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SOME PHYSICAL LAWS SUCH AS CONSTANT SPEED OF LIGHT CAN BE EXPLAINED ACCORDING TO THE PRINCIPLE THAT ANY MATTER MUST HAVE FINITE ENERGY

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ABSTRACT

In this paper, a physical principle that any matter must have finite energy is first proposed, which is expressed that any matter must have energy and the energy is finite under any conditions. According to this principle and energy conservation principle, some physical laws with unclear reasons are explained: The mass of a composite particle is greater than the sum of the mass of component particles; The potential energy of a composite particle is smaller than the potential energy sum of the component particles; Any massless matter must move at the speed of light under independent conditions; The velocity of static field without mass can be zero; Deriving inverse square law of massless field strength; Conditions for electromagnetic oscillation to form electromagnetic waves.

Keywords: Energy Principle, Invariance of Light Speed, Lorentz Transformation, Inverse Square Law, Potential Energy, Kinetic Energy, Static Energy

1. INTRODUCTION

At present, the development of physics is very advanced, and many natural phenomena and physical laws can be described effectively Wu (1998),Callahan (2000), Yoreo et al. (2015), Brown (1991). Many theories are based on assumptions and experimental laws, so it is necessary to further consider from the essence. For instance: Why is the mass of the composite particles greater than the sum of the masses of the component particles? Why is the potential energy of the composite particle less than the sum of the potential energies of the component particles? Special relativity is based on the assumption that the speed of light is constant, why is the speed of light constant? According to the special theory of relativity, any massless matter must move at the speed of light, while the massless static field is stationary relative to the field source, why? The inverse square law expressed by Newton and Coulomb is very reasonable, what is the basic mechanism of this law? Electromagnetic oscillations are common, under certain special conditions electromagnetic waves and photons can be generated, what requirements must these special conditions meet?

I have thought about these problems for many years, finally a new physical principle is proposed, that is: the principle that any matter must have finite energy. In this paper, according to this principle and energy conservation principle, these physical laws mentioned above are explained. Through the explanation of these physical laws, the correctness of the principle that energy must have and be finite can be proved.

2. THE PRINCIPLE THAT ANY MATTER MUST HAVE ENERGY AND THE ENERGY IS FINITE

2.1. THE PRINCIPLE THAT ANY MATTER MUST HAVE FINITE ENERGY

The essence of matter existence is the existence of energy, so any matter must have finite energy; that is to say: the energy of any matter cannot be zero under any conditions, and the energy is finite under any conditions. In general, there are three types of energy: potential energy, kinetic energy, and static energy, so the principle that any matter must have finite energy can be expressed mathematically as follows:

$$\infty \neq E = E_p + E_k + E_0 \neq 0 \qquad \text{Equation 1}$$

According to physics: Potential energy is the energy of interaction, for independent objects, the potential energy is zero; Kinetic energy is the energy related to motion, for a relatively static reference frame, the kinetic energy of an object is zero; Static energy is the energy of an object with non-zero static mass in its static state, the static energy of a substance with zero static mass is zero. So, these three energies have corresponding value ranges under specific physical conditions, but according to the principle that any matter must have finite energy, these three energies cannot be zero at the same time under any conditions:

$$E = \begin{cases} E_0 \neq 0, \text{When } E_p = 0, E_k = 0 \\ E_p \neq 0, \text{When } E_k = 0, E_0 = 0 \\ E_k \neq 0, \text{When } E_0 = 0, E_p = 0 \end{cases} \qquad \text{Equation 2}$$

2.2. OVERVIEW OF ENERGY PRINCIPLE

The principle that energy must have and be finite, the principle of energy conservation, these two principles can summarize as the energy principle: energy must have, be finite and be conserved, which can be described in detail as: any existing matter must have energy under any condition, the energy is finite, and the energy is conserved in the process of energy conversion.

3. MATTER WITH NON-ZERO STATIC MASS IN PARTICLE PHYSICS

3.1. THE MASS OF A COMPOSITE PARTICLE IS GREATER THAN THE SUM OF THE MASS OF COMPONENT PARTICLES

In particle physics, experiments have proved that the mass of a composite particle is greater than the sum of the mass of component particles Morgan (1987), Lederman (1989), this conclusion can be explained according to Lorentz transformation and the energy principle. Suppose a composite particle C is composed of two component particles (A and B), these two component particles with non-zero static mass form composite particles through interaction, Therefore, before the formation of composite particles, the static energy, kinetic energy, and potential energy of each component particle are not zero. According to the law of conservation of energy and the principle that energy must have, when a static composite particle decays, some component particles are generated; Taking bi-component particles as an example, the energy conservation of the decay process of composite particles is expressed as follows：

$$E = E_{\mathrm{pC}} + E_{0C} = E_{\mathrm{pAB}} + (E_{\mathrm{kA}} + E_{0A}) + (E_{\mathrm{kB}} + E_{0B})$$

According to the special theory of relativity, the kinetic energy and static energy of particles with non-zero static mass can be described in a unified way by introducing momentum expression, the kinetic energy of particles A and B is related to their respective velocities u and v, using Lorentz transformation, the expression of four-dimensional momentum can be obtained:

$$\vec{P} = \begin{pmatrix} 1+\alpha\beta_1^2 & \alpha\beta_1\beta_2 & \alpha\beta_1\beta_3 & -i\gamma\beta_1 \\ \alpha\beta_2\beta_1 & 1+\alpha\beta_2^2 & \alpha\beta_2\beta_3 & -i\gamma\beta_2 \\ \alpha\beta_3\beta_1 & \alpha\beta_3\beta_2 & 1+\alpha\beta_3^2 & -i\gamma\beta_3 \\ i\gamma\beta_1 & i\gamma\beta_2 & i\gamma\beta_3 & \gamma \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ 0 \\ \frac{i}{c} m_0 c^2 \end{pmatrix}$$

$$= \frac{\gamma}{c} \begin{pmatrix} \beta_1 m_0 c^2 \\ \beta_2 m_0 c^2 \\ \beta_3 m_0 c^2 \\ i m_0 c^2 \end{pmatrix} = \gamma \begin{pmatrix} u_1 m_0 \\ u_2 m_0 \\ u_3 m_0 \\ icm_0 \end{pmatrix}$$

Using the above formula, the momentum of composite particle C and component particles A, B are:

$$\vec{P}_C = \begin{pmatrix} 0 \\ 0 \\ 0 \\ icm_C \end{pmatrix} \quad \vec{P}_A = \gamma_u \begin{pmatrix} u_1 m_A \\ u_2 m_A \\ u_3 m_A \\ icm_A \end{pmatrix} \quad \vec{P}_B = \gamma_v \begin{pmatrix} v_1 m_B \\ v_2 m_B \\ v_3 m_B \\ icm_B \end{pmatrix}$$

According to the law of conservation of momentum, the momentum of the composite particle can be calculated:

$$\vec{P}_C = \vec{P}_A + \vec{P}_B \Rightarrow \begin{pmatrix} 0 \\ 0 \\ 0 \\ icm_C \end{pmatrix} = \begin{pmatrix} \gamma_u u_1 m_A + \gamma_v v_1 m_B \\ \gamma_u u_2 m_A + \gamma_v v_2 m_B \\ \gamma_u u_3 m_A + \gamma_v v_3 m_B \\ i\gamma_u c m_A + i\gamma_v c m_B \end{pmatrix}$$

According to the symmetry mechanism of Lorentz transformation, the four-dimensional momentum component satisfies the following formula:

$$\begin{aligned} p_\mu p_\mu &= -c^2 m_C^2 \\ &= (\gamma_u u_1 m_A + \gamma_v v_1 m_B)^2 + (\gamma_u u_2 m_A + \gamma_v v_2 m_B)^2 + (\gamma_u u_3 m_A + \gamma_v v_3 m_B)^2 \\ &\qquad + (i\gamma_u c m_A + i\gamma_v c m_B)^2 \\ &= 2(\gamma_u u_1 m_A \gamma_v v_1 m_B + \gamma_u u_2 m_A \gamma_v v_2 m_B + \gamma_u u_3 m_A \gamma_v v_3 m_B - \gamma_u c m_A \gamma_v c m_B) \\ &\qquad - c^2(m_A^2 + m_B^2) \end{aligned}$$

In the above formula, the sum of dot products of momentum components is equal, so we can simplify the above formula and get:

$$m_C^2 = m_A^2 + m_B^2 + 2\frac{\gamma_u \gamma_v (c^2 - u_1 v_1 - u_2 v_2 - u_3 v_3)}{c^2} m_A m_B$$

Analyse the above formula under the condition that the speed u and v cannot be zero:

$$\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} \gamma_u u_1 m_A + \gamma_v v_1 m_B \\ \gamma_u u_2 m_A + \gamma_v v_2 m_B \\ \gamma_u u_3 m_A + \gamma_v v_3 m_B \end{pmatrix} \Rightarrow \begin{cases} u_1 v_1 < 0 \\ u_2 v_2 < 0 \\ u_3 v_3 < 0 \end{cases}$$
$$\Rightarrow (c^2 - u_1 v_1 - u_2 v_2 - u_3 v_3) > c^2$$

So, the following results can be obtained:

$$\frac{\gamma_u \gamma_v (c^2 - u_1 v_1 - u_2 v_2 - u_3 v_3)}{c^2} > 1$$

By comparing the above two formulas, we can know that the sum of the mass of the two component particles is smaller than the mass of the composite particle:

$$\begin{aligned} m_C^2 &= m_A^2 + m_B^2 + 2\frac{\gamma_u \gamma_v (c^2 - u_1 v_1 - u_2 v_2 - u_3 v_3)}{c^2} m_A m_B \\ &> m_A^2 + m_B^2 + 2 m_A m_B \\ &\Rightarrow m_C > m_A + m_B \end{aligned}$$

Equation 3

3.2. POTENTIAL ENERGY REDUCTION MECHANISM OF COMPOSITE PARTICLE

According to the energy conversion mechanism of the interaction, it can be proved that the potential energy of a composite particle is less than the total potential energy of component particles, this conclusion is exactly consistent with the principle of minimum energy. The kinetic energy of component particles is generated by interaction and comes from the conversion of potential energy, after the component particles enter the static state, their kinetic energy is transformed into mutual potential energy, so the energy conservation also can be expressed as:

$$E = E_{\mathrm{pC}} + E_{0C} = E_{\mathrm{pAB}} + E_{0A} + E_{0B}$$

Based on the above formula, it can be proved that the internal potential energy of a composite particle is lower than the total potential energy of component particles:

$$E_{0C} = E_{\mathrm{pAB}} - E_{\mathrm{pC}} + E_{0A} + E_{0B} \Rightarrow m_C = \frac{(E_{\mathrm{pAB}} - E_{\mathrm{pC}})}{c^2} + (m_A + m_B)$$

$$\because m_C > m_A + m_B \therefore\Rightarrow \frac{(E_{\mathrm{pAB}} - E_{\mathrm{pC}})}{c^2} > 0 \Rightarrow E_{\mathrm{pAB}} > E_{\mathrm{pC}}$$

Equation 4

Scope of Application: According to the analysis of the above methods, it can be proved that the mass of a composite particle is greater than the sum of the mass of component particles, the internal potential energy of a composite particle is lower than the total potential energy of component particles. The application scope of these two mechanisms may be: The mass conclusion only applies to elementary particles such as leptons and baryons, not to non-elementary particles such as molecules; the conclusion of potential energy may be general.

4. PROVING THE INVARIANCE OF THE SPEED OF LIGHT

Under the condition of independent freedom, the potential energy of matter is zero, according to the principle that energy must have can be expressed as $E = E_k + E_0 \neq 0$. Under this condition, for matter with non-zero static energy ($E_0 \neq 0$), the kinetic energy can be zero, so that the kinetic energy of a relatively stationary matter in the coordinate transformation is zero. However, for matter with zero static energy ($E_0 = 0$), according to the principle that energy must have, the kinetic energy cannot be zero under independent conditions, namely $E_k \neq 0$.

Kinetic energy is caused by motion and has relativity, therefore coordinate transformation should be introduced to describe. According to the enlightenment of Galileo transformation Danielson (2003), Arnold, V. I. (1989), assuming that the system moves at speed v in the x direction relative to the S system, the description and transformation of the coordinate, time, and speed of a moving body relative to the two systems can be expressed as follows:

$$x' = k(x - vt), x = k(x' + vt')$$
$$u' = \frac{dx'}{dt'} = k(\frac{dx}{dt'} - v\frac{dt}{dt'}) = k(\frac{dx}{dt} - v)\frac{dt}{dt'} = k(u - v)\frac{dt}{dt'}$$
$$u = \frac{dx}{dt} = k(\frac{dx'}{dt} + v\frac{dt'}{dt}) = k(\frac{dx'}{dt'} + v)\frac{dt'}{dt} = k(u' + v)\frac{dt'}{dt}$$

Where k is the transformation coefficient, which is a function of the speed v. Clearly, when $u = v$ can know that $u' = 0$, thus showing that the kinetic energy relative to the system is zero, which is reasonable for matter with non-zero static energy. And then according to the principle that energy must have and be finite, the speed v must be finite, which cannot be infinite.

However, for matters with zero static energy $E_0 = 0$, the kinetic energy cannot be zero in free states. Therefore, according to the transformation of the above formulas, it is necessary to ensure that $u \neq 0, u' \neq 0$ under any conditions, and the prerequisite is to ensure that $u \neq v, u' \neq -v$. If these calculating mechanisms can be established, only a certain limited speed c_0 can be set for matters with zero static energy:

$$u > c_0, u' > c_0 \qquad \text{Equation 5}$$

The reference system is generally an object with static energy, so according to the principle that energy must have and be finite, the relative velocity of the reference frame is also limited, namely:

$$v \leq c_0 \qquad \text{Equation 6}$$

Where c_0 can be understood as the limited speed of an object whose static energy is not zero; Under this condition, the velocity of the matter with zero static energy can be expressed as:

$$u' = c_0 + \alpha = k(u - v)\frac{dt}{dt'} = k(c_0 + \beta - v)\frac{dt}{dt'}$$
$$u = c_0 + \beta = k(u' + v)\frac{dt'}{dt} = k(c_0 + \alpha + v)\frac{dt'}{dt}$$

Where $\alpha > 0, \beta > 0$, the product of the two velocity expressions is：

$$u'u = (c_0 + \alpha)(c_0 + \beta) = k^2(c_0 + \beta - v)(c_0 + \alpha + v)$$

By simplifying the above formula, we can obtain:

$$k^2 = \frac{(c_0+\alpha)(c_0+\beta)}{(c_0+\beta-v)(c_0+\alpha+v)} = \frac{c_0^2+(\alpha+\beta)c_0+\alpha\beta}{[c_0^2+(\alpha+\beta)c_0+\alpha\beta]+[(\beta-\alpha)v-v^2]}$$
$$= \frac{1}{1+\frac{(\beta-\alpha)v-v^2}{c_0^2+(\alpha+\beta)c_0+\alpha\beta}}$$

According to the covariant principle of physics and mathematical mechanism k^2, is only the function of v, which is irrelevant with α, β ; From this, we can know that are respectively constants, so they can be expressed as:

$$\alpha-\beta=c_1, \alpha+\beta=c_2, \alpha\beta=c_3$$

Where c_1, c_2, c_3 are constants, by introducing these constants we can get :

$$k^2 = \frac{1}{1+\frac{c_1 v-v^2}{c_0^2+c_2 c_0+c_3}}$$

, $\alpha = \frac{c_1+c_2}{2}, \beta = \frac{c_2-c_1}{2}, \alpha\beta = c_3 = \frac{c_2^2-c_1^2}{4}$

Clearly α, β are constants, and the value of u, u' are independent with the choice of v, specifically when $v = 0$, there should be:

$$u=u' \Rightarrow \alpha=\beta \Rightarrow \frac{c_1+c_2}{2} = \frac{c_2-c_1}{2} \Rightarrow c_1=0, \alpha=\beta=\frac{c_2}{2}, c_3=\frac{c_2^2}{4}$$

Therefore :

$$k^2 = \frac{1}{1-\frac{v^2}{c_0^2+c_2c_0+(c_2/2)^2}} = \frac{1}{1-\frac{v^2}{(c_0+c_2/2)^2}}$$

It can be seen that the velocity of a substance with zero static energy relative to any reference frame is $c_0 + c_2/2$, being a constant ; In the known substances with zero static energy, the velocity of the photon is c, so it is exactly :

$$c = c_0 + \frac{c_2}{2}$$

So that we can deduce Lorentz transformation coefficient :

$$k^2 = \frac{1}{1-\frac{v^2}{c^2}} \Rightarrow \gamma = k = \frac{1}{\sqrt{1-v^2/c^2}}$$ Equation 7

The expression is just Lorentz transformation, which proves the assumption that the velocity of light is constant. Just based on the principle that energy must have and be finite, it is proved: Under independent conditions, any substance without static energy must move relative to any reference frames at the velocity of light.

5. THE VELOCITY AND POTENTIAL ENERGY OF STATIC FIELD WITHOUT STATIC ENERGY

5.1. THE VELOCITY OF STATIC FIELD WITHOUT STATIC ENERGY CAN BE ZERO

Taking the electric field as example to analyse, the electrostatic field has no mass, and the energy of the field is potential energy which related with field source [9]. Therefore, according to the principle of energy must have, it can be concluded that the field is stationary relative to the field source, the energy of the electrostatic field is expressed as follows:

$$E_0 = 0, E = E_p \neq 0 \Rightarrow E_k = 0$$

Obviously, the electrostatic field without mass has no static energy, the energy of the electrostatic field is the potential energy associated with the field source charge, the electrostatic field has no kinetic energy under the static condition of the field source, so the electrostatic field is stopped with respect to the field source charge. The law of this typical example can be generalized to the general conclusion that the static field with zero mass is stopped relative to the field source.

5.2. THE POTENTIAL ENERGY CAN BE CLASSIFIED AS SELF POTENTIAL ENERGY AND MUTUAL POTENTIAL ENERGY RESPECTIVELY

Also taking the electric field as example to analyse, the electrostatic field is related to the electron, so the energy of the field can be interpreted as the potential energy, and the electric energy of the electron is the sum of the energy of the relevant electrostatic field, which can be interpreted as the self-potential energy of the electron under independent conditions. According to the classical electromagnetic theory, the self-potential energy of electron is expressed as follows:

$$w_e = \frac{1}{2}\varepsilon_0 \vec{E}^2, E = \frac{1}{4\pi\varepsilon_0}\frac{e}{r^2} \Rightarrow w_e = \frac{1}{32\pi^2\varepsilon_0}\frac{e^2}{r^4}$$

$$W = \int_{r_0}^{\infty} w_e 4\pi r^2 dr = \int_{r_0}^{\infty} \frac{1}{2}\varepsilon_0 (\frac{e}{4\pi\varepsilon_0 r^2})^2 4\pi r^2 dr = \frac{e^2}{8\pi\varepsilon_0 r_0}$$ Equation 8

Where w_e is the energy density of electrostatic field, W is the total self-potential energy of electron, r_0 is the radius of electron. When two electrons are close to each other, they will interact with each other to form mutual potential energy, according to the law of energy conservation, the mutual potential energy of the double electrons system comes from the conversion of the self-potential energy of the electrons, which is expressed as follows:

$$w_{1,2} = \frac{1}{2}\varepsilon_0\vec{E}^2 = \frac{1}{2}\varepsilon_0(\vec{E}_1 + \vec{E}_2)^2 = \frac{1}{2}\varepsilon_0\vec{E}_1^2 + \frac{1}{2}\varepsilon_0\vec{E}_2^2 + \varepsilon_0\vec{E}_1 \cdot \vec{E}_2$$
$$= w_1 + w_2 + \varepsilon_0\vec{E}_1 \cdot \vec{E}_2$$

$$U + W_{1,2} = W_1 + W_2 \Rightarrow U = (W_1 + W_2) - W_{1,2} = -\int \varepsilon_0\vec{E}_1 \cdot \vec{E}_2 dV$$

Equation 9

Where $w_{1,2}$, $W_{1,2}$ and U is respectively the energy density of electrostatic field, the self-potential energy, and the mutual potential energy of the double electrons system. According to the expression of mutual potential energy, it can be clearly seen that:

1) The field strengths of double charges cannot be perpendicular to each other everywhere.
2) The mutual potential energy may be positive or negative, it fundamentally comes from the transformation of self-potential energy.

In particular, a pair of positive and negative electrons will digest the electrostatic field to zero in space after contacting, the result is that the self-potential energy is all converted into the mutual potential energy. In essence, the disappearance of the self-potential energy is the disappearance of the charge. Therefore, the positive and negative electrons will evolve into photons after contacting each other, and the quasi-potential energy formed is the energy of photons. A brief description is as follows:

$$\because \vec{E}_1 = -\vec{E}_2 \Rightarrow W_{1,2} = 2W_1 - \int \varepsilon_0\vec{E}_1^2{}_1 dV = 2W_1 - 2W_1 = 0$$
$$\therefore E_k = U = (W_1 + W_2) - W_{1,2} = 2W_1$$

Equation 10

6. DERIVING INVERSE SQUARE LAW OF MASSLESS FIELD STRENGTH

According to the principle of energy, the essence of force can be understood as the flow transfer effect of energy, so the expression of relevant force can be analysed from the analysis of the flow effect of energy. The static field without mass is the density distribution of self-potential energy, which is carried by force load as a whole Davies (1986), Klein (2013). Suppose a load particle provides force, in which the total self-potential energy is W， force load is Q, so the energy density per unit force load is:

$$w = \frac{W}{Q}$$

Figure 1

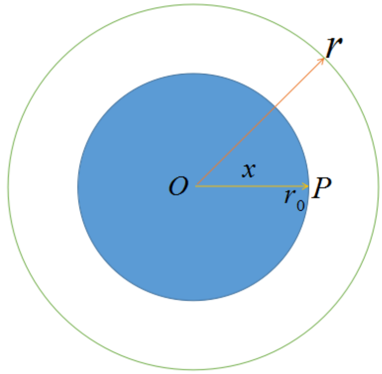

Figure 1 Geometry of Force Load

As shown in the figure, energy are uniformly distributed in the force load particle, and the structure radius of the force load particle is r_0 ; The force on a point on the surface of a particle comes from the transfer of all the energy carriers from the center O to that point, here use x to express the position of the energon on the OP line, the displacement of the energy carrier at x to the point P is $r_0 - x$, thus the total displacement of energy flow from x to P on the OP line is:

$$L = \int_0^{r_0} (r_0 - x)dx = (r_0^2 - \frac{1}{2}r_0^2) = \frac{1}{2}r_0^2$$

Suppose that the line density of the average distribution of the energy on the line OP is constant, the average displacement of these energy carriers on this line is：

$$\bar{l} = \frac{L}{r_0} = \frac{1}{2}r_0$$

Therefore, at the point P on the force load particle surface, the energy carriers on the OP line will move to this point, resulting in the field strength effect：

$$f_p = \frac{w}{\bar{l}} = \frac{W/Q}{r_0/2}$$

This energy flow is concentrated at a point on the surface, however the total energy flow on the surface of force load is：

$$f_s = f_p 4\pi r_0^2 = \frac{W/Q}{r_0/2} 4\pi r_0^2$$

At the point with distance r outside the force load surface, the field strength is the uniform distribution of the total energy flow on the spherical surface with radius r, which is obviously inversely proportional to the square of distance：

$$E_r = \frac{f_s}{S} = \frac{4\pi r_0^2}{4\pi r^2}\frac{W/Q}{r_0/2} = \frac{2r_0 W}{r^2 Q}$$ Equation 11

Here takes electric charge as an example to verify the above formula, the force load of electric charge is $Q=q$, and already know that the self-potential energy of a electric charge is $W = q^2/8\pi\varepsilon_0 r_0$, so the electrostatic field expression of Coulomb can be obtained by using the above formula:

$$E_r = \frac{2r_0 W}{r^2 Q} = \frac{2r_0}{r^2 q}\frac{q^2}{8\pi\varepsilon_0 r_0} = \frac{q}{4\pi\varepsilon_0 r^2}$$

7. CONDITIONS FOR ELECTROMAGNETIC OSCILLATION TO FORM ELECTROMAGNETIC WAVES

Electromagnetic waves are independent oscillations of electromagnetic fields, under this condition the oscillating electromagnetic field is separated from the electromagnetic field source Griffiths (1999), Klein (2013). It is known that electromagnetic waves have no mass, so we can know that the energy of electromagnetic waves in vacuum must move at the speed of light according to the principle that energy must have.

It is known that the electromagnetic wave is the associated oscillation of the electric field and the magnetic field, so the energy of the electromagnetic wave is provided by the electric field and the magnetic field respectively, according to the classical theory of electromagnetism, the energy density, and the energy flow density of electromagnetic field in vacuum are respectively:

$$w = \frac{1}{2}(\varepsilon_0 E^2 + \mu_0 H^2), \vec{S} = \vec{E} \times \vec{H} = EH \sin\theta \, \hat{e}_s$$

Energy flow density is the movement effect of energy density, so it can be expressed as the product of energy density w and speed:

$$\vec{S} = w\vec{u} = wu\hat{e}_s \Rightarrow \frac{u}{2}(\varepsilon_0 E^2 + \mu_0 H^2) = EH \sin\theta$$

By analysing the above formula, it can be judged whether electromagnetic wave is formed according to the speed of energy flow. The expression of energy flow density velocity can be obtained from the above formula:

$$u = \frac{2EH \sin\theta}{(\varepsilon_0 E^2 + \mu_0 H^2)} = \frac{2EH \sin\theta}{(\varepsilon_0 E^2 + \mu_0 H^2)}\frac{\sqrt{\varepsilon_0\mu_0}}{\sqrt{\varepsilon_0\mu_0}} = \frac{2c\sqrt{\varepsilon_0}E\sqrt{\mu_0}H \sin\theta}{(\varepsilon_0 E^2 + \mu_0 H^2)}$$ Equation 12

According to the above formula, the range of energy flow velocity can be known, and the analysis is as follows:

$$\because (\sqrt{\varepsilon_0}E - \sqrt{\mu_0}H)^2 \geq 0 \Rightarrow \varepsilon_0 E^2 + \mu_0 H^2 - 2\sqrt{\varepsilon_0}E\sqrt{\mu_0}H \geq 0$$

$$\therefore \varepsilon_0 E^2 + \mu_0 H^2 \geq 2\sqrt{\varepsilon_0}E\sqrt{\mu_0}H \Rightarrow \frac{2\sqrt{\varepsilon_0}E\sqrt{\mu_0}H}{(\varepsilon_0 E^2 + \mu_0 H^2)} \leq 1$$

Taking the above inequality into the expression of energy flow velocity, we can obtain:

$$u = \frac{2c\sqrt{\varepsilon_0}E\sqrt{\mu_0}H \sin\theta}{(\varepsilon_0 E^2 + \mu_0 H^2)} \leq c \sin\theta$$

According to the principle that energy must have, the energy flow velocity of electromagnetic wave in vacuum must be equal to the speed of light. The condition that the energy flow velocity is equal to the speed of light can be deduced from the expression above:

$$\because u = c \Rightarrow c = \frac{2c\sqrt{\varepsilon_0}E\sqrt{\mu_0}H \sin\theta}{(\varepsilon_0 E^2 + \mu_0 H^2)} \leq c \sin\theta$$

$$\therefore \sin\theta = 1, \varepsilon_0 E^2 + \mu_0 H^2 - 2\sqrt{\varepsilon_0}E\sqrt{\mu_0}H = 0 \Rightarrow \sqrt{\varepsilon_0}E = \sqrt{\mu_0}H \quad \text{Equation 13}$$

Obviously, the conditions for electromagnetic oscillation to form electromagnetic waves are:

$$\theta = \frac{\pi}{2}, \quad \sqrt{\varepsilon_0}E = \sqrt{\mu_0}H \Rightarrow \varepsilon_0 E^2 = \mu_0 H^2 \quad \text{Equation 14}$$

It indicates that:

1) The electric field and the magnetic field are perpendicular to each other and in the same phase
2) The energy density of electric field and magnetic field is equal.

8. SUMMARY

In this paper, the physical principle that energy must have and be finite is first proposed, then the principle is unified with the principle of energy conservation and is defined as energy principle as a whole. In order to verify the correctness of the energy principle, six physical laws are analysed according to the energy principle. If the energy principle is correct, some other physical laws can also be explained according to the principle, thus enhancing the depth of the existing physical theories.

CONFLICT OF INTERESTS

None.

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None.

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