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The Magnetic Longitudinal (P-) Wave's Propagation and Energy Models Underlying the Mechanisms of Its Capacity to Absorb Free Energy

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Abstract

The longitudinal wave term within Faraday's law of electromagnetic induction (Faraday's law) underwent recovery to ensure its suitability for theoretical derivation of the equation governing longitudinal electromagnetic (LEM) waves. The revised Maxwell's equations include the crucial parameters being the attenuation time constants of magnetic vortex potential and electric vortex potential generated by external electromagnetic field within the propagation medium. Specific expressions for them are obtained through theoretical analysis. Subsequently, a model for propagating magnetic P-wave generated by the superposition of a left-handed photo and a right-handed photon in a vacuum is formulated based on reevaluated total current law and revised Faraday's law, covering wave equations, energy equation, as well as propagation mode involving mutual induction and conversion between scalar magnetic field and vortex electric field. Furthermore, through theoretical derivations centered around magnetic P-wave, evidence was presented regarding its ability to absorb huge free energy through the entangled interaction between zero-point vacuum energy field and the torsion field produced by the vortex electric field.

Keywords

QED (Quantum Electrodynamics), Energy Wave and TEM (Transverse Electromagnetic) Wave, Magnetic P-Wave, Modified Faraday's Law of Electromagnetic Induction, Electric/Magnetic Vortex Potential, Zero-Point Vacuum Energy

1. Introduction

The longitudinal electromagnetic (LEM) wave, also named as scalar wave (SW), was first identified by Maxwell, who combined electricity and magnetism and developed the Maxwell's equations [1]. In 1890, Tesla observed the LEM wave while refining Hertz's experiment and introduced the concept of scalar field [2]. Aharonov and Bohm [3] experimentally demonstrated the presence of magnetic vector potential and electromagnetic scalar potential in a zero electromagnetic field in 1959, confirming the existence of LEM waves. Meyl [4] [5] conducted extensive research on LEM waves and proposed that Maxwell's equations have solutions involving longitudinal waves. Zohuri [6] [7] presented a quantum electrodynamic theoretical framework for LEM waves, Monstein [8] [9] provided their existence from an astrophysical perspective, while Oschman [10] suggested that two anti-phase coherent light waves would generate a LEM wave. When studying about the reflection of incidence waves in initially stressed dissipative half space, Ivanovs [11] found two complex quasi-P-wave and quasi-TEM waves. Drawing upon the principles of momentum conservation and energy conservation, Shekhar and Parvez [12] introduced a novel approach for computing the amplitudes (coefficients) of reflected and transmitted longitudinal waves.

The exceptional properties of LEM waves have attracted widespread attentions [13]-[18] for their potential applications in medicine and energy areas due to their harmlessly free penetration of the human body, potentially superluminal speed, absorption of free energy, and lossless energy transmission. However, there are some skepticism [19] regarding their existence and effectiveness due to the lack of rigorous theoretical models for LEM waves. Therefore, establishing robust propagation mode and wave equation for LEM waves is essential for advancing the application of LEM waves. However, current Maxwell's equations neglect the LEM wave item, rendering them incompatible with such waves. It is imperative to reintroduce the longitudinal wave item into Maxwell's equations and develop a rigorous mathematical model for LEM waves, integrating it into the theoretical framework of Maxwell's equations. Meanwhile, exploring the essence of LEM wave is helpful to unveil the underlying mechanisms of its absorption free energy and the applications in medical and energetic areas.

2. The LEM Wave Items and Electromagnetic Induction Laws Concealed in Faraday's Law and Total Current Law

2.1. The Mutual Conversion Relationship of the Electromagnetic Fields

The total current law can be expressed as

$$\nabla \times \boldsymbol{B}/\mu\varepsilon = \partial \boldsymbol{E}/\partial t + \frac{1}{\varepsilon}\boldsymbol{J} = \partial \boldsymbol{E}/\partial t - (\nabla \cdot \boldsymbol{E})\boldsymbol{V}_e = \partial \boldsymbol{E}/\partial t + \frac{\sigma}{\varepsilon}\boldsymbol{E} \quad (1)$$

Here, $\boldsymbol{V}_e$ is a constant vector, and from Equation (1), we can obtain

$$\begin{aligned}\nabla\times\boldsymbol{B}/\mu\varepsilon &= \partial\boldsymbol{E}/\partial t-(\nabla\cdot\boldsymbol{E})\boldsymbol{V}_e\\ &= -(\nabla\cdot\boldsymbol{E})\boldsymbol{V}_e-(\boldsymbol{E}\cdot\nabla)\boldsymbol{V}_e+(\boldsymbol{V}_e\cdot\nabla)\boldsymbol{E}+(\nabla\cdot\boldsymbol{V}_e)\boldsymbol{E}\\ &= \nabla\times(\boldsymbol{E}\times\boldsymbol{V}_e),\end{aligned}\tag{1.1}$$

that is,

$$\boldsymbol{B}/\mu\varepsilon=-\boldsymbol{V}_e\times\boldsymbol{E},\tag{1.2}$$

The projection of Equation (1) onto the z-axis in **Figure 1** gives

$$\begin{aligned}\nabla\times\boldsymbol{B}_z/\mu\varepsilon &= \partial\boldsymbol{E}_z/\partial t-(\nabla\cdot\boldsymbol{E}_z)\boldsymbol{V}_{ez}\\ &= -(\nabla\cdot\boldsymbol{E}_z)\boldsymbol{V}_{ez}-(\boldsymbol{E}_z\cdot\nabla)\boldsymbol{V}_{ez}+(\boldsymbol{V}_{ez}\cdot\nabla)\boldsymbol{E}_z+(\nabla\cdot\boldsymbol{V}_{ez})\boldsymbol{E}_z\\ &= \nabla\times(\boldsymbol{E}_z\times\boldsymbol{V}_{ez}),\end{aligned}\tag{1.3}$$

i.e.,

$$\boldsymbol{B}_z/\mu\varepsilon=-\boldsymbol{V}_{ez}\times\boldsymbol{E}_z,\tag{2}$$

Subtracting Equation (1) from Equation (2) yields

$$\boldsymbol{B}_t/\mu\varepsilon=-\boldsymbol{V}_{ez}\times\boldsymbol{E}_t-\boldsymbol{V}_{et}\times\boldsymbol{E}_z-\boldsymbol{V}_{et}\times\boldsymbol{E}_t=-\boldsymbol{V}_{ez}\times\boldsymbol{E}_t-\boldsymbol{V}_{et}\times\boldsymbol{E}_z.\tag{2.1}$$

Multiplying ∇ operator by both sides of the Equation (2.1) yields

$$\nabla\times\boldsymbol{B}_t/\mu\varepsilon=\partial\boldsymbol{E}_t/\partial t-(\nabla\cdot\boldsymbol{E}_z)\boldsymbol{V}_{et}=\partial\boldsymbol{E}_t/\partial t+\frac{\sigma}{\varepsilon}\boldsymbol{E}_t,\tag{2.2}$$

which is total current law of TEM waves. In a good conductor, $\sigma/\omega\varepsilon\gg1$, when electromagnetic waves propagate perpendicularly to the surface of the medium and enter it, Equation (2.2) combining Faraday's law of transverse electromagnetic (TEM) waves gives

$$\nabla^2\boldsymbol{E}_t-\mu\varepsilon\frac{\partial^2\boldsymbol{E}_t}{\partial t^2}-\mu\sigma\frac{\partial\boldsymbol{E}_t}{\partial t}=0\tag{2.3}$$

with a plane wave solution [20] shown as

$$\boldsymbol{E}_t(\boldsymbol{r},t)=\boldsymbol{E}_{t0}\exp\left[\mathrm{j}(kz-\omega t)\right],\tag{2.4}$$

where,

$$k\approx\frac{\omega}{V_B}+\mathrm{j}\frac{\omega}{V_B}=\left(\sqrt{\frac{1}{2}\mu\sigma\omega}+\mathrm{j}\sqrt{\frac{1}{2}\mu\sigma\omega}\right),\ V_B=\sqrt{2\omega/\mu\sigma}.\tag{2.5}$$

In accordance with Faraday's law of TEM wave [20], shown as $\nabla\times\boldsymbol{E}_t=-\frac{\partial\boldsymbol{B}_t}{\partial t}=\mathrm{j}\omega\boldsymbol{B}_t$, we can obtain that

$$\boldsymbol{e}_z\times\boldsymbol{B}_t=\frac{1}{\mathrm{j}\omega}\mathrm{j}\boldsymbol{k}\times\boldsymbol{E}_t=\sqrt{\frac{\mu\sigma}{2\omega}}(1+\mathrm{j})\boldsymbol{e}_z\times(\boldsymbol{e}_z\times\boldsymbol{E}_t)=\frac{1}{V_B}(1+\mathrm{j})\boldsymbol{e}_z\times(\boldsymbol{e}_z\times\boldsymbol{E}_t)=-\frac{1}{V_B}(1+\mathrm{j})\boldsymbol{E}_t$$

i.e.,

$$\boldsymbol{E}_t=-\boldsymbol{V}_B\times\boldsymbol{B}_t.\tag{3}$$

Assuming that Equation (3) is valid for LEM waves, it follows that

$$\boldsymbol{E}=-\boldsymbol{V}_B\times\boldsymbol{B}.\tag{4}$$

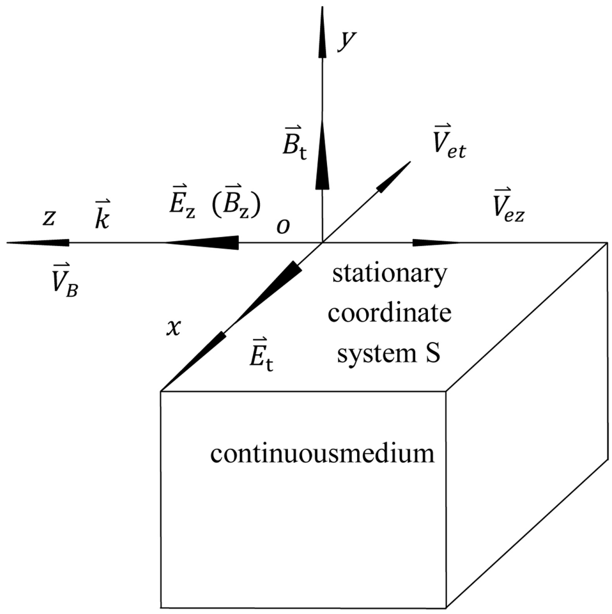


Figure 1. Electromagnetic fields in a continuous medium.

Equations (2), (2.1), and Equation (4) represent the formulas governing the inter-conversions of electromagnetic fields within a stationary conductive medium, where $-\boldsymbol{V}_{ez}$ denotes the phase velocity of LEM waves propagation through the medium, corresponding to the axial motion speed of the electric field (current) in the direction of electromagnetic wave propagation; while $\boldsymbol{V}_B$ signifies the phase velocity of TEM waves, *i.e.*, the velocity of the magnetic field motion. The directions of $-\boldsymbol{V}_{ez}$ and $\boldsymbol{V}_B$ are shown in Figure 1. Based on Equation (2) and Equation (4), it follows that $\boldsymbol{E}_z = -\boldsymbol{V}_B \times \boldsymbol{B}_z = 0$ and $\boldsymbol{B}_z/\mu\varepsilon = -\boldsymbol{V}_{ez} \times \boldsymbol{E}_z = 0$. It is important to note that here $\boldsymbol{E}_z = 0$ and $\boldsymbol{B}_z = 0$ do not indicate absolute zero values, but rather $E_z \ll E_t$ and $B_z \ll B_t$ Therefore, under typical conditions, the amplitude of the LEM wave is significantly smaller than that of the TEM wave and can be disregarded. However, under specific circumstances such as in the near field [13], Maxwell's equations necessitate consideration of the longitudinal wave term.

2.2. The Analysis of the Longitudinal Wave Terms in Total Current Law and Modified Faraday's Law

The electromagnetic conversion laws within the framework of total current law can be analyzed as follows: Illustrated in Figure 2, a conduction current $\boldsymbol{J}$ is generated within a region of a conductor with continuous free charge density ρ under the influence of the electric field component $\boldsymbol{E}_0$ from an externally excited electromagnetic field. The time-varying $\boldsymbol{J}$ gives rise to vortex-induced magnetic field (magnetic vortex potential) $\boldsymbol{B}_s$ and $\boldsymbol{B}_s$ simultaneously induces an eddy electric field $\boldsymbol{E}_s$ and eddy current $\boldsymbol{J}_s$ on the surface perpendicular to $\boldsymbol{B}_s$. Due to the presence of $\boldsymbol{J}_s$, at the center of the conductor, $\boldsymbol{J}_s$ opposes $\boldsymbol{J}$ in direction and equals it in magnitude, resulting in zero electromagnetic field within the interior of the conductor. On another side close to the conductor's surface, $\boldsymbol{J}_s$ aligns with $\boldsymbol{J}$. Consequently, only a thin layer (10^{-6} - 10^{-7} m) on the metal conductor surface concentrates induced electric fields $\boldsymbol{E}$ induced by $\boldsymbol{E}_0$, which represents skin effect caused by eddy currents [21]. By applying Gauss's theorem and conservation law for charge [20], we obtain $\partial\rho(t)/\partial t = -\sigma\rho(t)/\varepsilon$, where $\rho(t) = \rho_0 \exp(-\sigma t/\varepsilon)$. Introducing τ_1 as time attenuation constant when free charge $\rho(t)$ attenuations from its initial value ρ_0 to ρ_0/e yields

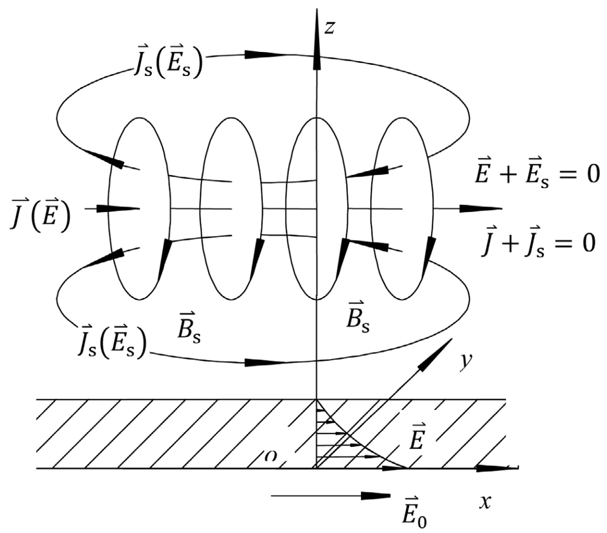


Figure 2. Magnetic vortex potential in metal conductor.

$$\tau_1 = \varepsilon/\sigma, \tag{5}$$

Substituting Equation (5) into Equation (1) yields

$$\nabla\times\boldsymbol{B}/\mu\varepsilon = \partial\boldsymbol{E}/\partial t + \frac{1}{\varepsilon}\boldsymbol{J} = \partial\boldsymbol{E}/\partial t - (\nabla\cdot\boldsymbol{E})\vec{V}_e = \partial\boldsymbol{E}/\partial t + \frac{\sigma}{\varepsilon}\boldsymbol{E} = \partial\boldsymbol{E}/\partial t + \boldsymbol{E}/\tau_1. \tag{6}$$

Here, $\boldsymbol{E}/\tau_1$ represents the longitudinal wave term, denoting the contribution of the scalar electric field $\boldsymbol{E}$ producing magnetic vortex potential $\boldsymbol{B}_s$ to $\nabla\times\boldsymbol{B}$ in a conductor. Electromagnetic duality suggests that there should exist a dual equation similar to Equation (6), and by cross-multiplying ∇ operator by both sides of Equation (4), we obtain modified Faraday's law considering the longitudinal wave term shown as

$$\nabla\times\boldsymbol{E} = \nabla\times(-\boldsymbol{V}_B\times\boldsymbol{B}) = (\boldsymbol{V}_B\cdot\nabla)\boldsymbol{B} - (\nabla\cdot\boldsymbol{B})\boldsymbol{V}_B = -\partial\boldsymbol{B}/\partial t - (\nabla\cdot\boldsymbol{B})\boldsymbol{V}_B. \tag{7}$$

Equation (7) is the dual of Equation (6), and the electromagnetic conversion law revealed by Equation (7) is analyzed as follows: When an external electromagnetic field acts on the surface of a conductor, its time-varying magnetic component $\boldsymbol{B}_0$ induces magnetic field $\boldsymbol{B}$ and vortex-induced electric field (electric vortex potential) $\boldsymbol{E}_w$ in the interior of the conductor, as depicted in Figure 3. Simultaneously, the time-varying $\boldsymbol{E}_w$ induces a magnetic field $\boldsymbol{B}_w$, which counteracts the intruding $\boldsymbol{B}_0$ field, resulting in a zero magnetic field within the conductor. Consequently, $\boldsymbol{B}$ induced by $\boldsymbol{B}_0$ is confined to a shallow layer on the surface of the conductor [21]. Referring to Equation (6), we can rewritten Equation (7) as

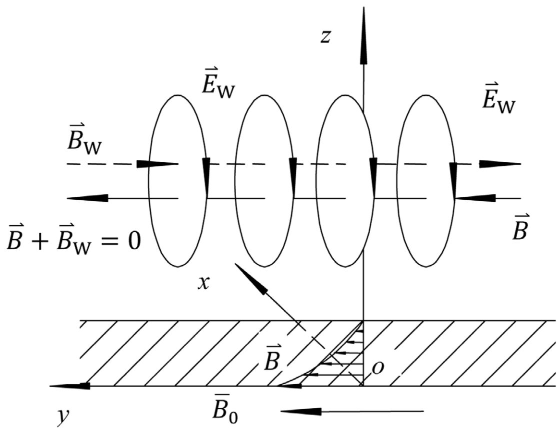


Figure 3. Electric vortex potential in metal conductor.

$$\nabla \times \boldsymbol{E} = -\partial \boldsymbol{B}/\partial t - (\nabla \cdot \boldsymbol{B})\boldsymbol{V}_B = -\partial \boldsymbol{B}/\partial t - \boldsymbol{B}/\tau_2 , \tag{8}$$

where $\boldsymbol{B}/\tau_2$ represents the contribution of the scalar magnetic field $\boldsymbol{B}$ generating electric vortex potential $\boldsymbol{E}_w$ to $\nabla \times \boldsymbol{E}$. Considering the definition of τ_1 as the time attenuation constant for the magnetic vortex potential $\boldsymbol{B}_s$ in Figure 2, τ_2 should be regarded as the time attenuation constant for electric vortex potential $\boldsymbol{E}_w$. According to literature [4], time attenuation constants τ_1 and τ_2 are related to medium's magnetic permeability μ, electrical conductivity σ, and dielectric constant ε. In addition to $\tau_1 = \varepsilon/\sigma$, it can be inferred that τ_2 is related to remaining parameters μ and σ. Using dimensional analysis yields

$$\tau_2 = \mu\sigma/k_0^2 , \tag{9}$$

where k_0 is a constant associated with characteristic parameters of medium and electromagnetic waves.

2.3. The Expression of τ_2

The wave equation for electromagnetic wave, formulated with Equation (6.1) and Equation (8.1) as its foundational equations, is expressed as

$$-\frac{1}{\mu\varepsilon}\nabla \times (\nabla \times \boldsymbol{E}) = -\frac{1}{\mu\varepsilon}\nabla(\nabla \cdot \boldsymbol{E}) + \frac{1}{\mu\varepsilon}\nabla^2 \boldsymbol{E} = \frac{\boldsymbol{E}}{\tau_1\tau_2} + \left(\frac{1}{\tau_1} + \frac{1}{\tau_2}\right)\frac{\partial \boldsymbol{E}}{\partial t} + \frac{\partial^2 \boldsymbol{E}}{\partial t^2}. \tag{10}$$

Taking a specific case as an analysis object, setting $\omega = \frac{1}{2}\left(\frac{1}{\tau_1} + \frac{1}{\tau_2}\right)$ and $\boldsymbol{E}(\boldsymbol{r},t) = \mathrm{e}^{-\omega t}\boldsymbol{E}_2(\boldsymbol{r},t)$, we can obtain that Equation (10) can be transformed into

$$\frac{1}{\mu\varepsilon}\nabla^2 \boldsymbol{E}_2 = \frac{\boldsymbol{E}_2}{\tau_1\tau_2} - \omega^2 \vec{E}_2 + \frac{\partial^2 \boldsymbol{E}_2}{\partial t^2}. \tag{10.1}$$

Again, setting $\boldsymbol{E}_2 = \mathrm{e}^{-\mathrm{j}\omega t}\boldsymbol{E}_1(\boldsymbol{r})$, substituting it into Equation (10.1) yields

$$\frac{1}{\mu\varepsilon}\nabla^2\boldsymbol{E}_1 = \frac{\boldsymbol{E}_1}{\tau_1\tau_2} - 2\omega^2\boldsymbol{E}_1, \tag{10.2}$$

$$\boldsymbol{E}_1 = \frac{\mathrm{j}}{\omega}\frac{\partial \boldsymbol{E}_1}{\partial t}. \tag{10.3}$$

Substituting Equation (10.3) into Equation (10.2) and considering the propagation medium as vacuum results in the following expression as

$$\mathrm{j}\hbar\frac{\partial \boldsymbol{E}_1}{\partial t} = -\frac{\hbar^2}{2m_1}\nabla^2\boldsymbol{E}_1 + \frac{\hbar}{2\omega\tau_1\tau_2}\boldsymbol{E}_1. \tag{10.4}$$

A motion model of photon with dynamic mass m_1 and zero rest mass m_0 is given as the counterpart of analysis and comparison. It moves in a spiral fashion along the *z*-axis (see to **Figure 4**) with a *z*-component linear velocity of *C*. Assuming the photon's spin linear velocity is also *C*, and its orbital linear velocity $\boldsymbol{V}$ being much smaller than the speed of light $\boldsymbol{C}$, we can neglect the photon's orbital kinetic energy compared to its spin kinetic energy [22]. The total energy of the photon can be expressed as

$$E = E_k + U = \hbar\omega = \frac{1}{2}PC + \frac{1}{2}S\omega = \frac{1}{2}m_1C^2 + \frac{1}{2}\hbar\omega = \frac{1}{2}m_1C^2 + U, \tag{10.5}$$

where E_k represents the kinetic energy of a photon in its linear motion along the *z*-axis, *P* denotes the photon momentum, *S* stands for the photon spin angular momentum, and *U* signifies photon spin kinetic energy [23], which is the intrinsic property of photon and can be interpreted as a potential energy term; $\hbar$ represents the reduced Planck constant. Equation (10.5) can be reformulated in operator form [23]

$$\mathrm{j}\hbar\frac{\partial \boldsymbol{E}_1}{\partial t} = -\frac{\hbar^2}{2m_1}\nabla^2\boldsymbol{E}_1 + U\boldsymbol{E}_1. \tag{10.6}$$

Upon substituting Equation (10.3) into Equation (10.6), it yields $-\frac{2m_1}{\hbar^2}\mathrm{j}\hbar\mathrm{j}\omega\boldsymbol{E}_1 - \frac{2m_1}{\hbar^2}U\boldsymbol{E}_1 = \frac{2m_1}{\hbar^2}(\hbar\omega - U)\boldsymbol{E}_1 = -\nabla^2\boldsymbol{E}_1 = \frac{\omega^2}{C^2}\boldsymbol{E}_1$, where $U = \hbar\omega - \frac{1}{2}\hbar\omega = \frac{1}{2}\hbar\omega = \frac{1}{2}m_1C^2$. Substituting it back into Equation (10.6) results in that

$$\mathrm{j}\hbar\frac{\partial \boldsymbol{E}_1}{\partial t} = -\frac{\hbar^2}{2m_1}\nabla^2\boldsymbol{E}_1 + \frac{1}{2}\hbar\omega\boldsymbol{E}_1. \tag{10.7}$$

Equation (10.7) is equivalent to Equation (10.4), where $\frac{\hbar}{2\omega\tau_1\tau_2} = \frac{1}{2}\hbar\omega$, implying that $1/\tau_1\tau_2 = \omega^2$. Substituting Equation (5) into it, we obtain

$$\tau_2 = \frac{\sigma}{\omega^2\varepsilon}. \tag{10.8}$$

Herein, ω refers to the frequency of TEM waves within the propagation medium, *i.e.*, the operating frequency of the external electromagnetic field.

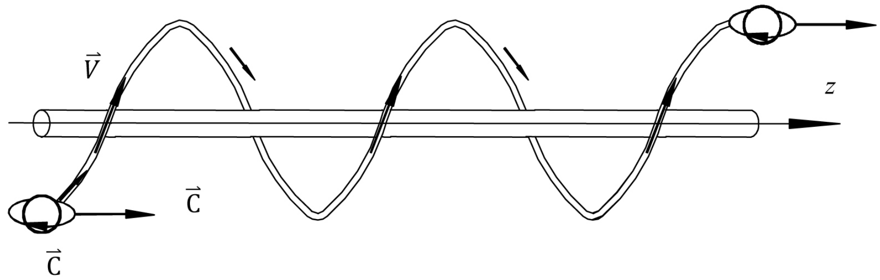


Figure 4. The motion of a photon.

2.4. The Electromagnetic Induction Laws Concealed in Modified Faraday's Law and Total Current Law

Table 1 presents a comparative analysis of total current law and modified Faraday's law in relation to the longitudinal wave terms and electromagnetic induction laws. By comparing Equation (6) and Equation (8) and analyzing Figure 2 and Figure 3, it becomes evident that the inter-conversion of electromagnetic fields is closely associated with the electromagnetic vortex potentials. The time attenuation constants for electromagnetic vortex potentials are the crucial parameters for electromagnetic conversion. From Table 1, it is apparent that both total current law and modified Faraday's law demonstrate an impeccable mathematical symmetry as well as a complete electromagnetic symmetry: scalar electric field and time-varying electric field can induce vortex magnetic field, while vortex electric field can induce scalar magnetic field; similarly, scalar magnetic field and time-varying magnetic field can induce vortex electric field, with vortex magnetic fields also capable of inducing scalar electric field. Consequently, it is evident that the current Maxwell's equations do not fully capture all aspects of electromagnetic conversion. The electromagnetic conversion laws of LEM waves, concealed in the total current law and the modified Faraday's law, are presented in Table 2. Upon analysis of Figure 5, it becomes evident that akin to the propagation through mutual conversion between electromagnetic fields of TEM waves, the forward progression of LEM waves is facilitated through mutual conversion between the scalar electromagnetic field and the electromagnetic vortex potential.

Moreover, Gauss's law and Gauss's magnetic law also have a complete electromagnetic symmetry. As per Equation (6.2), it follows that $\nabla \cdot \boldsymbol{E} = \nabla \cdot \boldsymbol{E}_z \neq 0$, and $\nabla \times \boldsymbol{E}_z = \mathrm{j}\boldsymbol{k} \times \boldsymbol{E}_z = 0$ in a metal medium, indicating $\boldsymbol{E}_z$ constitutes a passive vortex field. Assuming the frequency of $\boldsymbol{E}_z$ is denoted by ω_P, from Gauss's law, it is given

$$\nabla \cdot \boldsymbol{E} = \nabla \cdot \boldsymbol{E}_z = \mathrm{j}kE_z = \mathrm{j}\frac{\omega_P}{V_{ez}}E_z = -\mathrm{j}\frac{\rho\sigma E_z}{-\rho V_{ez}\sigma}\omega_P = -\mathrm{j}\frac{\rho}{\sigma}\omega_P = \frac{\rho}{\varepsilon}. \tag{10.9}$$

The frequency of E_z can be determined from Equation (10.9) as

$$\omega_P = \mathrm{j}\frac{\sigma}{\varepsilon}, \tag{11}$$

In a vacuum, $\nabla \times \boldsymbol{B}_z = \mathrm{j}\boldsymbol{k} \times \boldsymbol{B}_z = 0$. According to Equation (8.2), we can gain

Table 1. The LEM wave items and the electromagnetic induction laws concealed in total current law and Faraday's law.

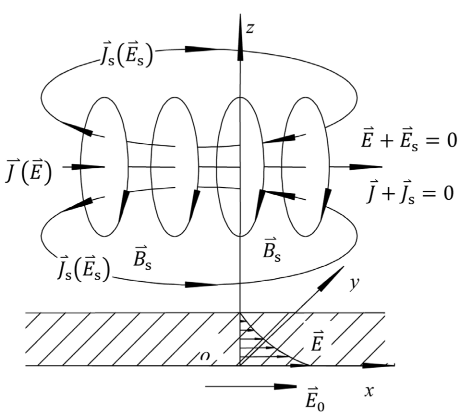
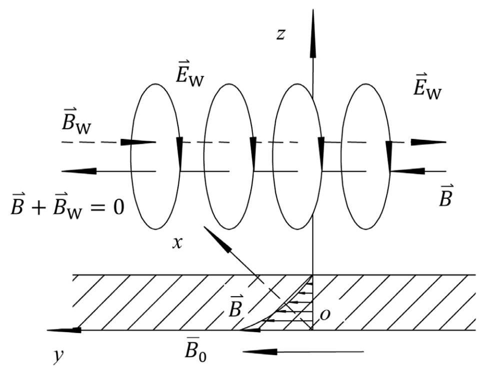
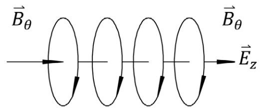
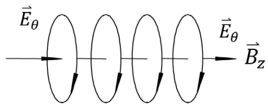
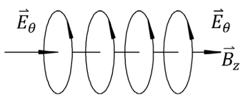
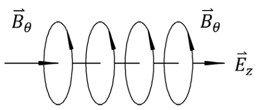
<table>
<tr><th></th><th>total current law</th><th>Faraday's law</th></tr>
<tr><td>equation</td><td>$\nabla\times\boldsymbol{B}/\mu\varepsilon=\partial\boldsymbol{E}/\partial t-(\nabla\cdot\boldsymbol{E})\boldsymbol{V}_e$
$\frac{\partial\boldsymbol{E}}{\partial t}-\frac{\rho}{\varepsilon}\boldsymbol{V}_e=\frac{\partial\boldsymbol{E}}{\partial t}+\frac{1}{\varepsilon}\boldsymbol{J}=\partial\boldsymbol{E}/\partial t+\boldsymbol{E}/\tau_1$ (6.1)
$\nabla\cdot\boldsymbol{E}=-E/V_e\tau_1=-\sigma E/V_e\varepsilon$ (6.2)</td><td>$\nabla\times\boldsymbol{E}=-\partial\boldsymbol{B}/\partial t-(\nabla\cdot\boldsymbol{B})\boldsymbol{V}_B$
$=-\partial\boldsymbol{B}/\partial t-\boldsymbol{B}_z/\tau_2$ (8.1)
$\nabla\cdot\boldsymbol{B}=B_z/V_B\tau_2=\omega^2\varepsilon B_z/V_B\sigma$ (8.2)</td></tr>
<tr><td>electromagnetic conversion formulas</td><td>$\boldsymbol{B}_z/\mu\varepsilon=-\boldsymbol{V}_{ez}\times\boldsymbol{E}_z$
$\boldsymbol{B}_t/\mu\varepsilon=-\boldsymbol{V}_{ez}\times\boldsymbol{E}_t-\boldsymbol{V}_{et}\times\boldsymbol{E}_z$</td><td>$\boldsymbol{E}=-\boldsymbol{V}_B\times\boldsymbol{B}$</td></tr>
<tr><td>connotation of essence</td><td>electric field is relativistic effect of magnetic field</td><td>magnetic field is relativistic effect of electric field</td></tr>
<tr><td>LEM wave item</td><td>$\frac{\boldsymbol{E}}{\tau_1}=-(\nabla\cdot\boldsymbol{E})\boldsymbol{V}_e=\frac{\sigma}{\varepsilon}\boldsymbol{E}$, (6.3)
the contribution of the scalar electric field $\boldsymbol{E}$ generating magnetic vortex potential to $\nabla\times\boldsymbol{B}$</td><td>$\frac{\boldsymbol{B}_z}{\tau_2}=(\nabla\cdot\boldsymbol{B})\boldsymbol{V}_B=\frac{\omega^2\varepsilon}{\sigma}\boldsymbol{B}_z$, (8.3)
the contribution of the scalar magnetic field $\boldsymbol{B}$ generating electric vortex potential to $\nabla\times\boldsymbol{E}$</td></tr>
<tr><td>ω_P</td><td>$\omega_P=\mathrm{j}\frac{1}{\tau_1}=\mathrm{j}\frac{\sigma}{\varepsilon}$ (11)</td><td>$\omega_P=-\mathrm{j}\frac{1}{\tau_2}=-\mathrm{j}\frac{\omega^2\varepsilon}{\sigma}$ (13)</td></tr>
<tr><td>vortex potential type</td><td>magnetic vortex potential $\boldsymbol{B}_s$ (vortex-induced magnetic field)</td><td>electric vortex potential $\boldsymbol{E}_w$ (vortex-induced electric field)</td></tr>
<tr><td>other linkage equations</td><td>$\partial\boldsymbol{E}_z/\partial t=(\boldsymbol{V}_{ez}\cdot\nabla)\boldsymbol{E}_z$
$=\left(0,0,\frac{\partial z}{\partial t}\right)\cdot\left(\frac{\partial}{\partial x},\frac{\partial}{\partial y},\frac{\partial}{\partial z}\right)\boldsymbol{E}_z$,
$-(\nabla\cdot\boldsymbol{E})\boldsymbol{V}_{ez}=\boldsymbol{E}_z/\tau_1$ (6.4)</td><td>$\partial\boldsymbol{B}_z/\partial t=-(\boldsymbol{V}_B\cdot\nabla)\boldsymbol{B}_z$
$=\left(0,0,\frac{\partial z}{\partial t}\right)\cdot\left(\frac{\partial}{\partial x},\frac{\partial}{\partial y},\frac{\partial}{\partial z}\right)\boldsymbol{B}_z$
$(\nabla\cdot\boldsymbol{B})\boldsymbol{V}_B=\boldsymbol{B}_z/\tau_2$ (8.4)</td></tr>
<tr><td>schematic diagrams of electric/magnetic vortex potential</td><td>
</td><td>
</td></tr>
<tr><td>electromagnetic induction</td><td>the scalar electric field ($\boldsymbol{E}$) and the time changing electric field ($\partial\boldsymbol{E}/\partial t$) can generate a vortex magnetic field ($\nabla\times\boldsymbol{B}_s$)</td><td>the scalar magnetic field ($\boldsymbol{B}_z$) and the time changing magnetic field ($-\partial\boldsymbol{B}/\partial t$) can create a vortex electric field ($\nabla\times\boldsymbol{E}_w$)</td></tr>
<tr><td>magnetic-electric induction</td><td>vortex electric field ($\nabla\times\boldsymbol{B}_s$) can induce scalar electric field $\boldsymbol{E}_s$</td><td>vortex electric field ($\nabla\times\boldsymbol{E}_w$) can induce scalar magnetic field $\boldsymbol{B}_w$</td></tr>
</table>

Table 2. The electromagnetic conversion laws of LEM waves.

electromagnetic conversion type	schematic diagram	electromagnetic conversion formula	rule of judgment	electromagnetic conversion essence
Electrogenerated magnetic field		$\nabla\times\boldsymbol{B}_\theta/\mu\varepsilon=\boldsymbol{E}_z/\tau_1$	right handed spiral rule	scalar electric field $\boldsymbol{E}_z$ can induce magnetic vortex potential $\nabla\times\boldsymbol{B}_\theta$
		$-\boldsymbol{B}_z/\tau_2=\nabla\times\boldsymbol{E}_\theta$	right handed spiral rule	electric vortex potential $\nabla\times\boldsymbol{E}_\theta$ can induce scalar magnetic field $\boldsymbol{B}_z$
magnetic generated electric field		$-\nabla\times\boldsymbol{E}_\theta=\boldsymbol{B}_z/\tau_2$	left handed spiral rule	scalar magnetic field $\boldsymbol{B}_z$ can induce electric vortex potential $\nabla\times\boldsymbol{E}_\theta$
		$\mu\varepsilon\boldsymbol{E}_z/\tau_1=\nabla\times\boldsymbol{B}_\theta$	left handed spiral rule	magnetic vortex potential $\nabla\times\boldsymbol{B}_\theta$ can induce scalar electric field $\boldsymbol{E}_z$

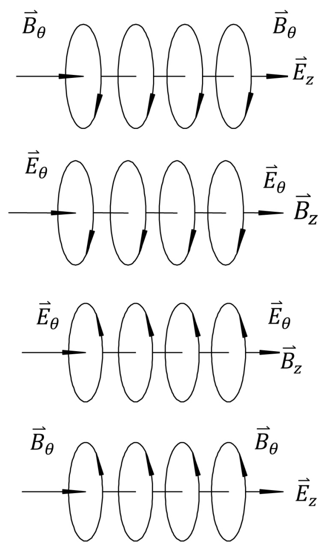


Figure 5. The electromagnetic conversion laws of LEM waves.

$\nabla\cdot\boldsymbol{B}_z\neq 0$, indicating that $\boldsymbol{B}_z$ also represents a passive vortex field. Referring to Equations (8.1) and (8.2), the modified Gauss's magnetic law can be expressed as

$$\nabla\cdot\boldsymbol{B}=\nabla\cdot\boldsymbol{B}_z=\mathrm{j}\frac{\omega_P}{C}B_z=\varepsilon_0\omega^2B_z/C\sigma_0\,. \tag{12}$$

From Equation (12), the frequency of B_z, denoted as ω_P, is given by

$$\omega_P=-\mathrm{j}\frac{\omega^2\varepsilon_0}{\sigma_0}\,. \tag{13}$$

As expressed in Equations (10.9) and (12), the electromagnetic symmetry of

Gauss's law and Gauss's magnetic law is unveiled.

3. The Wave Equations for TEM Wave and LEM Wave

As shown in Figure 1, $\boldsymbol{B}/\tau_2 = (\nabla \cdot \boldsymbol{B})\boldsymbol{V}_B$, so $\boldsymbol{B}/\tau_2$ has only the z-axis component. Therefore, Equation (10) needs to be rewritten as

$$\begin{aligned} -\frac{1}{\mu\varepsilon}\nabla\times(\nabla\times\boldsymbol{E}) &= -\frac{1}{\mu\varepsilon}\nabla(\nabla\cdot\boldsymbol{E}) + \frac{1}{\mu\varepsilon}\nabla^2\boldsymbol{E} \\ &= \frac{\partial^2\boldsymbol{E}}{\partial t^2} + \frac{1}{\tau_1}\frac{\partial\boldsymbol{E}}{\partial t} + \frac{1}{\tau_2}\frac{\partial\boldsymbol{E}_z}{\partial t} + \frac{\boldsymbol{E}_z}{\tau_2\tau_1}. \end{aligned} \tag{14}$$

For TEM waves, since $\nabla \cdot \boldsymbol{E} = 0$, the projection of Equation (14) along the transverse direction of electromagnetic wave propagation in Figure 1 gives that

$$\nabla^2\boldsymbol{E}_t - \mu\varepsilon\frac{\partial^2\boldsymbol{E}_t}{\partial t^2} - \mu\sigma\frac{\partial\boldsymbol{E}_t}{\partial t} = 0, \tag{15}$$

which is the wave equation for TEM wave in a good conductor.

For LEM wave in a good conductor, $\nabla\cdot\boldsymbol{E} = \nabla\cdot\boldsymbol{E}_z \neq 0$, when projected onto the axial direction of electromagnetic wave propagation (z-axis in Figure 1), Equation (14) yields

$$\begin{aligned} -\frac{1}{\mu\varepsilon}\nabla\times(\nabla\times\boldsymbol{E}_z) &= -\frac{1}{\mu\varepsilon}\nabla(\nabla\cdot\boldsymbol{E}_z) + \frac{1}{\mu\varepsilon}\nabla^2\boldsymbol{E}_z = 0 \\ &= \frac{\partial^2\boldsymbol{E}_z}{\partial t^2} + \frac{1}{\tau_1}\frac{\partial\boldsymbol{E}_z}{\partial t} + \frac{1}{\tau_2}\frac{\partial\boldsymbol{E}_z}{\partial t} + \frac{\boldsymbol{E}_z}{\tau_2\tau_1}. \end{aligned} \tag{16}$$

Equation (16) is the wave equation for LEM wave in a good conductor. Based on it, we can obtain that

$$\nabla(\nabla\cdot\boldsymbol{E}_z) = \nabla^2\boldsymbol{E}_z. \tag{17}$$

Combining Equation (16.1) and $\boldsymbol{E}_z = (0, 0, E_z)$ gives that $E_z = E_z(z,t)$. Similarly, for LEM wave in a vacuum, we can obtain $B_z = B_z(z,t)$.

4. Neutrino Propagation Model for Magnetic P-Wave

Kozyrev introduced a significant concept [24] known as torsion field (TF). He posited that a fixed spin should have relation to a spin field-TF like a fixed particle mass to a gravitational field and a fixed charge to an electromagnetic field. Based on the assumption that the positive and negative photon components undergo double helix motion [22], the TF model should consist of two neutrinos with reversely orbital rotation to sustain momentum balance. Figure 6 (left) represents the left-handed TF model composed of two neutrinos with left-handed spin. The neutrino spin velocity is the speed of light, and both of them move in a left-handed large spiral orbit along the forward axis, and the axial velocity is also the speed of light. The phase difference between the two neutrinos is π, and the total left-handed TF in a vacuum is equivalent to the left-handed magnetic P-wave B_L, representing a high energy state. The right-handed TF model is shown in Figure 6 (right), which is also composed of two neutrinos with left-handed spin, but moving in a right-handed large spiral orbit around the forward axis. Their phase difference is also π, and the total right-handed TF in a vacuum amounts to right-handed magnetic P-wave B_R, representing a low energy state. According to the law of electromagnetic induction, left-handed B_L can produce electric vortex potential E_L, whose vortex motion interacts with zero-point vacuum energy field to extracts positive free energy and generate high-energy rays, neutrons, and high-energy particles at the vortex center, accompanied by highly directed cold fusion [25] [26]. This process enables B_L to acquire significantly positive free energy. While right-handed B_R generated by right-handed TF in **Figure 6** (right) produces electric vortex potential E_R, which extracts negative free energy from zero-point vacuum energy field and does harm to organism.

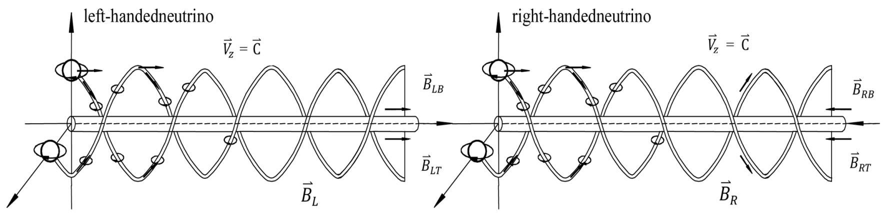


Figure 6. Left-handed TF (magnetic P-wave)/right-handed TF (magnetic P-wave).

5. Generation Mechanism of Magnetic P-Wave from Particle Perspective

In general, LEM waves are usually allowed to be neglected due to their significantly smaller amplitudes compared with that of TEM waves. But in certain scenarios such as the near fields [13], current Maxwell's equations fail to elucidate the mechanism of them. Hence, consideration must be given to LEM waves. The generation of substantial LEM wave typically occurs when two coherent light waves with identical frequency, amplitude, and propagation direction, but a phase difference of π (referred to as source waves), are superimposed within a vacuum medium, they will generate a magnetic P-wave B_z [10]. The electric field components of the source waves are represented by $\boldsymbol{E}_1$ and $\boldsymbol{E}_2$, while their corresponding magnetic field components are denoted as $\boldsymbol{B}_1$ and $\boldsymbol{B}_2$. Upon superposition of them, the resultant total electric fields are represented by $\boldsymbol{E}_t$ and $\boldsymbol{B}_t$, where

$$\begin{aligned}\boldsymbol{E}_t &= \boldsymbol{E}_1 + \boldsymbol{E}_2 = \boldsymbol{E}_0 \exp\left[\mathrm{j}\left(\boldsymbol{k}\cdot\boldsymbol{r} - \omega t\right)\right] + \boldsymbol{E}_0 \exp\left[\mathrm{j}\left(\boldsymbol{k}\cdot\boldsymbol{r} - \omega t + \pi\right)\right] \\ &= \boldsymbol{E}_0 \exp\left[\mathrm{j}\left(\boldsymbol{k}\cdot\boldsymbol{r} - \omega t\right)\right]\left[1 + \exp\left(\mathrm{j}\pi\right)\right] = 0,\end{aligned} \quad \boldsymbol{B}_t = \boldsymbol{B}_1 + \boldsymbol{B}_2 = \boldsymbol{B}_0 \exp\left[\mathrm{j}\left(\boldsymbol{k}\cdot\boldsymbol{r} - \omega t\right)\right]$$

$$\left[1 + \exp\left(\mathrm{j}\pi\right)\right] = 0. \tag{18}$$

When two source waves are superimposed, the total electromagnetic fields seemly both vanish. However, in accordance with the principle of energy conservation, all energy of source waves is actually transferred to B_z. This energy transfer can be explained by definitions of magnetic vector potential $\boldsymbol{A}$ and scalar potential φ [20] shown as

$$\boldsymbol{B}_t = \boldsymbol{B}_1 + \boldsymbol{B}_2 = \nabla \times (\boldsymbol{A}_1 + \boldsymbol{A}_2) = 0\text{, } i.e.,\ \ \boldsymbol{A} = \boldsymbol{A}_1 + \boldsymbol{A}_2 = \nabla \psi \neq 0\text{,} \tag{18.1}$$

$$\boldsymbol{E}_t = \boldsymbol{E}_1 + \boldsymbol{E}_2 = -\nabla \varphi - \frac{\partial \boldsymbol{A}}{\partial t} = 0\text{, and } \nabla \varphi = -\frac{\partial \boldsymbol{A}}{\partial t} = -\nabla \frac{\partial \psi}{\partial t} \neq 0\text{, that is,}$$

$$\varphi = -\frac{\partial \psi}{\partial t} \neq 0. \tag{18.2}$$

Here, ψ represents a scalar field known as the "zero-point vacuum energy field" [25], "torsion field" [26]. This phenomenon can be mutually corroborated by the Aharov-Bohm effect [3], which highlights the significance of $\boldsymbol{A}$ and φ in comparison to $\boldsymbol{E}_t$ and $\boldsymbol{B}_t$.

Our photonic structure model can effectively elucidate the essence of this phenomenon. The left-handed photon model depicted in the left of **Figure 7** illustrates left-handed photon composed of positron and electron with equal charge. The positron, spinning to the right, follows a right-handed circular orbit around the forward axis, generating a left-handed magnetic P-wave B_{z+} [27]. Similarly, the electron, spinning to the left, orbits the forward axis in a left-handed circular path, producing a left-handed magnetic P-wave B_{z-}. The combined effect of these motions results in a total left-handed magnetic P-wave given by $B_z = B_{z-} + B_{z+}$. As per reference [20], $\boldsymbol{B}_t / \mu_0 \varepsilon_0 = \boldsymbol{C} \times \boldsymbol{E}_t$. Consequently, at point A where positron and electron intersect without colliding, the overall neutrality of the photon is observed along with zero electric field intensity $\boldsymbol{E}_t$ and magnetic induction intensity $\boldsymbol{B}_t$. At points B and H where positron and electron are at their maximum distance from each other; $\boldsymbol{E}_t$ and $\boldsymbol{B}_t$ exhibit negative and positive maximum values respectively. **Figure 8** presents an illustration depicting the TEM waves $\boldsymbol{E}_t$ and $\boldsymbol{B}_t$ produced by left-handed photon alongside magnetic P-wave B_L. The right-handed photon model is depicted in the middle of **Figure 7**, where the positron, spinning to the right, follows a left-handed circular orbit around the forward axis; the electron, spinning to the left, orbits the forward axis in a right-handed circular path. Their resultant motions leads to a total right-handed magnetic P-wave given as B_R.

The superposition of two source light waves is equivalent to a left-handed photon γ_L superposing with a right-handed photon γ_R. As depicted in **Figure 7**, at point E, H, positrons from γ_L encounter with electrons from γ_R, while at point G, F, electrons from γ_L meet with positrons from γ_R. Their superposition leads to the annihilations of positrons/electrons [28], resulting in the generation of a substantially free energy (zero-point vacuum energy) and a magnetic P-wave B_z. This reaction can be mathematically expressed as follows

$$\gamma_R + \gamma_L \to B_z + \text{zero point vacuum energy}. \tag{18.3}$$

On this occasion, after superposition, although resultant total electric fields vanish in space, both magnetic vector potential $\boldsymbol{A}$ and scalar potential φ still persist and consist of B_z, where $\boldsymbol{A} = \nabla \psi$, $\varphi = -\partial \psi / \partial t$ and ψ is a scalar field related to B_z.

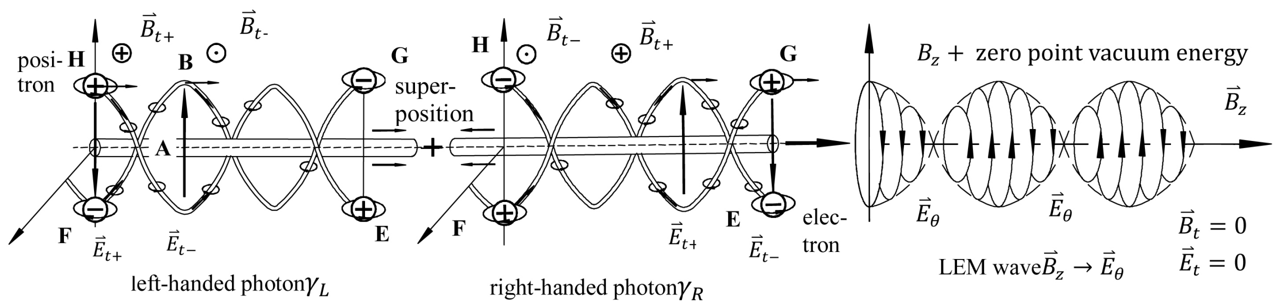


Figure 7. Superposition of left-handed photon/right-handed photon.

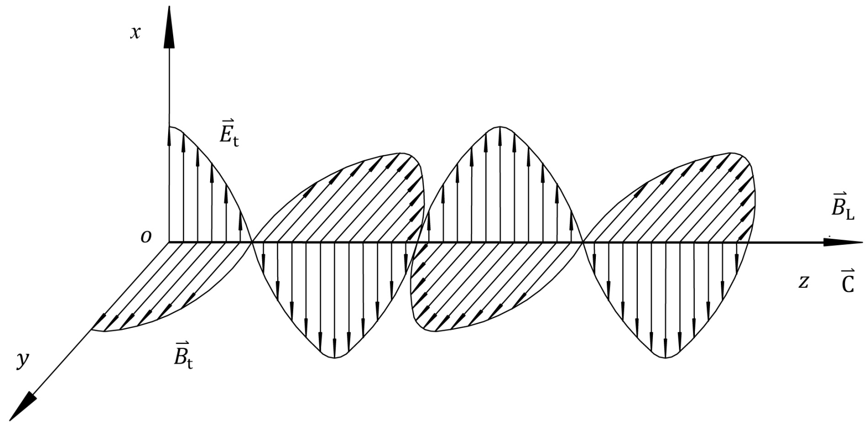


Figure 8. The magnetic P-wave and TEM waves produced by left-handed photon.

6. Propagation Model and Energy Equation for Magnetic P-Wave from Wave Perspective

A certain region $d\Omega$ in a medium where light waves $\boldsymbol{E}$ and $\boldsymbol{B}$ propagate has a free charge density ρ with charge number q. At any given moment, the Lorentz force acting on charge q in region $d\Omega$ can be expressed as $\boldsymbol{F} = q(\boldsymbol{E} + \boldsymbol{V} \times \boldsymbol{E})$, where $\boldsymbol{V}$ represents the motion speed of free charge. Consequently, after dt time, the work done by $\boldsymbol{F}$ on q in $d\Omega$ is $dw = q(\boldsymbol{E} + \boldsymbol{V} \times \boldsymbol{E}) \cdot \boldsymbol{V}dt = \rho d\Omega(\boldsymbol{E} + \boldsymbol{V} \times \boldsymbol{E}) \cdot \boldsymbol{V}dt = d\Omega\boldsymbol{E} \cdot (\rho\boldsymbol{V})dt = d\Omega\boldsymbol{E} \cdot \boldsymbol{J}dt$. By applying superposition principle, work done by Lorentz force $\boldsymbol{F}$ on all free charges in entire region Ω per unit time can be expressed as

$$dW/dt = \int_\Omega \boldsymbol{E} \cdot \boldsymbol{J} d\Omega, \tag{18.4}$$

where $\boldsymbol{J}$ denotes electric current density within $d\Omega$. From Equation (6.1), we can obtain

$$\boldsymbol{E} \cdot \boldsymbol{J} = \boldsymbol{E} \cdot \frac{1}{\mu}(\nabla \times \boldsymbol{B}) - \frac{\varepsilon}{2}\frac{\partial \boldsymbol{E}^2}{\partial t} = \frac{1}{\mu}\boldsymbol{B} \cdot (\nabla \times \boldsymbol{E}) - \frac{1}{\mu}\nabla \cdot (\boldsymbol{E} \times \boldsymbol{B}) - \frac{\varepsilon}{2}\frac{\partial \boldsymbol{E}^2}{\partial t}. \tag{18.5}$$

Equation (8.1) is substituted into Equation (18.5), it is obtained that

$$\boldsymbol{E} \cdot \boldsymbol{J} = -\frac{1}{\mu}\boldsymbol{B} \cdot \left[\partial \boldsymbol{B}/\partial t + (\nabla \cdot \boldsymbol{B}_z)\boldsymbol{C}\right] - \frac{1}{\mu}\nabla \cdot (\boldsymbol{E} \times \boldsymbol{B}) - \frac{\varepsilon}{2}\frac{\partial \boldsymbol{E}^2}{\partial t}. \tag{18.6}$$

Substituting Equation (18.6) back to Equation (18.4) gives

$$
\begin{aligned}
E_T &= \int_\Omega -\frac{1}{2\mu}\frac{\partial \boldsymbol{B}^2}{\partial t} - \frac{\varepsilon}{2}\frac{\partial \boldsymbol{E}^2}{\partial t}\mathrm{d}\Omega = \mathrm{d}W/\mathrm{d}t + E_P + \int_\Omega \frac{1}{\mu}\nabla\cdot(\boldsymbol{E}\times\boldsymbol{B})\mathrm{d}\Omega \\
&= \mathrm{d}W/\mathrm{d}t + \int_\Omega \frac{1}{\mu}(\nabla\cdot\boldsymbol{B})(\boldsymbol{B}\cdot\boldsymbol{C})\mathrm{d}\Omega + \int_\Omega \frac{1}{\mu}\nabla\cdot(\boldsymbol{E}\times\boldsymbol{B})\mathrm{d}\Omega \\
&= \mathrm{d}W/\mathrm{d}t + \int_\Omega \frac{1}{\mu}(\nabla B_z)(B_z\cdot C)\mathrm{d}\Omega + \int_\Omega \frac{1}{\mu}\nabla\cdot(\boldsymbol{E}\times\boldsymbol{B})\mathrm{d}\Omega.
\end{aligned}
\tag{18.7}
$$

In Equation (18.7), E_T denotes the total light energy within Ω; the first term on the right-hand side represents the work done by the electromagnetic force on free charges, *i.e.*, energy converted into joule heat; the second term signifies the energy E_P transformed into LEM wave; and final term accounts for pure incoming and outgoing energy at Ω's boundary surface. Equation (18.7) presents a modified Poynting theorem incorporating consideration of LEM wave terms. After superimposing two source lightwaves in a vacuum, as per Equations (6.3) and (8.3), B_z gains non-zero value, while E_z is equal to zero if electrical conductivity σ equals 0 for a vacuum, *i.e.*, $\int_\Omega \frac{1}{\mu}\nabla\cdot(\boldsymbol{E}\times\boldsymbol{B})\mathrm{d}\Omega = \frac{1}{\mu}\oint_s (0\times\boldsymbol{B}_z)\mathrm{d}s = 0$. Moreover, for a vacuum medium with no electric charge, $\mathrm{d}W/\mathrm{d}t = 0$. And then E_T is equal to E_P, that is,

$$
\begin{aligned}
E_P &= \int_\Omega -\frac{1}{2\mu}\frac{\partial B_z^2}{\partial t}\mathrm{d}\Omega = \int_\Omega \mathrm{j}\omega B_z^2\frac{1}{\mu}\mathrm{d}\Omega = \int_\Omega \frac{1}{\mu}(\nabla B_z)(B_z\cdot C)\mathrm{d}\Omega \\
&= E_T = \int_\Omega -\frac{1}{\mu}\frac{\partial B_1^2}{\partial t} - \frac{1}{\mu}\frac{\partial B_2^2}{\partial t}\mathrm{d}\Omega = \int_\Omega 2\mathrm{j}\omega\frac{1}{\mu}\left(B_1^2 + B_2^2\right)\mathrm{d}\Omega,
\end{aligned}
\tag{19}
$$

From Equation (19), we can derive the wave equation for B_z, given by

$$
\frac{\partial^2 B_z}{\partial t^2} - C^2\frac{\partial^2 B_z}{\partial z^2} = 0, \tag{20}
$$

$$
|B_z| = B_{z0} = \sqrt{2\left|B_1^2 + B_2^2\right|} = \sqrt{2 + 2\exp^2(\mathrm{j}\pi)}B_0 = 2B_0. \tag{21}
$$

$$
B_z = B_{z0}\exp\left[\mathrm{j}\left(\frac{\omega_P}{C}z - \omega_P t\right)\right]. \tag{21.1}
$$

Referring to the fundamental equations for a TEM wave in a vacuum $\nabla\times\boldsymbol{E}_t = -\partial\boldsymbol{B}_t/\partial t$ and $\nabla\times\boldsymbol{B}_t/\mu_0\varepsilon_0 = \partial\boldsymbol{E}_t/\partial t$, from Equation (4) and **Table 2**, it can be inferred that within a vacuum, the magnetic P-wave $\boldsymbol{B}_z$ and its electric counterpart $\boldsymbol{E}_\theta$ can be converted into each other through their specific relationship formulas shown as

$$
\nabla\times\boldsymbol{E}_\theta = -\frac{\boldsymbol{B}_z}{\tau_2} = -\frac{1}{\tau_2}B_{z0}\boldsymbol{e}_z\exp\left[\mathrm{j}\left(\frac{\omega_P}{C}z - \omega_P t\right)\right]. \tag{21.2}
$$

$$
\boldsymbol{E}_\theta = -\boldsymbol{C}\times\boldsymbol{B}_z, \tag{21.3}
$$

which gives that

$$
\nabla\times\boldsymbol{E}_\theta = \mathrm{j}\boldsymbol{k}\times\boldsymbol{E} = \mathrm{j}kE_\theta\boldsymbol{e}_z = -\frac{1}{\tau_2}B_{z0}\boldsymbol{e}_z\exp\left[\mathrm{j}\left(\frac{\omega_P}{C}z - \omega_P t\right)\right]. \tag{21.4}
$$

Equation (13) is substituted into Equation (21.4), it is obtained that

$$\boldsymbol{E}_\theta = \frac{CB_{z0}}{\omega_P \tau_2} \exp\left[\mathrm{j}\left(\frac{\omega}{C} z - \omega t + \frac{\pi}{2} \right) \right] \boldsymbol{e}_\theta = CB_{z0} \exp\left[\mathrm{j}\left(\frac{\omega}{C} z - \omega t + \frac{\pi}{2} \right) \right] \boldsymbol{e}_\theta . \quad (21.5)$$

Equations (21.1) and (21.5) represent solutions to the wave equations governing the LEM waves $\boldsymbol{E}_\theta$ and $\boldsymbol{B}_z$. The propagation model for $\boldsymbol{E}_\theta$ and $\boldsymbol{B}_z$ is depicted in Figure 9, illustrating that the phase angle of $\boldsymbol{E}_\theta$ leads $\boldsymbol{B}_z$ by 90˚. The conversion process from vortex electric field $\boldsymbol{E}_\theta$ to scalar magnetic field $\boldsymbol{B}_z$ is illustrated in Figure 9 as O to A and B to C, while the transformation from $\boldsymbol{B}_z$ into $\boldsymbol{E}_\theta$ is shown as A to B and C to D. This cyclic process involves alternating induction and conversion between $\boldsymbol{E}_\theta$ and $\boldsymbol{B}_z$, propagating along the positive *z*-axis at a phase velocity *C*.

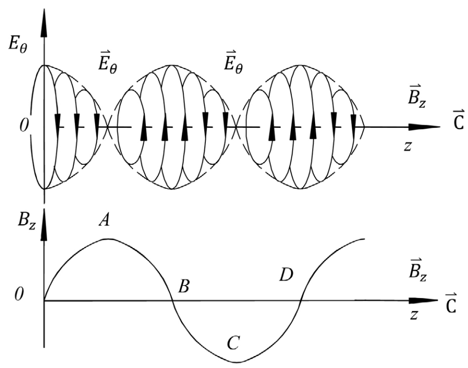


Figure 9. The propagation of ELM waves in a vacuum.

If there is no signal interference, $\boldsymbol{E}_\theta$ and $\boldsymbol{B}_z$ can be transformed into each other and propagate in a straight line to infinity, with a vector tail of $\boldsymbol{B}_z$ never connecting to its vector head. Consequently, $\boldsymbol{B}_z$ can be considered as a magnetic monopole. Thus, we derive the condition for the generation of magnetic monopole as follows: two coherent light waves with identical frequency, amplitude, and propagation direction, but a phase difference of π are superimposed within a vacuum medium.

Under this circumstance, magnetic P-wave $|B_z| = 2B_0 \neq 0$, which cannot be disregarded; that is, $(\nabla \cdot \boldsymbol{B})\boldsymbol{C} = \boldsymbol{B}/\tau_2 = -\mathrm{j}kB_z C \neq 0$ in Equation (8). Otherwise, it would lead to a violation of energy conservation in Equation (19). It is deduced from Equations (19) and (21.5) that

$$\begin{aligned} E_P &= \int_\Omega \left(-\frac{1}{2\mu_0} \frac{\partial B_z^2}{\partial t} - \frac{\varepsilon_0}{2} \frac{\partial E_z^2}{\partial t} \right) \mathrm{d}\Omega = \int_\Omega \left(-\frac{1}{2\mu_0} \frac{\partial B_z^2}{\partial t} \right) \mathrm{d}\Omega \\ &= \int_\Omega \left(-\frac{\varepsilon_0}{2} \frac{\partial E_\theta^2}{\partial t} \right) \mathrm{d}\Omega = \int_\Omega \frac{1}{\mu_0} (\nabla B_z)(B_z \cdot C) \mathrm{d}\Omega \\ &= \int_\Omega \nabla \left(\frac{1}{2\mu_0} CB_z^2 \right) \mathrm{d}\Omega = \int_\Omega \nabla \left(\frac{\varepsilon_0}{2C} E_\theta^2 \right) \mathrm{d}\Omega, \end{aligned} \quad (22)$$

which is energy equation for magnetic P-wave B_z.

7. Characteristics of Magnetic P-Wave

1) Wave velocity

According to Equation (20), the wave speed of B_z is equal to the speed of light C.

2) Frequency

According to Equation (13), the frequency ω_P of B_z can be expressed as

$$\left|\omega_P\right| = \left|-\mathrm{j}\frac{1}{\tau_2}\right| = \frac{\omega^2 \varepsilon_0}{\sigma_0} = 10^{31}\ \mathrm{Hz}, \tag{23}$$

where $\varepsilon_0 \sim 10^{-11}\ \mathrm{F/m}$, is the vacuum dielectric constant [20], $\sigma_0 \sim 10^{-14}\ \mathrm{S/m}$ is the atmospheric electrical conductivity [29], which is approximately the vacuum electrical conductivity, ω taken as 10^{14} Hz (the frequency of light waves) is the source TEM waves frequency.

3) Wavelength

The typical wavelength of B_z is calculated as $\lambda_z = \frac{C}{\omega_P} = \frac{10^8}{10^{31}} = 10^{-25}\ \mathrm{m}$.

4) Exceptionally harmless penetration for conductive material

Owing to the skin effect, TEM waves are unable to penetrate good conductive medium and can only propagate within a thin layer δ on its surface [21]. The frequency ω_P of B_z is approximately 10^{31} Hz, while the typical metal's plasma resonance frequency ω_z is on the order of 1×10^{15} Hz, and damping coefficient γ_s of metallic bound electrons is around 1×10^{13} Hz. Substituting these parameters [30] into the classical Drude equation [31], yields a dielectric constant for metal corresponding to frequency 10^{31} Hz as $\varepsilon_r = 1 - \frac{\omega_z^2}{\gamma_s^2 + \omega_P^2} + \mathrm{j}\frac{\omega_z^2 \gamma_s}{\omega_P\left(\gamma_s^2 + \omega_P^2\right)} \approx 1$. Under this circumstance, it becomes evident that a conductive medium cannot shield against B_z; thus, it exhibits "high-frequency transparency" [32] [33] and has unhindered ability to permeate through human tissue. This observation aligns with Meyl K.'s assertion regarding LEM wave characteristic that "the Faraday cage cannot shield against LEM waves" [5]. What's more, neutrinos are assumed as the propagating particles of B_z. The extremely small cross-section of $10^{-43}\ \mathrm{cm}^2$ for neutrino interaction with atomic nuclei results in a minuscule probability of its capture by an atomic nucleus within a square centimeter area, thus demonstrating a harmlessly penetrative capability of B_z to organism cells [34].

5) The ability to absorb free energy

The total energy associated with two source light waves can be represented as

$$\begin{aligned} E_T &= \int_\Omega -\varepsilon_0 \frac{\partial E_1^2}{\partial t} - \varepsilon_0 \frac{\partial E_2^2}{\partial t} \mathrm{d}\Omega \\ &= \int_\Omega 2\mathrm{j}\omega\varepsilon_0 \left(E_1^2 + E_2^2\right) \mathrm{d}\Omega \\ &= \int_\Omega 2\mathrm{j}\omega\varepsilon_0 E_0^2 \left\{\exp^2\left[\mathrm{j}\left(\boldsymbol{k}\cdot\boldsymbol{r} - \omega t\right)\right] + \exp^2\left[\mathrm{j}\left(\boldsymbol{k}\cdot\boldsymbol{r} - \omega t + \pi\right)\right]\right\} \mathrm{d}\Omega \\ &= \int_\Omega 4\omega\varepsilon_0 E_0^2 \sin 2\left(\frac{\omega}{C} z - \omega t\right) \mathrm{d}\Omega \\ &= 4\Omega\omega\varepsilon_0 E_0^2 = 4\Omega\omega \frac{1}{\mu_0} B_0^2. \end{aligned} \tag{24}$$

From Equation (19), after the superposition the total energy of E_P can be expressed as

$$
\begin{aligned}
E_P &= \int_\Omega -\frac{\varepsilon_0}{2}\frac{\partial E_\theta^2}{\partial t}\mathrm{d}\Omega = \int_\Omega \mathrm{j}\omega_P\varepsilon_0 E_\theta^2 \mathrm{d}\Omega \\
&= \mathrm{j}\omega_P\varepsilon_0 E_{\theta 0}^2 \int_\Omega \exp^2\left[\mathrm{j}\left(\frac{\omega_P}{C}z-\omega_P t\right)\right]\mathrm{d}\Omega \\
&= \Omega\omega_P\varepsilon_0 E_{\theta 0}^2 = \Omega\omega_P\frac{1}{\mu_0}B_{z0}^2 = 4\Omega\omega_P\frac{1}{\mu_0}B_0^2.
\end{aligned} \tag{25}
$$

The ratio of the energy of LEM wave to TEM waves can be expressed as

$$
\frac{E_P}{E_T} = \frac{\omega_P}{\omega} = \frac{10^{31}\,\mathrm{Hz}}{10^{14}\,\mathrm{Hz}} = 10^{17}. \tag{26}
$$

In accordance with Equation (26), the energy of the magnetic P-wave is 10^{17} times that of the source TEM waves. The mechanism for the additional energy gained by magnetic P-wave B_z is likely associated with its induced vortex-magnetic field E_θ, which has the capability to extract zero-point vacuum energy through the entangled interaction between its produced torsion field and zero-point vacuum energy field. As per Equation (19), the total energy of B_z can be represented as

$$
E_P = -\mathrm{d}W/\mathrm{d}t + E_T \tag{27}
$$

Here, $-\mathrm{d}W/\mathrm{d}t$ denotes work performed by the zero-point vacuum energy field on B_z. As shown in Figure 10, because $E_P \gg E_T$, it follows that $E_P \approx -\mathrm{d}W/\mathrm{d}t$; thus, indicating that most of B_z's energy originates from its interaction with "zero-point vacuum energy field". Although mysteries surrounding "zero-point vacuum energy" remain unresolved, it can be inferred that apart from E_T, B_z must acquire additional free energy from zero-point vacuum fields to uphold genuine energy conservation. This aligns with Meyl K.'s assertion regarding characteristic of LEM waves having "the ability to absorb free energies" [5].

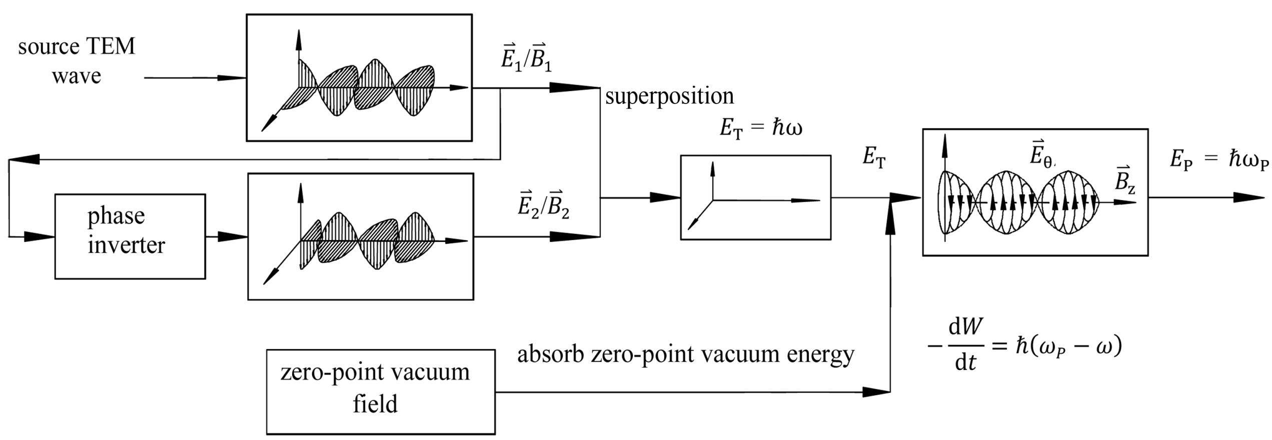


Figure 10. Energy transfer of magnetic P-wave.

8. The Validation for the Action of Magnetic P-Wave

In the main processes of life, such as photosynthesis and respiration, the essence of these chemical reactions is electron transfer. In these processes, electron transport is realized by protease which is actually a long chain connected by amino acid molecules with a left-handed chirality. In 2021, Ohio State University announced the identification of the protein deoxyuridine triphosphate nucleotidohydrolase (dUTPase) as a key modulator of the immune response that contributes to the immunological and neuro-logical abnormalities in individuals [35]. It suggests that dUTPase could be used as a biomarker of chronic fatigue syndrome. DUTPase, as a hydrolase, primarily utilizes pyrophosphate as its substrate and is involved in the hydrolysis of inorganic pyrophosphate (PPi, $P_2O_7^{4-}$) generated in the uridylation pathway of protein meTableolisminto orthophosphate ions (Pi, HPO_4^{2-}), which promotes thermodynamic equilibrium towards mitochondrial ATP (adenosine triphosphate) synthesis. ATP in mitochondria is a crucial cellular energy source. When it is hydrolyzed back to ADP (adenosine diphosphate) and Pi, energy is released to drive many biochemical processes within the cell, thereby enhancing the whole energy of the biological field of life and restoring the body's health.

After organism receives the left-handed magnetic P-wave B_L with drug or nutrition biochemical information and free energy emitted by the therapeutic apparatus by utilizing the tunnel nanotubes as biological signal waveguides in the cell membrane [36] [37], B_L induces the left-handed electric vortex potential $\boldsymbol{E}_v$ on the long chain of dUTPase (see **Figure 11**). $\boldsymbol{E}_v$ attracts the left-handed free electrons in the cell fluid to do left-handed helix movement along the long chain of dUTPase, which increases the ionization speed of the cell fluid, increases the concentration and the electrical potential energy of hydrogen ions (protons), breaks the concentration balance of ATP/ADP in mitochondria, then accelerating the chemical reaction speed of ATP synthesis. Moreover, the enrichment of free electrons in cell membrane also stimulates the efficiency of dUTPase, which increases the ability to catalyze the conversion of PPi into Pi, thus accelerating the speed of ATP synthesis and increasing the concentration ratio of ATP/ADP in the mitochondria, and cause organism in a high energy state (see **Figure 11**). While right-handed magnetic P-wave B_R produces an opposite effect, and then reducing the concentration ratio of ATP/ADP in mitochondria and causing living body in a low energy state.

Schnabl and Meyl [15] [38] conducted a study using a Tesla magnetic P-wave generator (10 mW, 6.7 MHz) to investigate the effects of magnetic P-wave on plant growth. Their research revealed that the left-handed magnetic P-wave signal led to a 40% increase in ATP content in the mitochondria of Ephorbia pulcherrima (10 mW, 90 seconds, red columns in contrast to blue controls, see **Figure 12**). According to our magnetic P-wave model, left-handed magnetic P-wave can induce a left-handed electric vortex potential $\boldsymbol{E}_v$ on the long chain of amino acid molecules within organisms. $\boldsymbol{E}_v$ attracts more free electrons in

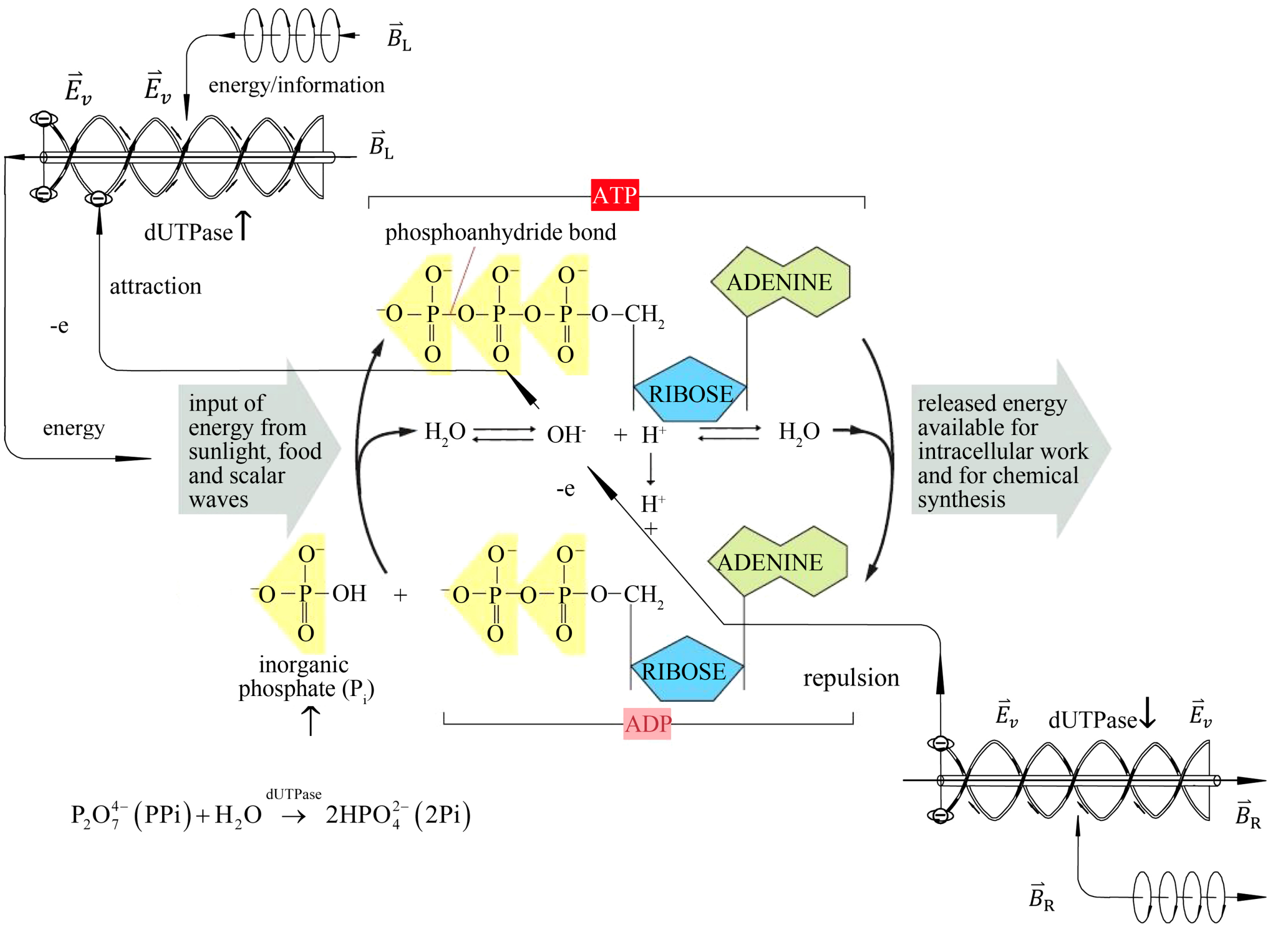


Figure 11. ATP/ADP mutual conversion in mitochondria of cells under the action of magnetic P-wave.

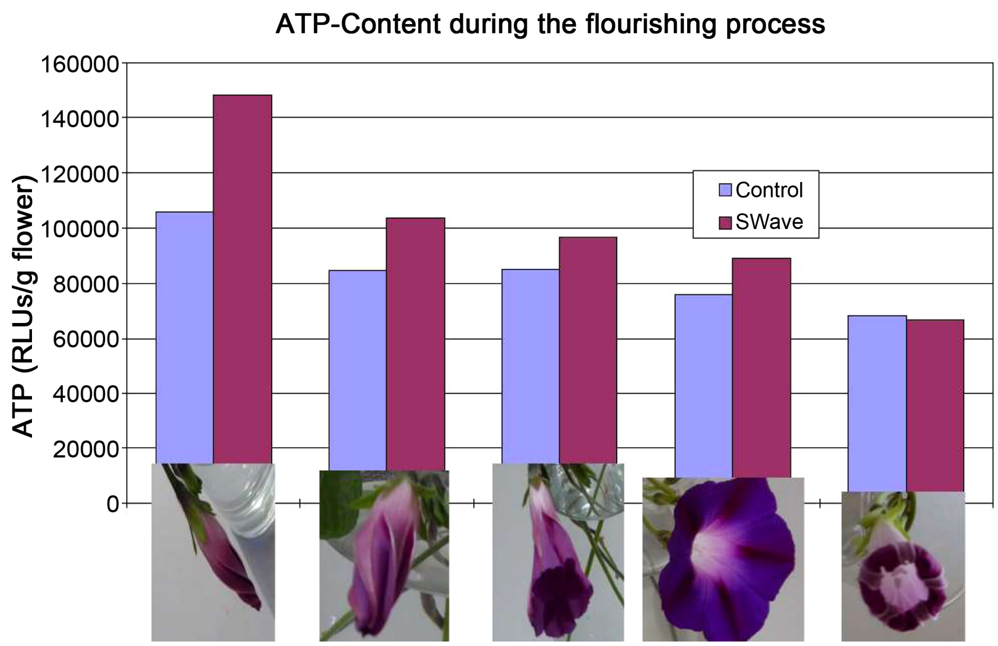


Figure 12. The ATP-level in the buds increased by 40% due to magnetic P-wave treatment (10 mW, 90 sec, red columns in contrast to blue controls) [15].

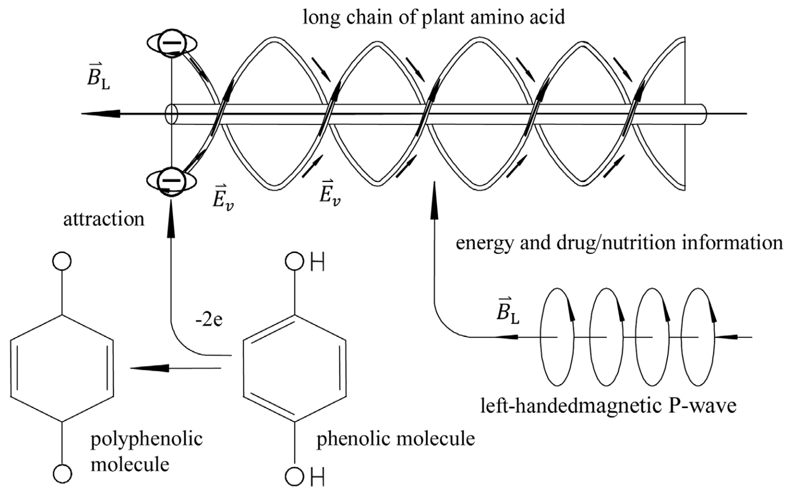


Figure 13. Transition from the phenolic to the chinoidal stage within plant molecules generated by left-handed magnetic P-wave.

cell fluid to do left-handed helix movement into cell membrane, which results in a transition of plant molecules from the phenolic to the chinoidal stage (see Figure 13), thus enhancing mitochondrial efficiency and antioxidant effects while improving overall energy levels in plants.

9. Conclusion

Referring to the time attenuation constant of magnetic vortex potential in total current law for, we recover the longitudinal wave term $\boldsymbol{B}/\tau_2$ in Faraday's law, where τ_2 represents the attenuation time constant of electric vortex potential. Based on reevaluated total current law and modified Faraday's law, we develop the wave equation, energy equation, and propagation model for magnetic P-wave that involve inter-induction/conversion between scalar magnetic field and vortex electric field. These findings support the significant presence of magnetic P-wave reflecting profound electromagnetic essence. Rigorous wave and energy models for magnetic P-wave generated by the superposition of a left-handed photo and a right-handed photon can provide theoretical support and optimization strategies for its medical and energy applications while elucidating the underlying mechanisms for its absorption to free energy: left-handed magnetic P-wave can induce vortex electric field to generate high-energy rays, neutrons, and high-energy particles at its vortex center accompanied by highly directed cold fusion. This leads to substantial free energy absorption through interaction between zero-point vacuum energy field and the produced torsion field by vortex electric field. These models describing the ability of magnetic P-wave to absorb free energy are validated by the interaction between positive magnetic P-wave and cell fluid/long chains of amino acids in a plant organism.

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Visualization: JJZ
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Writing-review & editing: JJZ

Data and Materials Availability

All data are available in the main text or the supplementary materials.

Competing Interests

Authors declare that they have no competing interests.

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