rotating pellet. According to our LEM wave propagation particle model [10, 11], the LEM wave \vec{B}_z consists of two neutrinos with the same orbital rotation and spin direction. The orbital linear velocity of the neutrino \vec{V}_θ and orbital radius \vec{R}_1 of

the neutrino's revolution around the core of \vec{B}_z are equal to the speed of light C and the wavelength λ_z of \vec{B}_z . Then the centripetal acceleration \vec{a}_R of the neutrino's rotating around the core of \vec{B}_z is shown as in Fig. 3.

$$\vec{a}_R = -\frac{C^2}{\lambda_z} \vec{e}_R = -\frac{C}{\tau_z} \vec{e}_R. \quad (25)$$

Therefore, from Eqs. (22) and (25), we can obtain

$$\vec{a} = -\vec{E}_\theta \times \frac{\vec{B}_z}{B_z^2 \tau_z} = -\frac{C}{\tau_z} \vec{e}_r = -\frac{C^2}{\lambda_z} \vec{e}_r = \vec{a}_R \quad (26)$$

which means the artificial gravitational field \vec{a} generated by \vec{E}_θ/\vec{B}_z is equal to precisely the centripetal acceleration field \vec{a}_R of the neutrinos that constitute the LEM wave and rotate around its central core. Through the method of analogy, it can be obtained that the mechanism by which the LEM wave generates the gravitational field and rotational speed on the polyethylene pellet should be the same as the mechanism by which the neutrinos rotate around the central core of the LEM wave, that is, the rotation direction of the polyethylene pellet should be the same as the rotation direction of the neutrinos rotating around the central core of the LEM wave, which is counterclockwise. Our experiment clearly proves this point.

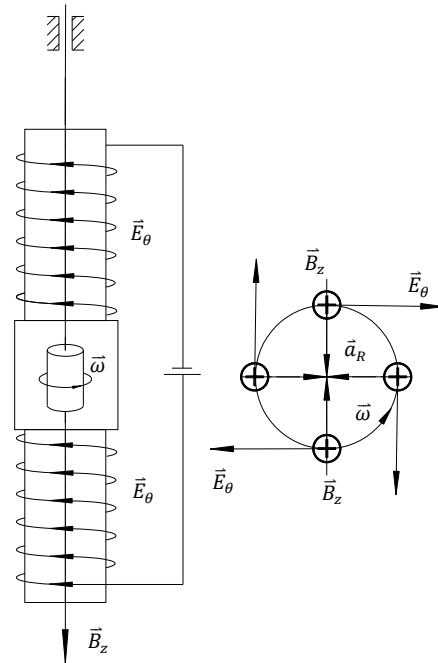


Fig. 6 Working principle diagram of the experimental setup.

6. Discussion

6.1 LEM Waves May Be Capable of Generating Anti-gravitation Field

From above analysis, it should be inferred that vacuum LEM waves are capable of generating artificial gravitational fields. This conclusion still requires a substantial amount of experimentation for validation. If aforementioned theory holds true, humanity can utilize LEM waves to achieve anti-gravitation fields. When the mass of an object becomes zero, in accordance with special relativity [1], the object can reach the speed of light. Furthermore, based on the relativistic length contraction effect and time dilation effect [1], the space dimension at the speed of light can be reduced to zero, and time comes to a halt, meaning that humanity can achieve interstellar teleportation and explore far away location in the universe.

6.2 The Gravitational Field Produced by TEM Waves Can Be Negligible

By employing the same analytical approach, it can be obtained $\frac{1}{\mu_0 \epsilon_0} \frac{\partial \vec{B}_t}{\partial t} = \vec{a}_t \times \vec{E}_t$ and $\frac{\partial \vec{E}_t}{\partial t} = -\vec{a}_t \times \vec{B}_t$ where $\vec{a}_t = -\frac{C^2}{\lambda_t} \vec{e}_t = -C\omega \vec{e}_t$ while $\vec{a} = -\frac{C^2}{\lambda_z} \vec{e}_R = -\frac{C}{\tau_2} \vec{e}_R = -C\omega_P \vec{e}_R$. Jiang and Wang [11] give that $\omega_P \approx 10^{29}$ Hz $\gg \omega = 10^{13}$ Hz, which results in $a_t \ll a$, that is, the vacuum gravitational field is mainly generated by LEM waves, and the gravitational field a_t generated by TEM waves can be disregarded.

6.3 The Material Basis of Unified Field Theory

In Fig. 7, it has been proven that LEM wave \vec{E}_θ and \vec{B}_z [11] propagating at the speed $C\vec{e}_R/C\vec{e}_\theta$ and $V_R\vec{e}_R$ in a static vacuum space are equivalent to the additional static electromagnetic fields \vec{E}_{θ_0} and \vec{B}_{z_0} waving with a vacuum space moving at the speed $C\vec{e}_R$, $V_R\vec{e}_R$ and $C\vec{e}_\theta$, generated by the relativistic scaling effect of the

motions of the moving vacuum space in which the momentum and force on \vec{e}_R of an object with a mass m can be presented as:

$$\vec{P} = mC\vec{e}_R + mV_R\vec{e}_R + mC\vec{e}_\theta \quad (27)$$

$$\vec{F}_R = \partial \vec{P} / \partial t = -ma\vec{e}_R - m\frac{C^2}{\lambda_z}\vec{e}_R + (C +$$

$$V_R)\vec{e}_R \partial m / \partial t = -ma\vec{e}_R - m\frac{C^2}{\lambda_z}\vec{e}_R + C\vec{e}_R \partial m / \partial t$$

which gives that

$$\begin{aligned} \frac{\vec{F}_R}{m} &= \vec{a} + \vec{a}_s + \vec{a}_c = \vec{a} - \frac{C^2}{\lambda_z}\vec{e}_R + C\vec{e}_R \frac{\partial}{\partial t} \\ &= \vec{a} + C\vec{e}_R/\tau_2 - C\vec{e}_R/\tau_2 = \vec{a} \end{aligned} \quad (28)$$

where

$$\frac{\partial m}{\partial t} = m/\tau_2 = -j\omega_P m \quad (29)$$

notifying that mass has the same frequency as LEM waves, i.e., LEM waves are the material basis of unified field theory; \vec{a}_s is the gravitational field on \vec{e}_R produced by motion $C\vec{e}_\theta$ of \mathbf{V} while \vec{a}_c is the gravitational field in the R direction generated by the mass variation of the substance; $V_R = r_D H = 6.371 \times 10^6 \times 67.8 \times 10^3 / (3.08 \times 10^{22}) = 1.4 \times 10^{-11}$ m/s $\ll C$. Here, H is Hubble constant [31].

Eq. (28) represents gravitational field on the Earth is caused by the expanding motion $\vec{V}_R = V_R\vec{e}_R$ of our vacuum space \mathbf{V} while the gravitational fields on \vec{e}_R caused by motion $C\vec{e}_\theta$ of \mathbf{V} and by the mass variation of the substance just counterbalance.

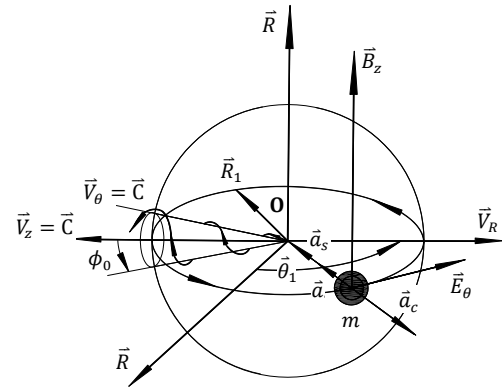


Fig. 7 Gravitational field on the Earth caused by the motions of our vacuum space.

6.4 The Essence of Time and the Space-Time Basis of Unified Field Theory

The space we are situated in, denoted as \mathbf{V} in a spherical coordinate system, can be expressed as:

$$\begin{aligned}\vec{R}_P &= (R_1, \theta_1, \phi_1) \\ &= \left(V_R t, \frac{1}{R_1} V_\theta t, \frac{1}{R_1 \sin \theta_1} V_\phi t \right) \quad (30) \\ &= \left(V_R + C, \frac{C}{R_1}, 0 \right) t = \vec{V} t\end{aligned}$$

In fact, the motion of our vacuum space \mathbf{V} consists of an outward light-speed spiral motion with a radius of R_1 (a combined motion of the light-speed motion $\vec{V}_z = C\vec{e}_R$ in the positive R -direction, a light-speed rotational motion $\vec{V}_\theta = C\vec{e}_\theta$ in the positive θ -direction) and a spatial expansional motion $\vec{V}_R = V_R\vec{e}_R$ along the positive R -axis, which is the space basis of unified field theory. Space \mathbf{V} commences its motion from the center of our Earth, accelerating from zero velocity along R and θ directions to C . At this instant, the R and θ -axes of \mathbf{V} are shortened to zero due to the length contraction effect of special relativity. Therefore, the time t_c and space \vec{R}_c generated by motion $C\vec{e}_R$ and $C\vec{e}_\theta$ of \mathbf{V} can be expressed as:

$$t_c = (R', \theta', 0)/(C, C/R', 0) = (R'/C, \theta'/C, 0/C) / (1, 1/R', 0) = 0/(1, \infty, 0) = 0, \quad (31)$$

$$\vec{R}_c = (C, C/R', 0)t_c = (0, 0, 0) \quad (32)$$

indicating that both the dimension and time in space \mathbf{V} moving at the speed of light will vanish. This presents that there is no concept of distance ($R' = Ct_c = 0$) in the directions of light-speed motions, that is, no matter how long R -distant in \mathbf{V} , an object moving at the speed of light without mass can arrive instantaneously. This theoretical conclusion is in accordance with special relativity and serves as the theoretical foundation for interstellar teleportation.

The time t generated by the expansion velocity $\vec{V}_R = V_R\vec{e}_R$ in our vacuum space \mathbf{V} can be expressed as $\vec{R}_t = \vec{V}_R t$, that is,

$$t = (R, 0, 0)/(V_R, 0, 0) = \vec{R}/\vec{V}_R = R/V_R, \quad (33)$$

i.e., essentially, time on Earth is the rate of change of dimension R over the unit space expansion velocity

V_R , and our time is produced by the expansion motion in R -direction of our vacuum space \mathbf{V} , which is the time basis of unified field theory.

7. Conclusion

It can be known from the previous theoretical analysis that the vacuum space we are in has two types of motions: a radial outward counterclockwise helical light-speed motion and a radial space expansion motion, a unified field equation can be obtained, where, the gravitational field might be equivalent to the acceleration field of the radial expansion of the vacuum space we are in, denoted as $V_R\vec{e}_R$, the strong nuclear force field presumably is generated by its light-speed rotational motion $C\vec{e}_\theta$, the electromagnetic field is undoubtedly produced by its linear light-speed motion $C\vec{e}_R$ and the weak nuclear force field equaling V_R/τ_2 is most probably produced by its radial expansion motion $V_R\vec{e}_R$. Additionally, it has been proved that the vacuum LEM waves can generate an artificial gravitational field, which constitutes the material basis of the unified field theory. Essentially, the time on Earth is generated by the radial expansion of our vacuum space and is equal to the rate of change of the radial dimension distance per unit space expansion speed. The time and space generated by the outward light-speed helical motion of our vacuum space can be expressed as $t_c = 0$ and $\vec{R}_c = (0, 0, 0)$, indicating that this motion does not affect our continuous perception of the seemingly perpetually static space we are in and the existing gravitational field in our space, which forms the spatio-temporal basis of the unified field theory. Due to the amplitude of the LEM waves being much smaller than that of the TEM waves [11], the existing instruments are basically incapable of measuring the LEM waves. Therefore, only the direction in which the LEM waves generate the gravitational field has been verified. The relationship between the frequency of the LEM waves and the gravitational field they generate has not been verified, which is the focus of subsequent research work.

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