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Differential Equation of Motion of the Particle with Helical Structure and Spin $\frac{\hbar}{2}$ Has the Form Like Schrodinger's

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Abstract. Electromagnetic radiations are obviously waves. Photoelectric effect caused A. Einstein to postulate that light of frequency ν itself consists of individual quanta of energy $\in = h\nu$. Follow Einstein directly, we try to treat a thin beam of conical wave train with energy $h\nu$ as a photon to see if there is anything interesting. We first prove theoretically that such a train must be covered by a membrane of perfect reflection and zero rest mass as lateral boundary. Then we prove that there is a pair of symmetrical spirals of maximum stress $\Sigma_{\max} \propto E^2$ that divides the membrane into equal parts with same amount of different charges. Once the field being strengthened strongly and the conditions of mass and charge satisfied, the membrane will break into two ±charged particles of spin $\hbar/2$. Charges and mass distribution inside are proved to be of helical symmetry. Then we prove that the spin of this class of particles are generally consisted of two parts: owing to such spiral structure's translational motion plus extra self-rotation. Just because of this special structure, we prove at last that differential equation of motion particle's inner system satisfied looks like Schrodinger equation although interpretation for the wave function is different.

Keywords: Membrane**,** O-planes, ±charged spiral-halves, un-forming ±electron.

pitch, spin, spiral structure, "rotating on O-planes", intrinsic frequency, extra self-rotation, wave function, mass density, helical symmetry, Schrodinger equation

I. Introduction

Electromagnetic radiations are obviously waves. Photoelectric effect caused A. Einstein to postulate that light of frequency ν itself consists of individual quanta of energy $\in = h\nu$.

In the demonstration of quantum electrodynamics, E. Fermi(1) and then R. P. Feynman(2) connected the average energy density ($= h\nu$) of electromagnetic wave with the probability (=1) of finding a photon there to be a basic.

To follow A. Einstein's idea directly, it is natural to treat a thin beam of a monochromatic spherical electromagnetic wave from $\rho = 0$, with solid angle Ω_R and length L having energy $h\nu$ as a photon. That is

$$\int_{\rho-L}^{\rho} d\rho \int_0^{S_R} \frac{1}{2}\left\{ \frac{\varepsilon_0 A^2(\frac{r}{R})}{\rho^2}\cos^2 2\pi\left[\frac{t}{T}-\frac{\rho}{\lambda}\right] + \frac{\mu_0 H^2(\frac{r}{R})}{\rho^2}\cos^2 2\pi\left[\frac{t}{T}-\frac{\rho}{\lambda}\right]\right\} dS_r = h\nu \quad (1)$$

Where r, R is the spherical distant from the center of wave surface to the inner and boundary circumferences and L equals to multiple wavelength. The spherical area of the ring through point r on surface is $dS_r = 2\pi\rho^2 \sin\varphi \, d\varphi$. $\varphi = \frac{r}{\rho}$ is the plane angle that r suspends at $\rho = 0$. Here we treat **E**'s, **H**'s magnitudes A, H disregard of the direction of r on wave surface, just because that a photon wave train must be symmetric with its longitudinal axis.

And then, we depend on a series of logical inferences to see if there is anything interesting we will have? Are they worth to be further studied theoretically and detected by experiments?

II. A photon wave train must be covered by a membrane of perfect reflection and zero rest mass as lateral boundary.

As well known, if they are far enough from varying dipole **U**, vectors **E** and **H** are transverse, mutually perpendicular, in phase, and its magnitude [3]:

$$E = \sqrt{\frac{\mu_0}{\varepsilon_0}} H \propto \frac{\left| \ddot{U}\,(t - \frac{\rho}{c}) \right|}{\rho} \sin\theta \qquad (2)$$

According to equation (2), $E = H = 0$ when $\theta = 0$. It leads to that certain photon waves with the boundary tangent to the line of $\theta = 0$ will have $E = H = 0$ at tangent points. Because of the symmetry of a photon and the identity between photons, we can affirm that any photon wave train has got $E = H = 0$ along its circular boundary, despite of the distribution function of $A(\frac{r}{R})$ and $H(\frac{r}{R})$ are continued or discrete here.

For convenience in later illustration, we name the geometrical plane (the synonym of the thin layer) as observation (O)-plane if a plane wave passes through it perpendicularly. Of course, for a spherical wave "O-plane" is refer to spherical and coincides with the spherical wave surface. We often use "tangential" to represent the direction tangent or parallel to the wave surface.

Now a spherical photon wave train emitted from $\rho = 0$ can be expressed as

$$E(r, \rho, t') = \frac{A(\frac{r}{R})}{\rho} \cos 2\pi \left(\frac{t'}{T} - \frac{\rho}{\lambda}\right) \qquad \left(\left|\frac{r}{R}\right| \le 1,\; t' \ge 0,\, \rho \succ 0\right) \qquad (3)$$

Since the area of spherical circle of radius R on wave surface is $\rho^2 \Omega_R = \int_0^{\Phi} 2\pi\rho^2 \sin\varphi \, d\varphi = 4\pi\rho^2 \sin^2\frac{\Phi}{2}$, where $\Phi = \frac{R}{\rho} = 2\sin^{-1}\sqrt{\frac{\Omega_R}{4\pi}}$ (constant) and $\frac{r}{R} = \frac{\varphi}{\Phi}$. Then $\frac{r}{R}$ and $E(\frac{r}{R})$ just are functions of φ, disregard of the radial coordinate ρ. Expression (3) satisfies differential wave equation.

Since $A(\frac{r}{R})$ is always an even function and equal to 0 at boundary $r = R$, it can be expanded in Fourier series as follow:

$$A(\frac{r}{R}) = \sum_{j=1}^{\infty} b_{2j-1} \cos 2\pi \left(2j-1\right) \frac{r}{4R}$$

$$\underline{\underline{let}} \sum_{j=1}^{\infty} b_{2j-1} \cos 2\pi \left(2j-1\right) \frac{r}{\Lambda} \qquad (\Lambda = 4R \ , \ \ |r| \le R) \qquad (4)$$

The wave function (3) will make a stationary vibration on the O-plane located at ρ_o. Its function is

$$E(r,\rho_{o,}t) = \frac{A(\frac{r}{R_o})}{\rho_o} \cos 2\pi \frac{t}{T} \ \underline{\underline{let}} \ E(r,t)$$

$$A(\frac{r = R_0}{R_0}) = 0 \qquad (|r| \prec R_o, 0 \le t \le T\frac{L}{\lambda}) \qquad (5)$$

Hear we have chosen the zero point of t so as initial phase of cosine function equal to zero.

Instead equation (4) into (5), we have

$$E(r,t) = \frac{1}{2\rho_o} \sum_{j=1}^{\infty} b_{2j-1} \cos 2\pi \left(\frac{r}{\Lambda_{2j-1}} - \frac{t}{T}\right) + \frac{1}{2\rho_o} \sum_{j=1}^{\infty} b_{2j-1} \cos 2\pi \left(\frac{r}{\Lambda_{2j-1}} + \frac{t}{T}\right)$$

$$\underline{\underline{let}} \ E_+(r - Vt) + E_-(r + Vt)$$

$$(\Lambda_{2j-1} = \frac{\Lambda}{(2j-1)}, \ \Lambda = 4R_o, \ V = \frac{\Lambda}{T}, \ |r| \le R_o \ , \ 0 \le t \le T\frac{L}{\lambda}) \qquad (6)$$

For any direction of **r** on the O-plane (thin layer), $E_+(r - Vt)$ is the sum of all traveling waves to the right. And $E_-(r + Vt)$ is the one to the left. They move toward each other and reflect perfectly at the boundary points with 180^0 phase loss (where $E = H = 0$)

The identity of equations (5) and (6) means when a photon wave passes ρ_o-plane at time t, the energy exited in the thin layer can be treated as storage either in type of stationary vibration, or in type of the distribution of infinite pairs of transversal traveling waves along the O-plane at same time. They are mathematically equivalent. An interesting question is whether the transversal traveling electromagnetic waves really exist over the O-plane (the space that thin layer occupied)? The answer is certainly positive. As a matter of fact, for every moment t, **E** of all points at same layer are parallel and varying synchronically. They will excite radiation along all directions ***include the tangential directions of the layer***. The mutual tangential radiations, then mutual Poynting vectors (**S**= **E**$\times$**H**) and mutual radiation pressures **Q** across the interface of any two adjacent parts in the same layer are really existed. Equation (6) means that the resultant transversal traveling waves and energy flow are radial in the thin layer.

The radiation intensity from a varying **E** is anisotropic even along wave surface, equation (2). If a photon wave is linear polarized, the coefficients in equation (6) must be different in different r-direction. So the photon waves just emitted from varying dipole must be equal mixtures of right and left circular polarized. A photon must be certain sort of circular polarized and the coefficients of equation (6) must be the statistical mean values in the half period ($\frac{1}{\pi}\int_0^{\pi} E_{\max}\sin\theta\, d\theta = \frac{2}{\pi}E_{\max}$). It makes the coefficients same along any r-direction on same wave surface.

For eq. (1), since

$$\frac{A^2(\frac{r}{R})}{\rho^2}(2\pi\rho^2\sin\varphi d\varphi) = 2\pi A^2(\frac{r}{R})\sin(\Phi\frac{r}{R})\, d(\Phi\frac{r}{R}) \tag{7}$$

And the limits of this integral are $\int_0^{\Phi}$, so the total average energy over any wave surface with unit thickness are equal and independent of ρ. A photon's energy is restricted within the solid angle Ω_R subtended at the point source $\rho = 0$ despite of how large the area of wave surfaces during propagation. **It means that no radiation energy can run out perpendicularly across a photon's lateral boundary surface.**

On the other hand, outward tangential radiations from the region ($R - r \le \beta, \beta \succ 0$) along the circumference of O-planes are always existed. The outward Poynting vectors perpendicular to the lateral surface $\mathbf{S}(R,\theta,\rho,t)$ = $\mathbf{E}(R,\theta,\rho,t)\times\mathbf{H}(R,\theta,\rho,t)$, ($0 \le \theta \le 2\pi, 0 \prec \rho \le L$) are generally different to zero over whole boundary. For simplify of notation, we use $(R,\theta,...)$ to represent

"$(r,\theta,...)$ where $|r-R| \prec \beta$ for small enough $\beta \succ 0$" here and in the following.

Since electromagnetic radiation can not be reflected from vacuum. Therefore, we come to a very important conclusion: The lateral boundary of a photon wave train must be covered by a membrane of perfect reflection and zero rest mass. This material must be directly transferred from the energy of source material.

By the way if unrelated to this article, as an important corollary, it was pointed out in one of our last papers (4) that varying field is not the sufficient condition for the production of a photon. It is just a necessary condition. Another one is that the source can provide the energy to be membrane, although its energy is supposed to be so small in compare with photon's field energies. It seems to be the reason of why the electron of atom in ground state is stable, since there is not any available lower state permit him to locate so as no extra energy of electron can provide the necessary membrane no matter how small it is.

All resultant transversal waves on O-planes are radial, equation (6). Any beam of the transversal traveling wave $E_+(r-Vt)$ and $E_-(r+Vt)$) is sector-like. Let $\delta\theta$ be the angle of the sector. Then on the same sector, the energy flow passes through the area $r_i\,\delta\theta\,\delta\rho$ equal to the one through $r_k\,\delta\theta\,\delta\rho$. That is

$$S(r_i,\theta,\rho,t)\,r_i\,\delta\theta\,\delta\rho = S(r_k,\theta,\rho,t)\,r_k\,\delta\theta\,\delta\rho \quad (0 \prec r_i \prec r_k \prec R) \qquad (8)$$

Since $S=\sqrt{\dfrac{\varepsilon_0}{\mu_0}}E^2=\sqrt{\dfrac{\varepsilon_0}{\mu_0}}\dfrac{A^2(\frac{r}{R})}{\rho^2}$, let $r_i = r$, $r_k \to R$ and $A_R = \lim\limits_{r \to R} A(\frac{r}{R})$,

then equation (8) gives the relation between magnitudes A of r and R as follow

$$A(\frac{r}{R}) = A_R\sqrt{\frac{R}{r}} \qquad (0 < r < R)$$

$$A(\frac{R}{R}) = 0 \qquad (r = R) \qquad (9)$$

Where A_R is a constant disregard of ρ. The later boundary condition has been discussed at the beginning of this paper. Equation (9) is the distribution function of $A(\frac{r}{R})$ on any wave surface.

To substitute equation (9) into (3), we have the wave function of a photon emmited from the point source $\rho = 0$

$$E(r,\rho,t) = \frac{A_R}{\rho}\sqrt{\frac{R}{r}}\cos 2\pi(\frac{t}{T}-\frac{\rho}{\lambda}) \quad (|r| \prec R\text{,}\ \ t_0 \le t \le t_0 + T\frac{L}{\lambda},\ \ \rho \succ 0)$$

$$E(R,\rho,t) \ = \ 0 \qquad (10)$$

Equation (10) refers to that such a photon's reaction probability with other particle at wave's center is far greater than other parts of it.

On the other hand, the time rate of change of momentum at boundary is $2\,\mathrm{S}(R,\theta,\rho,t) \big/ c$. It will cause the existence of centrifugal pressure of same amount $Q_{mem}(R,\theta,\rho,t)$ from all points of the cover membrane.

$$Q_{mem}(R,\theta,\rho,t) = \ 2\,\mathrm{S}(R,\theta,\rho,t) \big/ c \quad (-\pi \le \theta \le \pi\text{,}\ \ \rho_0 \le \rho \le \rho_0 + L) \qquad (11)$$

Combining equations (11) with (8), we have the equilibrium equation between two opposite surfaces $r\ \delta\theta\ \delta\rho$ and $R\ \delta\theta\ \delta\rho$ in the same sector space

$$Q_{outward}(r,\theta,\rho,t)\ r\ \delta\theta\ \delta\rho = Q_{mem}(R,\theta,\rho,t)\ R\ \delta\theta\ \delta\rho$$

$$(0 \prec r \prec R,\ \ 0 \le \theta \le 2\pi\text{,}\ \ 0 \le \rho \le L) \qquad (12)$$

III. Four important mechanical and electromagnetic properties of the membrane

Figure 1 is a sketch map of the distribution of **E(** r **)** on a wave surface,. Let θ be the angle of radius **R** from abscissa $\overline{OF}$. **M**omentum's rate of change at the boundary $\frac{2S(R,\rho,\theta)}{c}$ makes the circular tension per unit length of wave train $T(R,\rho,\theta)$ in the membrane. That is

$$T(R,\rho,\theta) = \frac{2R}{c} S(R,\rho,\theta) = \frac{2R}{c\rho^2}\sqrt{\frac{\varepsilon_0}{\mu_0}} A_R^2 \cos^2\theta \tag{13}$$

The maximum happens at points A and F, $T_F(R,\rho,0) = T_A(R,\rho,\pi) = T_{\max} = \frac{2\Phi^2}{cR}\sqrt{\frac{\varepsilon_0}{\mu_0}} A_R^2$. This relation is valid for other A and F points of every wave layer. Connecting all these points A and F respectively they form two parallel spirals, A- spiral and F- spiral (right-handed or left-handed double thread) on the lateral surface of the circular polarized wave train.

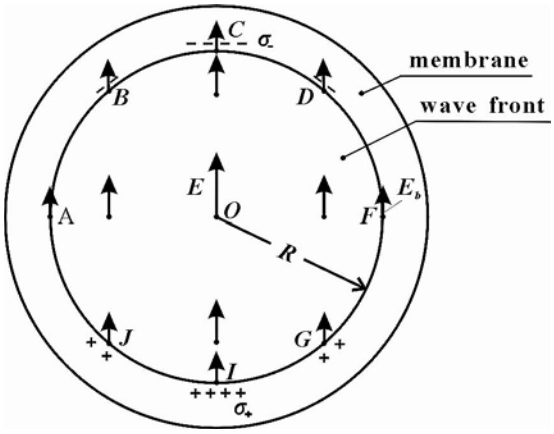

Figure 1

The material of membrane must be very easy to change its shape during propagation, so we suppose it is a liquid-like material having almost constant volume. The area of membrane's cross-section $2\pi R\,\delta R \overset{let}{=} 2\pi\Gamma$ is constant. So the thickness

$$\delta R = \frac{\Gamma}{R} \tag{14}$$

Let $\Sigma_{\max}$ be the maximum normal stress on the cross-section. Since $T_{\max} = \Sigma_{\max}\delta R$ and equation (13), it gives

$$\Sigma_{\max} = \frac{2}{c\Gamma\rho^2}\sqrt{\frac{\varepsilon_0}{\mu_0}} A_R^2 R^2 = \frac{2\Phi^2}{c\Gamma}\sqrt{\frac{\varepsilon_0}{\mu_0}} A_R^2 \tag{15}$$

For a photon of circular polarized with given ν, there are four important properties of its membrane:

(**i**) The maximum stress $\Sigma_{\max}$ is constant, eq.(15) that always happened along A-spiral and F-spiral on the photon's lateral surface despite of the magnitude of ρ and R.

The electromagnetic wave train plus cover membrane form an independent structure. Under general circumstances, the photon train will always keep its integrity unless there is a very strong external effect, for example, try to stop the train and greatly increase the density of its E-H field around **A,F** and **makes** $\Sigma_{\max}$ **bigger than ultimate tensile strength** (unknown but must exist) **and break the membrane.**

(**ii**) Since surface density of charge σ on the inner side of the membrane equals to D_n $(=\varepsilon_0 E_n)$, so, for the upper spiral-half. Fig 1, the absolute value of σ_θ is

$$\sigma_\theta = \left| \varepsilon_0 \frac{A_R}{\rho} \sin\theta \right| \qquad (0 \le \theta \le \pi) \qquad (16)$$

The charge density σ_θ of any point forms an equal-magnitude spiral on the inner side of the membrane. This is to say that charges inside distribute with helical symmetry about its longitudinally central axis. The total negative charge in upper spiral-half is

$$q = \int_0^L d\rho \int_{\theta=0}^{\pi} \sigma_\theta \, R \, d\theta = 2\varepsilon_0 \frac{A_R}{\rho} R L = 2\varepsilon_0 \Phi A_R L \qquad (17)$$

The lower half has same amount of positive charge. Like the $\Sigma_{\max}$, quantity q in the ±charged spiral-halves always exists and keeps unchanged despite of the magnitude of ρ and R.

(iii) The increase of wave surfaces' magnitude as photon moves forward will cause the circumferences of membrane become longer and longer. Within $d\theta$ region, when the radius of membrane increases from R to $R + dR$, the increment of circumference is $dR\,d\theta$. The work down in the $\delta\rho$-layer of the wave train against tension from original nucleus dimension R_0 to final R is

$$\delta W = \delta\rho\int_{R_0}^{R} 4\int_0^{\frac{\pi}{2}} T(R,\rho,\theta)\,dR\,d\theta = \frac{2\pi\Phi^2}{c}\sqrt{\frac{\varepsilon_0}{\mu_0}}A_R^2\,\delta\rho\ln\frac{R}{R_0} \tag{18}$$

For a photon, the work can be down against the tension is certainly finite, $\ln\frac{R}{R_0}$ and then the radius R of photon wave surfaces must be upper bounded if a photon cannot self blast. A photon wave train will at last becomes exactly (not approximately) cylindrical with radius $R_{\max}$. This will make the photon that came from the end of our universe ten billion years ago still having a finite $R_{\max}$ wave surface.

(**iv**) As well-known the intrinsic frequency $\nu_\gamma (= \frac{\in_\gamma}{h})$ of the circular polarized photon is exactly the rotation frequency of **E,H** on different O-planes with different initial phases caused by translational motion of photon's **E,H** fields. Such rotations on the O-planes make photon's spin and equal to $\hbar$. As parts of a photon, it is evident that ν_γ and $\hbar$ are also the frequency and spin of the pair of ±charged spiral-halves. The pitches of the pair and the photon are equal. These properties are owing to the translational motion of a helical structure of fields or of energy densities and charges at speed c. For simply of illustration in the following we always use "rotating on O-planes" to express such special kind of rotation.

IV External production and charges distribute inside charged and anti-charged particles.

If the energy of a photon equal to the double of certain ±charged particle's $m_p c^2$ and q in eq.(17) equals to the amount of this particle's charge, such as leptons and hadrons (with spin $\frac{\hbar}{2}$), then under appropriate conditions, that is the fields **E, H** of photon increased strongly and break the membrane, external production of such pair may happen.

As a possible case, if a photon closely skims over a heavy nuclei and the superposition of fields make certain parts of membrane's neighborhood $(\Sigma_{\max} \propto) E_R^2$ overload and larger than its ultimate tensile strength, it will be possible to have the membrane quickly and then entirely split along A-spiral and F-spiral. The pair of ±charged spiral-halves of the photon will become two independent charged spiral-parts (no longer a photon but two un-forming ±particles) although they are still superimposed temporarily before axial departure completed. The later is because of opposite magnetic fields the rotating ±charges produced.

In this process:

(a) Split of membrane makes redistribution of its ±charges. Electric attraction will cause two electric flows along different membrane's circumferences and at last stop evenly at two ends A and F. The photon's **E, H** field (who produces the charges in membrane, not the reverse) still exists at all points inside. The original field directions are different on different O-planes, so the distribution of energy density on any O-planes must have directional property, otherwise its spin will vanish and break the conservation law of angular momentum. As a matter of fact, two charged points (positive or negative) located at the ends of the diameter $\overline{AF}$ (X-axis) will certainly effect the distribution of energy density and make them having similar axial symmetry on any O-plane. The charges' distribution on any un-forming ±particle's surface looks like symmetric double helix. Connection of the points of equal energy density among all neighboring O-planes forms equal-magnitude spiral in it. The distribution of charges and mass are all of helical symmetry.

(b) The circumference of any layer's membrane after split will contract and recovery to its original length. And in the meantime, attraction between ±charges on opposite ±particles' surfaces will greatly shorten its diameter. The result is that the large R-radius un-forming ±particle become the small ones with original nucleus radius R_0 (or even smaller). Since superposition of fields and radial contraction of cross-sections do not change the length of its longitudinal pitch and they still move with speed c before axial separation by magnetic repulsion begins, so rotating frequency of the small pairs on O-planes still equals to ν_γ (= c/pitch). The spin $\hbar$ must be conserved in this process. So the moment of inertias (=spin/$2\pi\nu_\gamma$) of the small pair and of the big pair are equal, despite of the magnitude of all layer's radius (even if they are not equal). Every small un-forming ±particle has spin $\frac{\hbar}{2}$.

(c) In the process of axial separation of the small un-forming ±particle, they must still move at speed c. Repulsion force along radial direction between the charged spiral itself will step by step expand particle's diameter to increase its moment of inertia and decrease the rotating frequency of dq (dm_e also) on the O-planes until they are totally separated.

The pair production of electron and positron is a real example. Let $\nu_{real(c)}$ express the final rotating frequency of dq on O-planes while the small un-forming ±electrons are totally separated but temporarily still at speed c. In this process, the spin must be conserved. So $\nu_{real(c)}$ is the necessary and sufficient frequency for the free un-forming ±electron to guarantee its spin $\frac{\hbar}{2}$.

According to the conservation law of energy, each un-forming ±electron produced must have energy $\in_e$

$$\in_e = \frac{1}{2} h\nu_\gamma \overset{let}{=} h\nu_{e(c)} \tag{19}$$

We name $\nu_{e(c)}$ as intrinsic frequency of the un-forming electron. Does $\nu_{real(c)}$ equal to $\nu_{e(c)}$? There are just two types of expression to indicate a thing's total energy that is Einstein's $\in = h\nu$ and $\in = mc^2$ correspondent to zero and none zero rest mass respectively. $h\nu_{real(c)}$ has energy dimension. If $h\nu_{real} \neq h\nu_e$, it means there must be happened an extra gain or loss of energy $\pm h\delta\nu$ during this microscopic process. So, if different type of energy transfer does not happen in this process of pair production, we will have

$$h\nu_{real(c)} = h\nu_{e(c)} = \in_e \tag{20}$$

Intrinsic frequency $\nu_{e(c)} (= \frac{\in_e}{h})$ is really the necessary and sufficient frequency for the un-forming electron rotating on O-planes to guarantee its spin $\frac{\hbar}{2}$. This is the physical meaning of this intrinsic frequency.

At last, during electromagnetic energy transfers to material ($m_0 \neq 0$), un-forming electron becomes a free electron and speed decreases to V. Since variation of longitudinal velocity from c to V do not affect the radial distribution of mass on cross-sections; do not affect its moment of inertia, if we suppose electron is made up by isotropic material. Then the ratio $\nu_{e(c)} : \hbar/2$ will keep unchanged. Above assertion will be still available for ±electron not only for un-forming one. Or in other words, **the physical meaning of electron's intrinsic frequency $\nu_{e(c)} (= \frac{\in_e}{h})$ is that the intrinsic frequency is really the necessary and sufficient frequency rotated on O-planes to guarantee its spin $\frac{\hbar}{2}$.**

On the other hand, $\nu_{real(c)}$ also refers to that the $\nu_{real(c)}$ time of $\lambda_{e(c)}$ equals to c.

$$c = \nu_{e(c)} \lambda_{e(c)} \tag{21}$$

Where $\lambda_{e(c)}$ is the pitch of un-forming electron just separated but still at speed c.

For the un-forming electron just totally separated, since $\nu_{e(c)} = \frac{1}{2}\nu_\gamma$, the pitch $\lambda_{e(c)}$ is

$$\lambda_{e(c)} = 2\lambda_\gamma \tag{22}$$

This lengthening effect of un-forming electron's pitch can be explained as self longitudinal repulsion of every charged spiral itself.

Besides, conservation law makes the momentum of each un-forming electron to be $\frac{1}{2} p_\gamma$. Or

$$p_{e(c)} = \frac{1}{2}\frac{h}{\lambda_\gamma} \overset{(22)}{=} \frac{h}{\lambda_{e(c)}}. \tag{23}$$

When an un-forming electron changes to a free electron, field energy becomes mass ($m_0 \neq 0$) and speed decreases to V. According to special relativity, the momentum of electron is

$$p_{e(V)} = m_e V = \frac{h\nu_{e(c)}}{c^2} V \overset{(21)}{=} \frac{h}{\lambda_{e(c)}} \frac{V}{c} \overset{let}{=} \frac{h}{\lambda_{e(V)}} . \tag{24}$$

or

$$p_{e(V)} = \frac{h}{\lambda_{e(V)}} \qquad \left(\lambda_{e(V)} = \frac{c}{V} \lambda_{e(c)} \overset{(21)}{=} \frac{c^2}{V} T_{e(c)} \right) \tag{25}$$

Comparing eq. (25) with eq. (23), $\lambda_{e(V)}$ and $\lambda_{e(c)}$ have same dimension and same form of relation with momentum p and $\lim_{V \to c} \lambda_{e(V)} = \lambda_{e(c)}$. We can reasonably assert that $\lambda_{e(V)}$ is the pitch of electron during speed V. It is $\frac{c}{V}$ times of $\lambda_{e(c)}$. Why?

According to conservation of energy from un-forming electron to electron $m_e c^2 = \in_e = p_{e(c)} c$ and Einstein's energy-momentum relation $p_{e(V)}^2 = \frac{m_e^2 c^4}{c^2} - m_0^2 c^2$, then $\frac{h^2}{\lambda_{e(V)}^2} = \frac{h^2}{\lambda_{e(c)}^2} - m_0^2 c^2$, the appearance of $m_0 c \neq 0$ increases its pitch from $\lambda_{e(c)}$ to $\lambda_{e(V)}$.

Above results are all available at least for ±charged particles with spin $\frac{\hbar}{2}$ and even the neutral particles if it can be modeled as double ±charged spirals of same pitch inside.

We have noticed that $\in_e = h\nu_{e(c)}$ and $p_{e(V)} = \frac{h}{\lambda_{e(V)}}$ (In general symbol, that is $\in = h\nu$ and $p = \frac{h}{\lambda}$) are just a logical result here, not a postulate. They reflect the features of particle's spiral structure. They represent different physical meaning as they used to be.

V. Formation of spin and the equation of motion of charged particle's inner system

Let a charged particle moves with V in direction of Z-axis and the coordinate of first dq_1 be $x=1, y=0, z=0$ at $t=0$. Let $T_{e(V)}$ be the period of dq_1 cycling on the O-planes during the charges' translational motion is of speed V. Then we have the relation $\lambda_{e(V)} = VT_{e(V)}$. The equation of motion of right-handed spiral charge dq_1 is

$$x = R_q \cos 2\pi(\frac{z}{\lambda_{e(V)}} - \frac{t}{T_{e(V)}}) \tag{26}$$

$$y = R_q \sin 2\pi(\frac{z}{\lambda_{e(V)}} - \frac{t}{T_{e(V)}}) \qquad (\lambda_{e(V)} = VT_{e(V)}) \tag{27}$$

$(-J\lambda_V \le z \le 0)$. Where J is the total number of pitches in the electron, R_q - the radius of charged spiral-halves. Treat X-, Y- as complex plane perpendicular to the direction of motion and rewrite (26),(27) in complex form

$$r = R_q\, e^{-i2\pi(\frac{t}{T_{e(V)}} - \frac{z}{\lambda_{e(V)}})} \tag{28}$$

On the other hand, the physical meaning of electron's intrinsic frequency shows that spin of magnitude $\frac{\hbar}{2}$ always demands electron's rotating frequency on O-planes equals to $\nu_{e(c)}$ (or cycling period equals to the intrinsic period $T_{e(c)} (=1/\nu_{e(c)})$ disregard the translational velocity is c or V. So the cycling period of dq, dm on O-planes must be $T_{e(c)}$ not $T_{e(V)}$. The electron must posses an extra self-rotation about Z-axis to meet the demand if $V < c$. That is

$$2\pi(\nu_{extra} t + \frac{t}{T_{e(V)}} - \frac{z}{\lambda_{e(V)}}) \overset{must}{=} 2\pi(\frac{t}{T_{e(c)}} - \frac{z}{\lambda_{e(V)}}) \qquad (\lambda_{e(V)} = VT_{e(V)}) \tag{29}$$

Since $\lambda_{e(V)} = \frac{c^2}{V} T_{e(c)}$, eq. (25), the extra self-rotation frequency ν_{extra} should be

$$\nu_{extra} = (1-\frac{V^2}{c^2})\nu_{e(c)} \qquad (\nu_{e(V)} = \frac{V^2}{c^2}\nu_{e(c)}) \tag{30}$$

If $V \to c$, $\nu_{extra} \to 0$, electron just moves translational for keeping spin $\frac{\hbar}{2}$. On the contrary, if $V \to 0$, charged particles' spin $\frac{\hbar}{2}$ totally depend on charged particle's self-rotation with frequency $\nu_{e(c)}$ about Z-axis.

Generally speaking, the electron's spin $\frac{\hbar}{2}$ consists of two parts: circular motion of all dq on O-planes caused by its translational motion of speed V and the extra self-rotation $\nu_{extra} = (1-\frac{V^2}{c^2})\nu_{e(c)}$ about symmetric axis.

The rotation restricts the radius of electron. Linear speed at its surface must be small then light.

Combine the spiral structure of charges inside with the extra self-rotation under the demand of spin $\frac{\hbar}{2}$, charge dq's equation of motion must be

$$r = R_q\, e^{-i2\pi(\frac{t}{T_{e(c)}} - \frac{z}{\lambda_{e(V)}})} \qquad (\lambda_{e(V)} = \frac{c^2}{V}T_{e(c)}) \tag{31}$$

Mathematically speaking, the spin $\frac{\hbar}{2}$ could be realized if the particle (without extra self-rotation) simply moves translational with phase velocity $\frac{c^2}{V}$. This is the physical meaning of phase velocity. It is the extra self-rotation that made the apparently superluminal effect of this velocity.

Since charge inside the particle distributes with helical symmetry about its longitudinally central axis, the distribution of mass density also have same symmetry as we mentioned above. So, vector **r** ($|r| = R_q = \sqrt{x^2+y^2}$) in equations (31) can be also used to express the motion of any mass density's spiral ($0 \le |r| \le R$). Let $\Psi(x,y,z,t)$ be the equation of motion of electron's mass density, the following relation holds

$$\Psi(x,y,z,t) = Ae^{-i2\pi(\frac{t}{T_{e(c)}} - \frac{z}{\lambda_{e(V)}})} \qquad (|A| = \sqrt{x^2 + y^2}\ ) \qquad (32)$$

According to equation (20) and (25), we can rewrite equation (32) into generalized complex form and neglect the subscript of $\in$ and p :

$$\Psi(x,y,z,t) = A\, e^{-\frac{i}{\hbar}(\in t - xp_x - yp_y - zp_z)} \qquad (33)$$

The differential form of this wave function is of the form like Schrodinger equation.

Here we arrive at such a conclusion that the spiral distribution inside plus the demand of spin $\frac{\hbar}{2}$ makes this kind of charged particles having eq. (33) as their equations of motion and satisfy the differential equations of the form like Schrodinger's (and Dirac's also). Therefore at least for this class of ±charged particles of spin $\frac{\hbar}{2}$, it seems we may simultaneously interpret the solutions of Schrodinger equation as the equation of motion of such particle's inner system. For example, it seems we may treat the electron cloud as the moving figure of electron's mass density distribution around the nucleus" etc.

VI. Conclusion

Base on Maxwell theory and Einstein quanta postulate, we have derived the differential equation of motion of the particle that possesses helical structure and spin $\hbar/2$. It has the form like Schrodinger's, although the interpretation of wave function is somewhat different. It gives us another way to understand great Schrodinger equation if we do not reject the idea that particle has its dimension and inner system. Under this premise, the wave function may use to indicate the space-time distribution of the particle's mass and charges.

To accept the idea that particle has its inner system not just point will help us to understand where and how does mass and ±charges come from in the pair production. And also help us to understand the mechanism of the formation of spin $\hbar/2$ in such particles.

The photon and the ±charged particles photon produced obey similar form of equations $\in_\gamma = h\nu_\gamma$, $p_\gamma = \frac{h}{\lambda_\gamma}$ and $\in_e = h\nu_{e(c)}$, $p_{e(V)} = \frac{h}{\lambda_{e(V)}}$ respectively just because they have similar structure of helical symmetry about the longitudinally central axis. A photon wave train has helical symmetry of field **E**, **H** and the particles have same symmetry of charges and mass distribution. Intrinsic frequencies ν_γ and $\nu_{e(c)}$ of them represent the necessary and sufficient frequencies of fields or of mass (include dq) on the O-planes to guarantee their spin $\hbar$ and $\hbar/2$ respectively. λ_γ and $\lambda_{e(V)}$ represent the pitch of the photon's and charged particle's structures. They are also the wave lengths of translational motion. An important difference between them is that those particles with non-zero rest mass have self-rotation in general in compensating itself to guarantee the spin $\frac{\hbar}{2}$.

As to the explanation of absorption by atom and Compton's effect and the diffraction behavior, include how a photon train can pass through a pinhole or slit with smaller area have been discussed in the former paper [4]. By the way, if there are somewhat different statements in our different papers about same thing, please take this paper's.

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References

(1) Enrico Fermi, Quantum Theory of Radiation, Revs. Modern Phys., **4,** 87 (1932).

(2) R.P.Feynman, Quantum Electrodynamics, W.A.Benjamin,Inc. (1961)

(3) Richard Fitzpartrick, Maxwell's Equations and the Principles of Electromagnetism, Infinity Science Press (2007).

(4) Chen Sen Nian, Photon, charged particle and anti-charged particle, *Adv. Studies Theor. Phys.*, Vol. 3, 2009, no. 9-12, 401-419.

(5) Chen Sen Nian, The formation of spin $\frac{\hbar}{2}$ in ±charged particles and different interpretation for the wave function, *Adv. Studies Theor. Phys.*, Vol. 4, 2010, no. 9-12, 565-574.

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