Confined Helical Wave Structure and the Electric Charge of Electron

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The authors show that that just as the rest mass and the spin, the electric charge of electron can also be attributed to its confined helical wave structure **[1]**. It turns out that the fine structure constant is the ratio of the electromagnetic field energy of the electron to its rest mass energy. The magnetic dipole moment of the electron also emerges in a simple manner from the confined helical wave structure of electron.

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1 Introduction

We saw that Maxwell's equations in vacuum accept solutions in terms of electromagnetic waves possessing spatial oscillations [2]. We further saw that such an electromagnetic wave when confined after imparting half spin acquires rest mass, and its time dependent part transforms into a plane wave that represents a particle [1]. The space-dependent component of the confined helical wave transforms to an amplitude wave which gets compacted into the internal coordinates. It was observed that the compacted amplitude wave accounts for the spin of the particle. The idea that particles like electrons and positrons are created from the confinement of the electromagnetic wave is quite appealing in the light of the fact that the electron-positron collision creates only high energy photons. We know that in the rest frame of reference, the confined helical wave structure of electron can be represented as **[1]**.

$$\phi_o^{L_1} \quad = \quad \eta_o\left[\mathbf{j}\cos\left(p_o z_o'/\hbar\right) \; + \mathbf{i}\sin\left(p_o z_o'/\hbar\right)\right] \; e^{-i\hbar^{-1}E_o t_o}, \qquad (1)$$

$$\phi_o^{L_2} \quad = \quad \eta_o[\mathbf{j}\cos(p_o z_o' / \hbar) - \mathbf{i}\sin(p_o z_o' / \hbar)]\, e^{-i\hbar^{-1}E_o t_o} \; . \qquad (2)$$

Here ϕ_o^{L1} represents the forward wave component of the confined helical wave while ϕ_o^{L2} represents the reverse wave. We know that this confined helical wave when given translational velocity along z-axis takes on the form of a plane wave given by **[1]**

$$\phi^{L_1} \;=\; \eta_1\left\{\mathbf{j}\cos\left[E\left(z' - vt'\right)/\hbar c\right] + \mathbf{i}\sin\left[E\left(z' - vt'\right)/\hbar c\right]\right\} e^{-i\hbar^{-1}(Et - \text{þz})} \;, \qquad (3)$$

$$\phi^{L_2} \;=\; \eta_2\left\{\mathbf{j}\cos\left[E\left(z' - vt'\right)/\hbar c\right] - \mathbf{i}\sin\left[E\left(z' - vt'\right)/\hbar c\right]\right\} e^{-i\hbar^{-1}(Et - \text{þz})} \;. \qquad (4)$$

The confined helical wave given here is left handed (positive helicity) and is oriented along z-axis. We may obtain the right handed one by changing the sign before the unit vector **i**.

We saw that this confined helical half wave structure of the particle explains the Pauli's exclusion principle in a simple manner. If this structure provides the explanation for its electric charge also, then it becomes reasonable to assume that the conventional approaches which treat electron as a point particle are just approximations. Note that the standard model treats particles as point masses which can at best be an idealization [3]. The proposed confined wave structure of electron appears to be an improvement over such a picture as it introduces definite spatial spread to the particle. We shall now attempt to extend the approach to explain the creation of the electric charge of the electron.

2 The Electromagnetic Field of a Charged Particle

We know that the relativistic transformation equations for the electromagnetic field are given by [4]

$$\boldsymbol{\xi} = \gamma(\boldsymbol{\xi}_o - \boldsymbol{\beta}\times\mathbf{B}_o); \quad \mathbf{B} = \gamma(\mathbf{B}_o + \boldsymbol{\beta}\times\boldsymbol{\xi}_o); \quad \boldsymbol{\xi}^2 - \mathbf{B}^2 = \boldsymbol{\xi}_o{}^2 - \mathbf{B}_o{}^2 \ . \tag{5}$$

Here $\boldsymbol{\xi}_o$ and $\mathbf{B}_o$ stand for the electric and magnetic fields in a given frame of reference while $\boldsymbol{\xi}$ and **B** represent their values when viewed from a second frame of reference which has a uniform velocity **-v** with regard to the first one**.** In the above equations, we have taken $\boldsymbol{\beta} = \mathbf{v}/c$ and $\gamma = (1-\beta^2)^{-1/2}$. Let us now find out the electric and magnetic fields of a charged particle moving with velocity v. For this purpose, we just have to assume that the charged particle is at rest in the first frame of reference which means that it possesses only electrostatic field and no magnetic field. Therefore, equating β to zero in (5) we have

$$\boldsymbol{\xi} = \gamma\boldsymbol{\xi}_o; \quad \mathbf{B} = \gamma\boldsymbol{\beta}\times\boldsymbol{\xi}_o; \quad \boldsymbol{\xi}^2 - \mathbf{B}^2 = \boldsymbol{\xi}_o^2 \ . \tag{6}$$

Now our aim is to show that the electric and the magnetic fields of a confined helical wave [2] have the same form as that of a point charge and also they behave similarly under a relativistic transformation. Such similarities will confirm that the confined helical wave indeed possesses the electric charge. With this purpose in mind let us take a confined helical wave whose electric and magnetic vectors are $\boldsymbol{\xi}_o$ and $\mathbf{B}_o$. If we now observe the system from a frame of reference with regard to which the confined helical wave has translational velocity v, then we know from (5) that the electric and the magnetic fields of a point on it will be linear combination of the forward and the reverse waves which can be expressed as

$$\boldsymbol{\xi}_1 = \gamma(\boldsymbol{\xi}_o - \boldsymbol{\beta}\times\mathbf{B}_o); \quad \boldsymbol{\xi}_2 = \gamma(\boldsymbol{\xi}_o + \boldsymbol{\beta}\times\mathbf{B}_o) \ . \tag{7}$$

$$\mathbf{B}_1 = \gamma(\mathbf{B}_o + \boldsymbol{\beta}\times\boldsymbol{\xi}_o); \quad \mathbf{B}_2 = -\gamma(\mathbf{B}_o - \boldsymbol{\beta}\times\boldsymbol{\xi}_o) \ . \tag{8}$$

Note that the difference between the forward and reverse waves is accounted by the change in the sign of velocity v and β. Here ξ_1 and B_1 denote the electric and magnetic fields of the forward wave while ξ_2 and B_2 the corresponding fields of the reverse wave. Note that the plane of incidence of the spatial wave is taken to be perpendicular to the spatial displacement and the electric field so that their direction remains unchanged on reflection while that of the magnetic field undergoes a reversal **[5]**. Using equations (7) and (8), we obtain the resultant values for the electric and the magnetic fields at a point on the confined wave as

$$i) \quad \boldsymbol{\xi}_S = (\boldsymbol{\xi}_1 + \boldsymbol{\xi}_2) = 2\gamma\boldsymbol{\xi}_o = \gamma\boldsymbol{\xi}_{So}; \quad (ii) \quad \mathbf{B}_S = (\mathbf{B}_1 + \mathbf{B}_2) = 2\gamma\,\boldsymbol{\beta}\times\boldsymbol{\xi}_o = \gamma\,\boldsymbol{\beta}\times\boldsymbol{\xi}_{So};$$

and

$$(iii) \quad \boldsymbol{\xi}_S^2 - \mathbf{B}_S^2 = 4\boldsymbol{\xi}_o^2 = \boldsymbol{\xi}_{So}^2 \ . \tag{9}$$

Here $\boldsymbol{\xi}_S$ and $\mathbf{B}_S$ stand for the electric and the magnetic fields of the confined wave while ξ_{SO} and B_{SO} represent the corresponding fields of the confined wave in its rest frame. Note that in the rest frame of reference, v = 0 and therefore, from (9.ii) we obtain, $\mathbf{B}_{SO} = 0$. However, once the confined wave gains translational velocity, the magnetic field makes its appearance.

A comparison of the transformation equations for the point charge given in (6) with those given in (9) shows that they are identical. This means that the electric and the magnetic fields of the confined wave transform exactly the same way as those of charged point particle. We already know that in a relativistic transformation, the energy and the momentum of the confined helical wave behave exactly the same way as those of a particle **[1]**. This reinforces our conviction that a charged particle like electron has the inner structure of the confined helical wave.

Here a question may be raised regarding the veracity of taking the linear combination of ξ_1 and ξ_2 as they pertain to two different points on the confined helical wave. To explain this we have to review the concept of the confined helical wave. In the approach followed till now we have considered the confinement of a single wavelet. Instead, we should have taken a wave train. This means that we have to consider a series of helical waves emerging from successive points on the circumference of a circle in the transverse plane. In fig.1 the precession of the

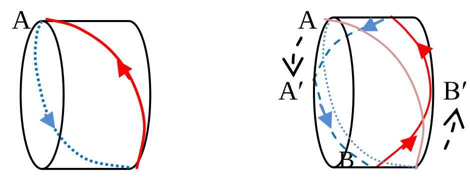


Figure.1-*(a) shows the path of a helical wave on the surface of an imaginary cylinder starting at A and getting reflected at B to arrive back at A. (b) shows the case after a small time interval when the wave undergoes precession with the starting point at A′ and the reflecting point at B′.*

helical wave on the surface of the cylinder is shown. The starting point of the helical wave moves from A to A` after a small time interval with the result we have another closed helical wave starting from point A`. This means that when we confine such a train of helical waves between two mirrors, we obtain a large number of parallel closed helical lines covering the entire surface of the imaginary cylinder.

When the curved surface of such a cylinder is straightened on a flat surface, the helical path taken by the wave would appear as straight line paths on a rectangle as given below. It is

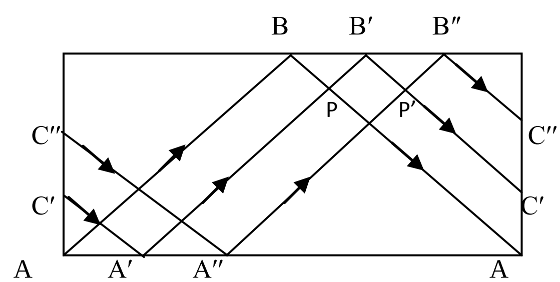


Figure.2- The figure shows the paths of helical waves at successive instants on the surface of the imaginary cylinder when its curved surface is sliced out and spread on a flat surface at points P and P′ the forward wave and the reflected waves crosses their paths.

obvious that the direction and the magnitude of the radius vectors of the forward and the reflected waves meeting at points P and P′ will be exactly equal. This relation holds good in the case of the electric vectors also. This means that for the electric field of the forward wave ξ_{1o} and that of the reverse wave ξ_{2o} would add up and the resultant field ξ_{So} will be given by

$$\xi_{so} = \xi_{10} + \xi_{20} \quad . \tag{10}$$

In the case of the magnetic field, there is a phase change of π on reflection. Therefore at the point P, we have

$$\mathbf{B}_{so} = \mathbf{B}_{10} + \mathbf{B}_{20} = 0 \quad . \tag{11}$$

The magnetic field is zero only in the rest frame of reference. Once the confined helical wave gains translational velocity, the magnetic field makes its appearance and is given by (9.ii).

Here one question that may be raised will be regarding the electric field component $\boldsymbol{\xi}_z$ of the charged particle moving along z-axis. A confined helical wave along z-axis does not possess any component of the electric field in that direction. Therefore, it may seem that the confined helical wave structure may not give a proper explanation for the existence of the electric field in the direction of the translational motion. Actually, the picture will become clear if we keep in mind that a particle is represented by infinite number of confined waves occupying all possible directions at a given point by the process of quantum superposition. These confined helical waves exist in a virtual state producing the electrical field symmetrically in all directions. In other words, the symmetric field experienced around a charged particle can be understood as caused by the virtual interactions undergone by the confined helical waves uniformly in all directions.

3 The Confined helical Wave and the Electric Charge

From (9) we observe that in its rest frame of reference the confined helical wave will possess only the electric field as its magnetic field gets destroyed by the reflected wave. Further, we saw from section 2 that the transformation equations for the electric and the magnetic fields of the confined helical wave are exactly same as that of a point charge. These properties force us to conclude that the confined helical wave not only creates mass, but also the electric charge. A confined helical wave structure may allow us to avoid the pitfalls of treating a particle like electron as a point mass or a point charge.

Let us now examine how the electrostatic field is created when the confined helical wave is formed. We know that the confined helical wave represents just one eigen state and by the process of quantum superposition, the resultant state will be spherically symmetric that can be

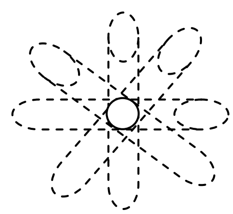


Figure.3-The figure shows a large number of confined helical waves centered at a point aligned in all possible directions by the phenomenon of quantum superposition resulting in a spherical structure that represents the particle.

represented by a sphere with radius $\lambda/2\pi$ (see figure 3). We saw from (9) that if ξ_o is the magnitude of the field of the electromagnetic wave, then, ξ_{so} ($\xi_{so}=2\xi_o$) will be the field on the spherical surface [1] and normal to it. In other words, the sphere behaves like a charged sphere with the electric field directed normal to it. This makes it possible to identify $\boldsymbol{\xi}_{So}$ (in the rest frame of reference) with the electrostatic field. Therefore, based on Coulomb's law we have

$$\xi_{SO} = 2\xi_o = e/4\pi\varepsilon_o R^2 \quad , \tag{12}$$

where R = $\lambda/2\pi$. Here e is the charge of the particle represented by the confined helical wave. The fact that the spherical structure is formed by a very large number of confined helical waves existing at a point in a virtual way due to quantum superposition does not mean that the charge present on the surface of the sphere will be infinite. This is because, in any interaction at an instant, the effect is attributed to one confined wave just as the rest energy of the particle is represented by the energy of a single confined wave. Note that the field around a charged particle is created by the virtual interactions and in that sense the representation of a particle as formed by a large number of virtual confined waves is consistent with the quantum mechanical approach.

Needless to say, Coulomb's law sets a definite value for the electric field of the confined helical wave. In (12), Taking R = $\lambda/2\pi$ = 1/k, we have

$$\xi_o \quad = \quad k^2 e / 8\pi\varepsilon_o \ . \tag{13}$$

According to the classical electrodynamics, ω and k of the electromagnetic wave are related to each other by a simple relation. But there is no such relation connecting its amplitude with k. The relation given in (13) closes that gap.

When a charged particle is represented by a confined helical wave, certain important issues need to be understood clearly. Here we should remember that the confined helical wave is created from a pure plane polarized spatial wave [1] and therefore ξ and ∇.ξ both will be zero for such a wave. But for the confined helical wave discussed above, we have $\nabla.\boldsymbol{\xi} \neq 0$ as it is now seen carry electric charge. We shall now examine how the electric potential gets created on confinement. We know that in the proper frame of reference of the confined wave, the electric field of the forward wave and the reverse wave can be expressed as

$$\xi_{1O} \quad = \quad -\nabla\varphi'_o - \partial A'_o/\partial t \quad ; \quad \xi_{2O} \quad = \quad -\nabla\varphi'_o + \partial A'_o/\partial t \ . \tag{14}$$

Note that the sign before the term $\partial A'_o/\partial t$ gets reversed in the second equation as the velocity gets reversed. Therefore the resultant field which is the linear combination of ξ_{10} and ξ_{20} can be expressed as

$$\boldsymbol{\xi}_{SO} \quad = \quad \boldsymbol{\xi}_{10} + \boldsymbol{\xi}_{20} \quad = \quad -2\nabla\varphi'_o \quad = \quad -\nabla\varphi_o \quad , \tag{15}$$

where $2\varphi'_o = \varphi_o$ .We know that the electric field on the surface of the imaginary cylinder is zero to begin with. This is what we should expect as the plane polarized spatial wave with which we started was having no electric (and magnetic) field. However, out of this zero electric field, we can imagine the creation of two equal fields but opposing each other so that the net field still remains zero. In other words, the electric field $-\boldsymbol{\xi}_{SO}$ created on the helical wave in the forward time is just equal and opposite to the electric field $\boldsymbol{\xi}_0$ created on the helical wave in the reverse time. Therefore, for the antiparticle created along with the particle on confinement, the opposite charge is created and its field will be given by

$$-\xi_{SO} \quad = \quad \nabla\varphi_o \quad . \tag{16}$$

We may now take

$$-\varphi_o \quad = \quad 1/4\pi\varepsilon_o r \quad . \tag{17}$$

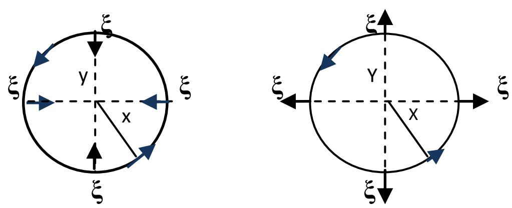
Note that in the case of the electromagnetic waves this inverse relationship with r does not get expressed as the wave is not localized, and for the wave front any point on it will have the same property as any other point on it. Therefore the spatial dependence of φ_o gets hidden in the case of the electromagnetic waves.

When the particle is given a translational velocity, we have from (6) that

$$\boldsymbol{\xi}_S \quad = \quad -\gamma\nabla\varphi_o \quad \text{and} \quad \mathbf{B}_S \quad = \quad \boldsymbol{\beta}\times\boldsymbol{\xi}_S \quad . \tag{18}$$

Here we should keep in mind that the energy of the electromagnetic field is positive whether it belongs to the negative charge or positive charge. This means that this energy of these fields has to come out of the energy of the oscillations in the electromagnetic field (of the electromagnetic wave). The plane polarized spatial wave is created out of two plane polarized electromagnetic waves with their spatial oscillations in phase while the oscillations in the electric and magnetic fields were having a phase difference of π. This involved disappearance of the energy of the electric and magnetic fields. However this energy reappeared when the particle and antiparticle were formed in the form of the electrostatic field energy. Such disappearance of the energy for a short while is allowed under the uncertainty principle. Therefore, formation of the electrostatic fields around the particle and antiparticle do not contravene the conservation principles. Here it is worthwhile to note that **[2]** the rest mass of the electron $E_o = \hbar\omega_o$ where ω_o is the frequency of the confined helical wave. This means that the energy of the spatial oscillations contribute to the rest mass of the particle while the electromagnetic field of the waves gets converted into its electrostatic fields of the particle antiparticle pair.

The confined helical wave in forward time discussed above when projected on to a transverse plane will give us a circle with radius λ/2π and with the electric vector pointing inward (figure. 4a). Note that there is phase difference of π between the spatial oscillations



(a) (b)

Figure.4- (a) represents the projection of the confined helical wave in forward time on to a transverse plane.(b) represents the corresponding picture for the confined helical wave in reverse time. Note the direction of the electric vector in the two cases.

and the oscillations of the electric field **[2]**. Such a direction of the electric vector would give us negative charge for the particle state. In the case of the helical wave defined in the reverse time the electric vector will be pointing outward (figure 4b). Here the phase difference between the spatial oscillations and the oscillations of the electric field is zero.

4 Meaning of the Fine Structure Constant

Now that we have a clear idea of how the confinement of the electromagnetic wave with a half spin creates the electric charge and the field around it, we may now try to find out the energy of the electromagnetic field around the electron represented by the confined helical wave. This is made simple by the fact that a particle like electron can now be attributed a spherical structure with a definite radius. We know that the energy density of the electric field if we consider two states of polarization is given by

$$\widehat{E}_e = \varepsilon_o \xi_{eo}^2 \quad . \tag{19}$$

where $\boldsymbol{\xi_{eo}}$ stands for the electric field at a point at a distance r from the centre of the spherical charge. Due to the spherical structure, the total energy, E_e of the electrostatic field of the electron will be given by

$$E_e = \int_R^\infty \varepsilon_o \xi_{So}^2 4\pi r^2 dr = \int_R^\infty \left(e^2/4\pi\varepsilon_o r^2\right) dr = e^2/4\pi\varepsilon_o R \quad \cdot \tag{20}$$

But $R = \lambda/2\pi = \hbar c/E_o$ where E_o is the energy of the electromagnetic wave with spatial amplitude forming the confined helical wave and can be taken as the rest energy of the electron. Therefore (20) can be written as

$$E_e = E_o e^2/4\pi\varepsilon_o \hbar c = \alpha E_o \quad , \tag{21}$$

where $\alpha = e^2/4\pi\varepsilon_o\hbar c$ is the fine structure constant. If the confined helical wave is given a translational velocity, E_e will have to be replaced by E_e' which represents the energy of the electromagnetic field due to the moving charge and E_o will have to be replaced by E which represents the total energy of the particle. Since E_e' and E behave identically in a relativistic transformation, the ratio E_e' to E will continue to be equal to α. In this approach we obtain actual significance of the fine structure constant. Thus we may state that the fine structure constant represents the ratio of the electromagnetic energy of the electron to its rest energy. This picture is consistent with the generally accepted idea that the fine structure constant is a measure of the strength of the interactions of a charged particle with the electromagnetic field.

5 Quantization of the Electric Charge

We saw from (12) that for the helical wave formed by introducing half spin to the electromagnetic wave, the relationship between its electric field vector and its spatial amplitude is given by

$$\xi_{so} = 2\xi_o = k^2 e/4\pi\varepsilon_o = e/4\pi\varepsilon_o R^2 \ . \tag{22}$$

It can be seen that the inverse square law of the electric charge arises from this relation. If we confine electromagnetic waves with lower energy, its wave length and as a result R will be larger. The electric field ξ_o which is inversely proportional to R^2 also will be smaller. But then the spherical particle formed by these waves by the process of superposition will have larger radius and will still satisfy the inverse square law on its surface. We observe that for the particle, the field on the surface of the sphere, $2\xi_o$ is related to the distance from the centre of the sphere by the inverse square law, and the electric charge weighted with a factor $1/4\pi\varepsilon_o$ comes out as the constant of proportionality. This means that the electric charge created by the confinement of the electromagnetic wave will always be having the same value 'e' and this is independent of the energy of the electromagnetic wave that is involved in the confinement. It is obvious that this quantization of the electric charge is the logical outcome of the relationship between the spatial amplitude and the electric field of the electromagnetic wave given in (22).

6 Explaining the Magnetic Dipole Moment

The fact that electron possesses the magnetic dipole moment is another pointer to the fact that it cannot be taken as a point charge. We shall now try to calculate the magnetic moment of electron. We know that the magnetic dipole moment of a circular conductor with current I is given by

$$\mu = IA \ , \tag{23}$$

where *A* is the area subtended by the conductor. Now if we take the case of the electron, we know that its magnetic moment is given by [8]

$$\mu_e = e\hbar/2m \ , \tag{24}$$

where m is its rest mass. The fact that the electron has the magnetic dipole moment shows that it cannot be taken as a point charge. The electron should resemble more of a revolving point charge.

This means that electron not only has a definite spatial spread but also contains within it moving charge. We shall now examine if this value of the magnetic dipole moment of electron emerges directly from its confined helical wave structure. We saw in the previous section that the confined helical wave representing an electron undergoes precession on the surface of an imaginary sphere with the same period as that of the confined helical wave. Since the charge e of the particle is created on the surface of the imaginary cylinder, it is obvious that it completes one circular motion in one period of the confined helical wave. Taking the radius of the circular path as λ/2π as discussed in the last section and the period of completing one full cycle by the charge as T, where T is the period of the oscillation of the electromagnetic wave, we have from (23)

$$\mu_e \;=\; (e/T)\pi R^2 \;=\; e(c/\lambda)\pi\lambda^2/4\pi^2 \;=\; ehc^2/4\pi E_o \;=\; \hbar e/2m \;. \qquad (25)$$

Thus we obtain a simple explanation for the magnetic dipole moment of the electron. This result in a way confirms that electron has the inner structure of a confined helical wave and this when viewed in the direction of progression appears like a circular coil with radius λ/2π with a current 'eν' in it where $\nu = E_o/h$.

7 Comparison with Hestenes Approach

It is interesting to note that Hestenes had proposed an electronic structure based on the "zitterbewegung" motion undergone by it [6][7]. His approach is based on the assumptions

(i) The electron is a point charge moving at the speed of light in a circular motion with angular momentum $\frac{1}{2}\hbar$ observed as spin.
(ii) The phase of the Dirac wave (plane wave) is a measure of the angular displacement in the circular motion.
(iii) The circular motion generates the observed magnetic moment of the electron
(iv) The circular motion also generates an electric dipole field fluctuating with zitterbewegung frequency of 10^{21} Hertz.

We observe that all these properties (except that of the electric dipole field for which in any case there is no experimental evidence) are explained by the confined helical wave structure of the electron. Hestenes presumes that electron is a point charge which travels along a helical path with its radius proportional to its Compton wave length. We observe that in the confined helical wave approach also we obtain a similar picture. But here the charge of the electron is not taken as a point charge, but as charge spread over the helical path. But the resultant current is similar in both cases. The assumptions (ii) and (iii) given above are also satisfied by the confined helical wave approach. But there is a difference regarding the zitterbewegung (zitter to be short) motion of the electron which is in the transverse direction in Hestenes' approach. In the confined helical wave approach, the zitter motion takes place both in the longitudinal direction as well as in the transverse direction (note that the circular motion within the confined helical wave takes place at the velocity of light). But the main problem arises when Hestenes assumes that the electron undergoes zitter motion at luminal velocities in the transverse direction. But motion at the luminal velocities for a point mass goes against the relativity theory. Note that in the confined helical wave approach the zitter motion at the luminal velocity does not create any problem as it is the luminal wave which is undergoing the zitter motion. We observe that in the confined helical wave picture, the concept of the internal coordinates resolves the issue neatly. We saw that the electromagnetic field gets compacted to the internal coordinates of the electron and it constitutes the inner structure of the electron while the electron as a whole is represented by the plane wave in the external coordinate system. This means that the confined helical wave structure is fully consistent with the plane wave representation and consequently with the quantum electrodynamics.

8 conclusion

We now observe that the treatment of electron as a point mass or a point particle is basically a convenient approximation. We see that a confined helical wave structure explains all attributes of electron. Such a structure implies that electron has a definite spatial spread and can be treated as a sphere having radius λ/2π where λ is its Compton wave length. With the confined helical wave structure we no longer have to face the problems of the infinite self energy of the electron. In fact, we now know the actual meaning of the fine structure constant as it represents the ratio of the electromagnetic energy of the electron to its rest energy.

In section 4 we observe that the fine structure constant is the ratio between the electromagnetic field energy and the rest energy of the electron. Since the fine structure constant represents the strength of the electromagnetic field, it would appear that the energy contained in the rest mass of the electron belongs to some other basic field. The spatial oscillations of the electromagnetic wave seem to suggest the existence of such a field. We shall, in a separate paper examine if this field can be identified with the Higgs field.

We have now shown that the confined helical wave structure gives a convincing explanation of the generation of the mass and the electric charge of a particle like electron. However, this interpretation can be considered complete only if we are able to show that such a wave can be taken as a solution of the Dirac equation. We shall be attempting that in the next paper.

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