Higgs Field and the Creation of Mass - Standing Wave Structure of the Electron-IV

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Abstract

The author develops his idea of the standing electromagnetic half wave structure of the electron and proposes that the confinement of the wave is effected by the interactions with the Higgs field which can be explained on the basis of the uncertainty principle. These interactions allow vacuum to act like a thermal bath with the standing half wave in equilibrium with it. It is shown that this equilibrium is not destroyed even when it is in uniform translational motion. This invariance of the equilibrium to the velocity transformation is another way of looking at the theory of relativity.

1. Introduction

It was earlier shown that the plane wave which represents the electron could be formed by the confinement of the electromagnetic wave between two perfect mirrors kept facing each other [1]**.** The standing helical half wave formed by such confinement is called "staphon" while a single electromagnetic wave constituting it is called "photino". It is observed that a photino on confinement acquires mass. The space dependent component of the standing wave (staphon) when given translational velocity was seen to get converted into the amplitude wave which gets compacted into the internal space while the time dependent component was seen to get converted into the phase wave or plane wave which represents the electron in the external coordinates [1]. The approach is extended to the 3-dimensional situation incorporating the half spin of the electron and it is shown that the Pauli's exclusion principle emerges out of the standing half wave structure [2]. It is also shown that the electric charge of the electron can be attributed to the staphon structure which is seen to be quite compatible with the Dirac equation [3]. It was observed that the staphon representing an electron when given translational velocity can be represented by

$$\phi \quad = \quad \left\{ \xi_{\mathrm{y}} \cos\left[E\left(x' - vt'\right)/\hbar c\right] - \xi_{\mathrm{z}} \sin\left[E\left(x' - vt'\right)/\hbar c\right] \right\} e^{-i\hbar^{-1}(E\,t - \text{þ}\,x)}. \quad (1)$$

Here the cosine and the sine terms which represent the amplitude wave are defined in the internal coordinates while the exponential factor which represents a plane wave is defined in the external coordinates. Note that a single plane wave is called broglino just as a single electromagnetic wave is called photino. Besides, we may assume that a large number of broglinos occupied successively constitute the plane wave (here plane wave stands for a very long wave train). We know that in the relativistic quantum mechanics, the plane wave may be taken as the eigen function of the four-momentum in the coordinate representation. Therefore, when we attribute an inner structure to the plane wave in terms of the staphon, we are actually attributing an inner structure to the eigen state. We shall be expanding this approach in a separate paper where a re-interpretation of the basic postulates of quantum mechanics will be attempted in the light of this approach.

In the approach followed by us, the artificial construct of a pair of mirrors facing each other was introduced to confine the photino and form a standing wave. Now we have to find out which natural phenomenon actually plays the role of the mirrors. Needless to say this role has to be played by waves or particles which are not observable directly. Therefore the obvious choice falls on the vacuum fluctuations. This is because vacuum fluctuations while interacting with particles, are themselves not observable. To begin with we shall examine the nature of vacuum in some detail.

2. Nature of Vacuum

According to quantum field theory, vacuum is analogous to a maze of interconnected balls and springs and the strength of the field at any point can be attributed to the displacement of the ball at that point from its ground state. The vibrations in this field propagate governed by the appropriate wave equation for the particular field in question. The second quantization of the quantum field theory requires that each such ball-spring combination be quantized which is another way of stating that the strength of the field be quantized at each point in space. Canonically, the field at each point in space is a simple harmonic oscillator and its quantization places a quantum harmonic oscillator at each point in space. The excitation of the field corresponds to the elementary particles. The vacuum, in this picture, is not seen as a static background, but it is a field where energy quanta keep bubbling up continuously [4] which is permitted by the uncertainty principle. This is the basic structure of vacuum on which quantum field theory is built.

Another way of looking at vacuum is to treat it as filled with electromagnetic waves of all frequencies and phases moving in all directions. The Maxwell's equations provide us with a new perspective of vacuum. We know that the solutions of the Maxwell's equations in vacuum represent the existence of the electromagnetic waves. This prompts us to treat vacuum as filled with electromagnetic waves of all possible frequencies and phases in all possible directions [5]. Of course, this random distribution of the phases of the electromagnetic waves would result in the destructive interference with the result that the vacuum would appear devoid of any waves. This would mean that vacuum is full of energy which does not get manifested. But there is a catch to this. This phenomenon of the electromagnetic waves getting destroyed completely by interference can take place only over long durations and regions which are not too small. However, when the time interval or the spatial region is small, the fluctuations in the energy and momentum become quite appreciable. Quantum electrodynamics treats vacuum as filled with not only virtual photons but also with all sorts of virtual particles. However, they exist only for a brief period. It is assumed that these particles are created and destroyed continuously which is permissible under the uncertainty principle. These vacuum fluctuations might play the role of the mirrors which confine the photino.

Such a vacuum is the repository of the zero point energy and this assumption appears to be confirmed by the experiments on the lamb shift [6] and Casimir effect [7]. Take the case of the Casimir effect. If two metallic plates having almost perfect reflecting surfaces are brought very close to each other with the distance separating in microns, then the plates should be acted upon by a force from the outer surfaces which forces them to come closer. While the vacuum fluctuations of electromagnetic waves of all wave lengths could exist outside, only those waves which could form standing waves between the two plates could exist between the two plates. This would mean that the outer sides of the plates are hit by more number of waves than the inner sides and this creates a force bringing the two plates closer. This experiment was actually carried out and such a force was found to exist [8]. This shows that vacuum is full of energy which does not find a way to express itself. In other words, vacuum is not an inert medium, but a dynamic one and it interacts with a particle continuously in a virtual fashion.

3 Vacuum and the Higgs Field

We shall now introduce a new field to explain the confinement of the electromagnetic wave. We saw that the electromagnetic wave could be understood in terms of two waves as given below which are coupled to each other [9].

$$\psi' = \xi_z \, e^{-i\hbar^{-1}(Et - þx)} \qquad (2)$$

$$\psi'' = (\hbar / þ) \, e^{-i\hbar^{-1}(Et - þx)} \qquad (2A)$$

In (2) ξ_z denotes the component of the electric field in the z-direction. In the conventional approach, the second wave is not taken into consideration. We saw that [3] an electron could be represented as a standing half wave formed by the confinement of the photino (single electromagnetic wave). Such a standing half wave (staphon) structure explains the creation of mass, electric charge and the spin of the electron. But one important finding brought out by this picture is that the fine structure constant is the ratio of the electrostatic field energy of the electron to its rest energy. Since the fine structure constant represents the strength of the electromagnetic interaction in relation to other types, it does not seem reasonable to attribute electromagnetic basis to the rest energy of the electron.

We saw that the rest energy of the electron has to be attributed to the energy of the photino itself which in turn is related to its frequency by the relation E = hν. But then what is the field in which this energy stored? When we confine the photino to form the staphon, we saw that its electromagnetic field which is in the transverse direction does not get confined at all [1][2]. Therefore the confined energy could only be the energy related to the oscillations of the wave in the physical space. This would mean that the energy of the photino which is accounted by its frequency will have to be attributed to some other field. We shall call it by the name H-field for the present. Therefore, it could be that the equation $E = \hbar\nu$ actually represents the relation between the frequency of the oscillations in the H-field which is represented by (2A) and its energy. In other words, the three dimensional space would have to be treated as filed with H-field.

We have now a very interesting way of interpreting the two components of the electromagnetic wave as given in (2) and (2A). We may assume that Ψ'' is created by the oscillations in the H-field assuming that vacuum possesses a constant H-field. The frequency (energy) of the electromagnetic wave which figures in the exponential terms in (2) and (2A) could be attributed to the oscillations in this field which possesses amplitude in the physical space. We may call the wave represented by (2A) by the name “H-wave”. We can now propose that the rest mass of the electron actually emerges from the confinement of the H-wave component of the electromagnetic wave. We have to assume that the electromagnetic part of the wave only contributes to the electromagnetic field of the electron and does not contribute to its rest mass. This means that the H-field is the one which accounts for the rest mass of the particle and therefore it plays the role of the Higgs field. In short, we may identify the H-field with the Higgs field.

We had taken Ψ′ and Ψ″ defined by (2) and (2A) as two waves which are coupled to each other. It is quite possible that Ψ″ could exist all by itself. This is because Ψ″ appears to be more fundamental than Ψ′ as it could exist in the three dimensional space without having an amplitude in the electromagnetic field. On the other hand Ψ′ needs both the Higgs field (note that the energy appearing in the exponential term of Ψ′ arises from the Higgs field) and the electromagnetic field to exist. One problem with Ψ″ which may be called the Higgs wave is that it is almost impossible to observe its existence as it does not interact with particles unlike the electromagnetic wave. Just as we could assume that vacuum is filled with electromagnetic waves of all frequencies and phases, we may as well assume that vacuum is filled with Higgs waves of all frequencies. The amplitude of these waves may vanish due to the total destructive interference. However fluctuations in the amplitude of the Higgs wave may still occur.

Now we have to understand the process involved by which vacuum confines the electromagnetic wave. We saw that by the process of vacuum fluctuations, the electromagnetic wave could come into existence for a short duration before it disappears. But this virtual wave cannot interact with the real photino and confine it. In fact, we know that one electromagnetic wave could travel through another approaching it head on. The superposition of the waves ensures that these waves affects only the amplitude by the process of interference. This means that the virtual electromagnetic waves produced by the vacuum fluctuations will not be able to cause the confinement of the photino. Let us now take the case of the Higgs waves given in (2A) which behave the same way as the electromagnetic waves. Here also the waves possess the property of superposition. But the Higgs wave may have the ability to interact with the staphon sustaining the confinement. Note that the photino constituting the staphon may not allow the Higgs waves created by the vacuum fluctuations to pass through it.

Here we should keep in mind that the photino will be interacting with the vacuum fluctuations in a virtual manner. Only those states which are allowed according to the conservation rules will be occupied by the principle of superposition. If we now take the case of a photon traversing in vacuum, it will not undergo interactions with the virtual Higgs waves and therefore, will not get slowed down. Note that any slowing down would involve creation of inertia or mass and this can happen only if the corresponding antiparticle is created simultaneously. But we know that conservation laws do not permit such a pair production in vacuum in the absence of any real field.

We saw that vacuum can be treated as a dynamical state due to the bubbling up of the vacuum fluctuations which includes the Higgs waves. The uncertainty principle

$$\Delta E\ \Delta t \quad \geq \quad h \qquad and \qquad \Delta þ\ \Delta x \quad \geq \quad \tfrac{1}{2} h \qquad (3)$$

plays a very important role here. If the period Δt is long, then the fluctuations in the energy of the Higgs field would become almost zero. We know from the quantum field theory that in spite of the fluctuations, vacuum is to be taken as the ground state. Any fluctuation in the energy which does not comply with the uncertainty relation given in (3) will remain a virtual one. In other words, if the vacuum fluctuations in the

Higgs field comply with the inequality $\Delta E\ \Delta t < h$, then such fluctuations would be virtual by nature.

From the earlier discussion [1], it is clear that we may take the broglino (single plane wave) as the projection of the staphon state on to the external coordinate system. We may now attribute the fluctuations in the energy of the staphon as caused by its interactions with the Higgs wave. Note that vacuum would lend or borrow energy and momentum for a short duration so long as the uncertainty principle is not violated. Needless to say the fluctuations in the energy and momentum of the staphon could be quite large. But if we take a group of such staphon states occupied successively, then, the net fluctuation in the energy and momentum of the group will be much lower. This is because the cumulative variations in the energy and momentum of the staphon states will nearly cancel each other out. The cancellation will be complete if the number of staphon states forming the group is infinitely large. Let us assume that the plane wave is formed by a large, but not infinitely large number of broglinos. Therefore, the variations in the energy-momentum of plane wave state will be small, but not negligible.

We know that a staphon in the rest frame of reference is taken as formed by a forward half photino with energy $\frac{1}{2}E_o$ and momentum $\frac{1}{2}p_o$ and a reverse half photino with energy $\frac{1}{2}E_o$ and momentum $-\frac{1}{2}p_o$. As a result, the energy and the momentum of the microstate could be taken as the sum of the corresponding values for the forward and the reverse half photinos. We may now assume that the reverse half photino undergoes a change in its momentum from $-\frac{1}{2}p_o$ to $\frac{1}{2}p_o$ as it gains momentum from the vacuum fluctuation. This variation in momentum which works out to p_o can last only for a small distance Δx and the upper limit of Δx will be given by

$$\Delta þ\ \Delta x \quad = \quad \tfrac{1}{2} h\ . \tag{4}$$

Within this distance, vacuum will take back the momentum lent to the photino. Here we have taken the equality sign as the limiting case of the relation $\Delta þ \Delta x < \frac{1}{2}h$. Since the momentum of the reverse photino changes from $-\frac{1}{2}p_o$ to $\frac{1}{2}p_o$, the net variation in momentum, $\Delta þ = p_o$. Substituting for Δp by p_o in (4) gives us

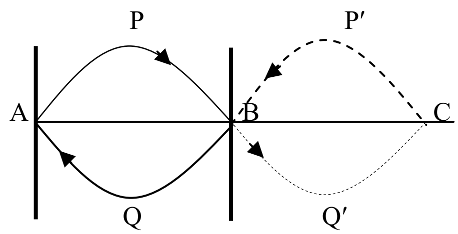
$$p_o\ \Delta x \quad = \quad \tfrac{1}{2} h\ . \tag{4A}$$

But keeping in mind that for a photino $p_o\lambda = h$, we observe that $\Delta x = \frac{1}{2}\lambda$. This means that the fluctuation will last only for a distance $\frac{1}{2}\lambda$ and then it will revert to the old state with momentum p_o. In other words, the reverse half photino which became the forward half photino will again revert to the reverse state. Thus the existence of the staphon could be attributed to the gaining and losing of the momentum caused by the interactions with the vacuum fluctuations which does not violate the uncertainty principle. We shall now try to identify the field to which the fluctuations could be attributed to.

Let us take the case of the real electromagnetic wave travelling from A to B (see figure 1). At B the vacuum fluctuation can be assumed to throw up an Higgs wave travelling in the opposite direction along CP′B. We find that the original wave APB gets reflected back along BQA by the virtual Higgs wave CP′B which in turn gets reflected along BQ′C. By the time the virtual wave reaches back at C, it vanishes as the maximum period for which the fluctuation can be sustained is one period of the oscillation. We obtain this result based on the uncertainty principle. We know that in the limit $\Delta t = h/\Delta E$. Taking $\Delta E = E$, the energy of the virtual wave which is generated in the fluctuation, we obtain

$$\Delta t = \mathrm{h/E} = T \qquad (4B)$$

where T is the period of the virtual wave. Now a similar interaction at A would



The figure shows the original wave travelling along APB which then gets reflected along BQ'A as it encounters the virtual Higgs wave CP'B at B which in turn gets reflected back along BQ'C. The original wave now forms a standing wave and will be sustained by the same process at A also.

Figure. 1

convert the reverse wave into the forward wave. In this manner, the Higgs wave created by the vacuum fluctuations could play the role of the reflecting mirrors.

In the above analysis, for the sake of simplicity the energy of the virtual Higgs wave was assumed to be exactly equal to that of the real photino which gets confined. Actually this need not be true. If the energy of the virtual Higgs wave were much more than that of the real photino, then it is reasonable to assume that it would die off before the photino completes one full oscillation. Therefore, Higgs waves having energy far higher than that of the photino would not live long enough to undergo any interaction. None the less the virtual Higgs waves having slightly more energy than that of the photino may interact with it. If the energy of the virtual Higgs wave is less than that of the photino, then it will result in the forward half photino having more energy than the reverse one and this would result in the translational motion of the staphon.

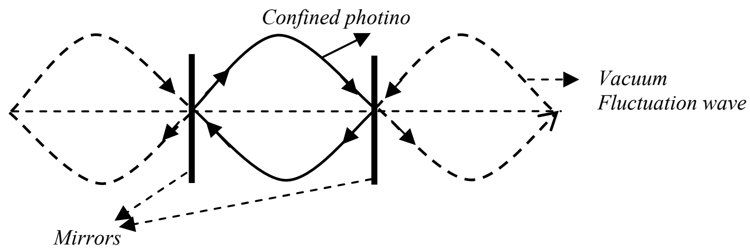
Let us now examine the situation in depth. Let us assume that the energy of the forward half photino is E_1 and it interacts with the Higgs wave having energy E_2 where $E_2 < E_1$. This would mean that the energy of the reverse half photino is E_2 and the staphon would have a translational motion in the forward direction. The energy of the staphon will be given by $E = \frac{1}{2}[E_1+E_2]$. The translational momentum of the staphon will be given by $\frac{1}{2}(E_1-E_2)/c$. This would mean that depending on the energy of the Higgs wave interacting with the staphon, it would under go random translational motion. We should remember that the random motion has to be understood in terms of the quantum superposition. In this manner, we may treat the energy of the particle having contribution from various momentum states. If the energy of the Higgs wave interacting is higher than that of the photino, then the staphon would occupy states having higher rest mass. This means that the observed rest mass of a particle is the average of the rest masses of a large number of such states. Note that if the particle is not localized using some external field, then the plane wave state representing the particle will have large number of broglino states which are closer to E_o, the observed rest energy of the particle. Remember that in any localization by an external field, the entity being confined is the plane wave which is defined in the external coordinate and not the staphon which forms the inner structure. When a particle is localized into a small region, the broglino states having low energy will be replaced by those with higher energy. This would result in a situation where the rest mass keeps on increasing as the localized region becomes smaller and smaller. This approach allows us to view mass as being distributed in concentric shells and would explain the problem of the infinite rest energy encountered in quantum field theory [6]. Before a full explanation of this problem of the infinite self energy is attempted, it would be necessary to introduce a few other concepts. This will be done in a separate paper.

Here we should keep in mind that the particle under study was electron and since electron interacts with only the Higgs field, the confinement could be effected entirely by the Higgs waves. But if we consider particles like quarks, the same virtual Higgs waves created by the vacuum fluctuations would be able to effect the confinement. But then we should remember that a quark may have to be thought of as created by the confinement of a composite wave which has vibrations in not only the 5^{th} dimension [10] (which accounts for the electromagnetic field), but also in other dimensions which could account for their properties like color and charm [11]. Note that for particles like quarks also the proposed mechanism for confinement using the virtual Higgs waves would be equally effective.

In the standard model, the creation of mass of a particles is attributed to its interaction with the Higgs boson which is the field particle of the Higgs field having a certain rest mass and zero spin. On the other hand in the present approach the Higgs mechanism that creates mass arises from the virtual Higgs waves created by the vacuum fluctuations. Needless to say, when the virtual Higgs wave gets reflected back forming a transient standing wave during the interaction, it would gain rest mass as a result. Note that the concept of the confined photino approach could be applied in the case of the Higgs wave also and this would mean that the standing wave formed by the Higgs wave has to be attributed half spin [2][3]. Let us call this transient standing Higgs wave by the name "virtual Higgs particle". It is quite clear that to confine the photino on the left side (see figure 1), we need another virtual Higgs particle there also and the spin of this particle will have to be just the reverse of the one on the right side. In other words, if the spin of the virtual Higgs particle on the right side is $\frac{1}{2}\hbar$, that on the left side will be $-\frac{1}{2}\hbar$. If we now want to attribute the interaction involved in the confinement of the photino to a single field particle, then it will have to be attributed zero spin and the mass will be twice that of the virtual Higgs particle described above. Thus the properties of the virtual Higgs particle appears to be similar to the Higgs boson in respect of spin. But in the present approach, the mass of the virtual Higgs particle does not appear to have a definite value.

4. Vacuum Fluctuations and the Theory of Relativity

We know that in the rest frame of reference, an electron can be represented by virtual staphons oriented in all directions centred at a point. As already discussed, the confinement can be attributed to the interactions with the virtual vacuum waves or Higgs waves. For a particle at rest, these interactions may be taken as isotropic and for the same reason, the staphon could occupy all possible directions. But as discussed earlier [2], when we introduce translational velocity, then only the staphons in the direction of motion needs to be considered as their amplitude in all other directions could be taken to be zero. Although the interactions with the virtual Higgs waves causes the confinement of the photino, we shall continue with the artificial construct of two perfect mirrors facing each other as the set up that causes

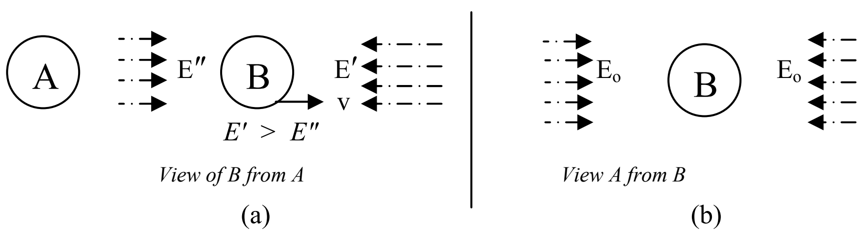


The two perfect mirrors reflects the photino back and forth forming a standing half wave. The force acting on the mirrors from the inner side is balanced by the virtual Higgs waves which impinge on the mirrors on the outer side and get reflected back.

Figure.2

the confinement. Note that the force acting upon the mirrors from inside on reflection of the photino will be balanced by the force acted upon by the virtual Higgs waves from the outside (figure.2). In other words, the reflecting mirrors act like a vessel containing a one dimensional gas in a heat bath and this could be taken as the case where the confined photino constituting the staphon is in equilibrium with the Higgs waves created by the vacuum fluctuations.

Let us now take a stationary particle A. Let B be another particle having uniform velocity, v with regard to A (figure.3). According to an observer on A, the energy of the virtual Higgs wave interacting with B from the forward direction will

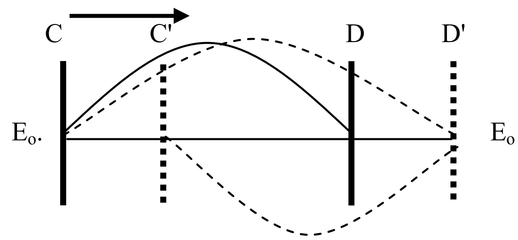


(a) An observer on particle A will assume that the particle B will be hit with more force in the forward direction than on the reverse direction due to the Doppler shift in the energy of the vacuum fluctuations.(b) But paradoxically, an observer on B, since it is at rest, will presume that the interaction with the vacuum fluctuations will be symmetric

Figure. 3

be more than that from the reverse direction forcing it to come to a standstill after some time. On the other hand, for an observer on B, its interactions with virtual Higgs wave would appear isotropic because for him B is at rest. This is a paradox. A would assume that the Higgs waves for B is anisotropic due to the difference in the Doppler shift in the frequency of these waves interacting with it in the front compared to those on the reverse.

Let us now take the case of the observer on B. We know that for the observer on B the energy, E_o and the magnitude of momentum, p_o of the forward and the reverse half photinos constituting B will be the same. However, for the observer on A, B would be having uniform velocity v (say, along the x-axis). Therefore, as far as A is concerned, the energy of the forward half photino of B will get Doppler shifted to a higher value while that of the reverse wave would get Doppler shifted to a lower one. Let us now study the effect of uniform velocity on the staphon. We should keep in mind that by the time the forward half photino moves from C to D (see figure.4), D



For an observer on A, by the time the forward half photino moves from C to D, D would have moved to D' thereby stretching the photino On the other hand, the reverse half photino would get compressed by the movement of C to C'.

Fiigure.4

would have traveled to D′ a distance $\frac{1}{2}vT_1$, where T_1 is the period of the forward half photino. This means that, for observer A, the forward half photino would get effectively stretched and the effective wave length of the forward wave would be given by

$$\tfrac{1}{2}\lambda_1' \quad = \quad \tfrac{1}{2}\lambda_1 + \tfrac{1}{2}vT_1 \quad = \quad \tfrac{1}{2}\lambda_1(1+v/c) \quad = \tfrac{1}{2}\lambda_o\sqrt{1-v^2/c^2} \tag{5}$$

where $\lambda_1 = \lambda_o\sqrt{(1-v/c)/(1+v/c)}$. Here λ_o is the wave length of the confined wave in the rest frame while λ_1 stands for the Doppler shifted wave length where the source is moving in the direction of the wave propagation. Note that (5) expresses the relativistic contraction of the distance between the two mirrors. Likewise, the effective wave length of the reverse wave would be given by

$$\tfrac{1}{2}\lambda_2' \quad = \quad \tfrac{1}{2}(\lambda_2 - vT_2) \quad = \quad \tfrac{1}{2}\lambda_2(1-v/c) \quad = \quad \tfrac{1}{2}\lambda_o\sqrt{(1-v^2/c^2} \tag{5A}$$

Here λ_2 stands for the Doppler shifted wave length where the source is moving in a direction opposite to that of the wave propagation. These results are quite logical as the length of the standing wave has to adjust itself to be equal to the separation between the mirrors which undergoes relativistic contraction.

In the case of uniform motion, the momentum of the forward half photino hitting the mirror D from the inner side will be equal to

$$p_1' \quad = \quad h/\lambda_1' \quad = \quad \gamma\, h/\lambda_o \quad = \quad \gamma\, p_o\ . \tag{6}$$

In the case of the reverse half photino the corresponding momentum will be given by

$$p_2' \quad = \quad h/\lambda_2' \quad = \quad \gamma\, h/\lambda_o \quad = \quad \gamma\, p_o\ . \tag{6A}$$

Note that the momentum of the virtual Higgs wave interacting with B from the forward direction will also undergo Doppler shift similar to what happened to the reverse wave as given in (6A) and as a result, the momentum of the wave interacting with B head on at D′ will be given by $p'_2 = \gamma p_o$. This means that the momentum hitting the wall D′ from the inside and that hitting it from the outside balance out. It can be easily seen that a similar balancing of momentum takes place on the reverse mirror C' also. This explains why the virtual Higgs waves do not act as a drag on the particle and why it moves forward with a uniform velocity.

Here one may ask why vacuum should not remain inert for accelerated motion also. Why is the uniform motion different from the accelerated motion? As already discussed, as an electron moves with uniform velocity, the forward wave and the reverse wave constituting it are in perfect equilibrium with the vacuum fluctuations. In other words, the vacuum neither lends nor borrows energy from the electron and therefore acts like an inert medium. But when we increase the velocity of the electron from v to v', then it moves from one state of equilibrium with the vacuum to another state of equilibrium which has got higher energy. The observer will find that the energy of the virtual Higgs waves interacting with the forward wave increases from one instant to another while that on the reverse direction decreases proportionately.

Let us assume that initially the electron is having velocity v and momentum þ. Let its rest energy be represented by E_o. Let the momentum of the forward and the reverse waves be p_1 and p_2 so that the momentum of the particle is given by

$$\text{þ} = \tfrac{1}{2}(p_1 - p_2) = \tfrac{1}{2}\gamma E_o\left[(1+\mathbf{v}/c) - (1-\mathbf{v}/c)\right] = \gamma E_o \mathbf{v}/c^2 \qquad (7)$$

where $\gamma = 1/\sqrt{(1-v^2/c^2)}$ and m is the rest mass of the particle. Let $\mathbf{v}' = (\mathbf{v} + \Delta\mathbf{v})$ be the velocity of the particle and **þ'** be its momentum after a very short duration Δt due to the action of a force on the particle. Then we have

$$\Delta\,\text{þ} = m\gamma'\mathbf{v}' - m\gamma\,\mathbf{v} = m\gamma^3\Delta\mathbf{v}$$

Taking the rate of change of momentum in the limit Δt → 0, we have

$$d\text{þ}/\mathrm{dt} = m\gamma^3\, d\mathbf{v}/dt = \mathbf{F} \qquad (7A)$$

Here m is the mass of the electron and F the spatial component of the relativistic force. To make matters simple, we have assumed that the variation in the momentum is in the direction of **þ** itself. We know that the relativistic acceleration could be defined as [9]

$$a = d(\gamma\,\mathbf{v})/dt = \gamma^3\, d\mathbf{v}/dt \qquad (7B)$$

so that (7A) could be expressed in the familiar classical form **F** = m**a**.

5. Vacuum Fluctuations as a Thermal bath

The above discussion shows that a particle in uniform motion is a thermodynamic state with a fixed internal energy which is in equilibrium with vacuum. When the particle is accelerated, the system is shifted from a thermodynamic state with a certain internal energy to another one with a higher internal energy. It is as if the system has undergone adiabatic compression which results in higher temperature and higher internal energy. This may sound stating the obvious. However, thermodynamic representation of a particle provides us with a new insight into the nature of inertial mass and the role played by the vacuum fluctuations in the form of virtual Higgs waves in it.

We saw that a particle in uniform motion is always in thermal equilibrium with the vacuum fluctuations. Therefore, in the thermodynamic sense the principle of relativity represents the fact that the equilibrium with vacuum is independent of the velocity of the particle. When a particle absorbs kinetic energy in an interaction, this equilibrium is disturbed and it has to gain velocity to reach a new equilibrium with the vacuum fluctuations of different energy and momentum. Note that there is a very important difference between the thermal bath formed by the vacuum fluctuations and the conventional thermal bath used in the laboratory. In the conventional thermal bath, the magnitudes of the energy and the momentum of the molecules of the thermal bath have well defined average values. But in the case of the thermal bath formed by the vacuum fluctuations, the energy of the interactions with a particle depends on the rest energy of the particle itself. A particle with higher rest mass will be interacting with vacuum fluctuations of higher energy. This is the reason why we have particles with different rest energies existing side by side in vacuum in equilibrium. In a conventional thermal bath it is not possible to have two systems with different intrinsic internal energy to be in equilibrium with it.

6. Conclusion

In the approach followed in this paper, the confinement of the photino which results in the formation of the staphon is effected by the Higgs field. We know that this confinement directly leads to the creation of mass and the electric charge [1][2]. This approach is in tune with the standard model which postulates the existence of the Higgs field to crystallize mass of a particle. Here also we are proposing the existence of a Higgs particle. But it does not have a specific value for rest mass. The rest mass of the virtual Higgs particle could vary depending upon the mass of the elementary particle under consideration.

The concept of the vacuum fluctuations that acts like a thermal bath needs to be studied in depth. It should be noted here that the interactions with the vacuum thermal bath should be understood in terms of the quantum superposition principle which allows a particle to occupy a large number of states at the same time. Needless to say the present approach which is based on the wave mechanical approach to quantum mechanics will have to be expressed in the formalism of quantum field theory for greater clarity and for comparing the results. This will be attempted in due course in separate papers.

Since a staphon is in equilibrium with the quantum thermal bath it will be occupying a range of states having a specific value for energy and momentum. These group of states could be treated as a gas which may be called the “primary gas”. Therefore, it should be possible to treat a particle as a thermodynamic system possessing properties like temperature, internal energy, entropy etc. and these thermodynamic properties could be related to the corresponding mechanical properties of the particle. In the next paper it will be shown how a particle could be treated as a gas and how its mechanics could be derived from the thermodynamic of the gas.

References:

1. V.A.Induchoodan Menon , vixra:0909.0035(2009), (quant- ph)
2. V.A.Induchoodan Menon, vixra: 0911.0017(2009), (quant-ph)
3. V.A.Induchoodan Menon , Vixra:1001.0008(2009), (quant-ph)

4. Franz Gross, Relativistic Quantum Mechanics and Field Theory, Wiley Science Paperback Series (1999), p.336-38.

5. Richard Feynman, The Feynman Lectures on Physics (The Definitive Edition), Vol.2, Dorling Kindersley (India) Pvt. Ltd.,(2009). p.20.8-20.9.

6. Franz Gross, Relativistic Quantum Mechanics and Field Theory, Wiley Science Paperback Series (1999), p.73-76.

7. K.A.Melton, Physical Manifestation of Zero Point Energy, published by Wold Scientific Publishing Co. Ltd.)New Jersey, London, Bangalore(2001), p. 3-8.

8. S.K. Lamoreaux, Demonstration of the Casimir Force in the 0.6 to 6 μm range, Phys. Rev. Lett., 78, p.5-8 (1997).

9. V.A.Induchoodan Menon, vixra:0912.0038(2009), (cond- matt)

10. M.J.Duff, arxiv:9410046 (hep-th)

11. John H. Schwarz, arxiv:9812037 (hep-th)