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The photon to electron/positron-pair transition

A. Meulenberg,[*a,b] R. F. Penland[b] and W. R. Hudgins[a]

[a] Science for Humanity Trust, Inc., New Market, Maryland, 21774, USA

[b] Science for Humanity Trust, Bangalore, India, 560003

ABSTRACT

This paper addresses the interference of photons with themselves and the conditions under which a specific resonance creates the entangled electron/positron pair. Analysis of the forces and potentials in the interaction between photons has raised the issue of oscillating charge as the source of the alternating electric and magnetic fields comprising the photon. Since the photon is net neutral, yet is composed of electric fields, the object of this paper is to explore the physical mechanism(s) describing how the alternating fields of photons can be 'rectified' to produce mass and the separated opposite charges of the electron and positron pair.

Keywords: Photon, electron, positron, potentials, creation, charge, mass, wormhole

1. INTRODUCTION

Our prior work has discussed the solitonic nature and interference of photons and light.[1,2,3,4,5,6,7] Since the leptons (electrons and positrons) are long-lived and have a unique charge and rest mass, they, like the source photon(s), must also be solitons. The conditions for resonance must be very tight.

Physics spent more than 50 years deciding that the lepton mass is entirely electromagnetic. Nevertheless, the concept of the electron being a bound photon has never been acceptable. The electron/positron pair creation and annihilation processes are considered to be a 'black-box' interaction or quantum-mechanical 'magic'. Since photons are here[vi??] considered to b r dimensions, we must also look to the 4th dimension M fields are modes of this oscillation. It is in the context of the standing waves of photons that the EM fields and potentials lead to a description of alternating (AC) 'currents' in time of unquantized alternating 'charge' (a distortion of space) that can be rectified into two coupled (at least initially) resonant bodies with charge and, now, with restmass.

This paper will not go into details of how the photonic-electron is configured beyond the two statements that the result must have: 1) a linearly-polarized photon bent into a circular configuration (ultimately spherical in the present model) with a 180° twist every ½ wavelength; and 2) a circularly-polarized photon bent into the circular form and untwisted at a rate comparable to the change in its polarization of 360° per wavelength. Thus, both photon types will be twisted at the same rate and only have one **E**-field direction pointing outward from the resultant structure during its whole extent. The equivalent story of electron/positron annihilation into a pair, or triplet, of photons (simpler in many ways) is to be published in another paper.

The main points addressed in the paper will be: 1) how the photon is bent and rectified; 2) how the photon is confined to a spherical configuration; and 3) how the resulting electron-positron pair is both separated and connected.

2. BENDING A PHOTON

It has been long known that a light path is bent as it passes by the sun. Whether this is a relativistic (gravitational) effect or a result of the plasma gradient[8] about the sun can be argued. The point is that photons can bend under the influence of matter and potentials. The electric and magnetic fields (**E** & **B** are potential gradients) of a charge are much greater than that of gravity. A photon can get much closer (e.g., $r_g/r_c > 10^{20}$) to the center of the potential ($V = e/r$) as it passes by a charged particle. The bending forces ($F_c = ee'/r_c^2$) will be many orders-of-magnitude greater (e.g., $F_c/F_g = r_g^2/r_c^2 > 10^{40}$) than that experienced by light passing near a star. Furthermore, the size (radius = r_γ) of a photon is again much larger than that of a nucleus (for 1 MeV, $r_\gamma = \lambda/2\pi$ = ~1.2um 1eV/1 MeV /2π = ~ $2x10^{-13}$m vs

* Mules333@gmail.com

r_n = ~10^{-15}m). As a consequence, many of the field lines of the photon switch termination from the photon to the nucleus[3] as the EM fields of the passing photon enter the near singularity of the nuclear Coulomb potential.

We do not believe that either effect is well explored in the literature. It is classical physics in a quantum-physics age. QM has not encouraged updating of the older models. Both effects apply to all photons transiting matter. Photons are considered to consist of millions of cycles (wavelengths). Visible light photons, because of their size (fractional micron in diameter and perhaps meters in length), may interact with billions of atoms (a large percentage simultaneously) when transiting matter. Almost all of the interaction is with the atomic electrons, not the nuclei. It would appear that only photons of sufficient energy are small enough (sub-picometer) to interact strongly with only a nuclear Coulomb field to constructively tear itself apart and to find a preferred resonance through which to reform. The portion of the photon field lines that terminate on the nucleus rather than the other charge sites of the photon will weaken the photon structure. The opposite field lines constitute the positive charge component of the photon, which is repelled by the nucleus. In the process of attraction and repulsion by the nuclear potential gradient, the 'fractured' photon parts curl in opposite directions and, if conditions are correct, form the electron and positron pair instead of reforming the photon (Fig. 1).

3. FORMATION OF A STABLE LEPTON

We have postulated the nuclear-induced fracture of a single neutral photon into a pair of charged entities. This is equivalent to the process of rectification that a pair of diodes can perform on an AC signal. A sinusoidal signal with no net charge is split into a pair of truncated sinusoids each with net charge. The rest of an electronic circuit determines whether the truncated sinusoids become charged sinusoids or a smoothed DC voltage. In the case of the fractured photon parts, only stable electrons and positrons are observed. Neither is obviously AC. However, both have deBroglie and Compton wavelengths and Zitterbewegung.[9] Therefore, they have AC components as well as the DC offsets in both charge and mass. What are the conditions of stability?

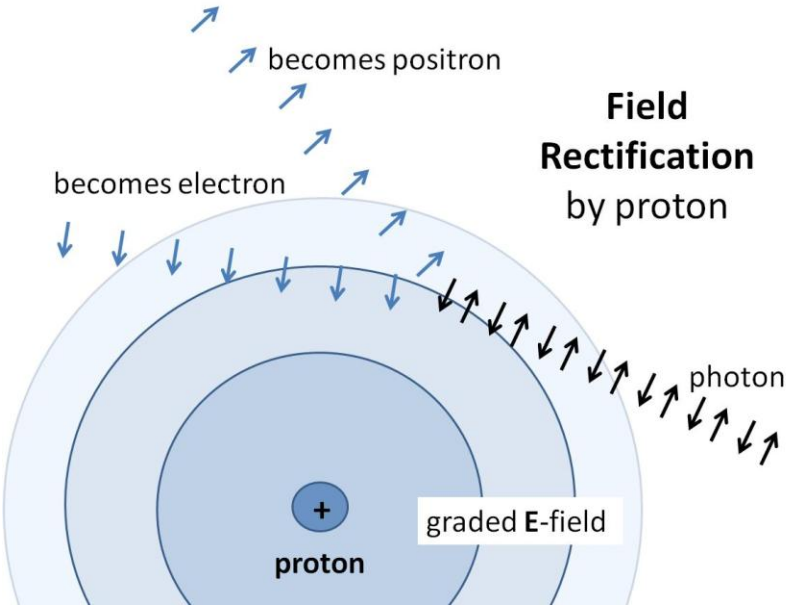

Fig. 1. 'Rectification' of a photon by a nuclear Coulomb field gradient. Dimensions are on the picometer scale to indicate the size (energy) of the photons needed to display this type activity.

Field lines vs charge and potentials

As a starting point, it is necessary to recognize a priority between fields and potentials. Using the electrical case as the example, we recognize that field lines, as the gradient of a potential, are derivative. A potential difference comes first and then the field, as represented by its lines, grow out of that. Electric-field lines themselves 'contain' or

represent a concentrated energy of some form; but, they cannot directly produce an electrical potential. Nevertheless, something else can. To make this statement, we must understand what causes potentials or make some assumptions on which to base and create a model. Maxwell's equations equate field lines with charge but cannot state primacy. An assumption could be that charge is the fundamental and, our present models are for charge to generally have unit values. Yet we also assume that charge can be created. Therefore, something else must be more basic. What is this basic?

We will assume that a distortion of space-time (of a form to be determined) is the source of what we call charge. In this form, charge is a variable collection of potentials and fields that have resonances that we call charges (electrons, positrons, etc.). This ambiguity in nomenclature in using the word 'charge' to mean both a variable and fixed quantity has caused problems. Maxwell's equations do not contain anything about photons or fixed charges. Nevertheless, they do not prevent those concepts, which are supported by experimental observation to the point that the concepts of non-photonic electro-magnetic radiation and variable charge have been 'lost'. Instead of assuming the pre-existence of photons and unit charges, we chose to look for a deeper, non-resonant, source of these observables.

Random distortions of space-time can cause many non-uniform distributions. All have energies that are above the state of complete uniformity (a state of maximum entropy). Most are able to find conditions that are more likely (stable) than others. All non-uniformities create potentials and field lines. The long-lasting conditions (states) become the 'observables' in our universe and are given names. It is easy to consider that the observables are the only existing states and conditions and this is the basis for much of science today. It leads to some problems. We favor the concept that resonances exist and can interact to produce the observable universe. However, the pre-existent universe still exists in part and continues to interact, at least partially, with its resonant components in a probabilistic/stochastic manner. The stable (and metastable) states may be created and destroyed under various conditions; some from interactions with other resonant states, some with the random background, and others with both. Since there are specific conditions for resonance, there are generally 'rules' whereby we can better understand the nature of the observables and their processes. The conservation laws are good rules to use and the conservation of energy, momentum, and charge all need to be applied in the understanding of conversion from photon to lepton pairs. These same rules probably apply to the creation of photons from the random Maxwell radiation fields as they do to photon creation from the observable (resonant) atomic-electron fields.

4. LEPTON FORMATION

One model of the photon[2] describes them in terms of regions of flat electrets (stationary electric dipoles) and thin magnets, both with alternating polarization along its length. This produces polarized field lines connecting and binding together opposite-charge regions. In one version, the amplitude of the field lines (transverse at the central axis) varies sinusoidally. In another, the polarization vector rotates about the velocity vector. To form an electron from either version photon, it is necessary to continuously 'twist' them by 180^{o} in ½ wavelength and 'curl' the result. This produces a circular structure with field lines of a single type pointing out from the center and begins to look like an electron. If the circular structure can be rotated, then a spherical structure with field lines pointing out again looks much like our picture of an electron. Is such a thing possible? If so, can it be real? If real how can it happen?

Electret-photon model

We propose a photonic-electron model here based on the electret-magnet photon model (Fig. 2).[2] If the density of field lines (**E** and **B**) from a photon are found to decay from the central line as 1/r, then the energy density decays as $1/r^2$. If the photon is bent into a circle, then the exterior field lines and their energy density decay much more rapidly and the interior field lines would now converge to the central charge causing the bending. This termination of the field lines at the central charge, rather than at the photon itself, would asymmetrically weaken the internal bonds of the photon and cause part of it to bend away from the attractive charge. Thus, there are two motions involved in the photon path. The attractive force of the field gradient shifts the path of a specific part of the photon toward the charge and the internal bending of the photon selectively orients the rest of the photon away from the charge.

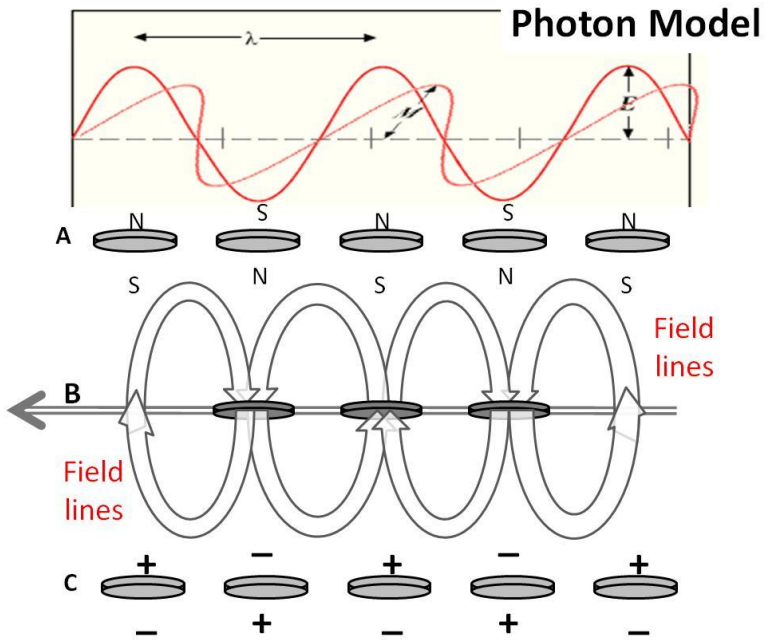

Fig. 2 Electret-magnet model of the photon. Electric and magnetic dipoles are arrayed along the central axis of a photon providing the normal fields (**E** and **M** above) predicted by Maxwell's equations. Off axis, the fields close on adjacent dipoles and provide the cohesiveness and rigidity of a photon.

This polarization action cannot happen without the photon being close to a large central potential. But, if the photon is close enough to the central charge, the large field-energy increase relative to the photon internal energies could be disruptive. The momentum of the photon would normally carry it away from the central charge and it would reform and continue on its way as the final part of a scattering process. However, other scenario could be envisioned: 1) the polarized photon could become bound to the nucleus and behave as a portion of the transient virtual electron-positron pairs considered to exist about any charge (https://en.wikipedia.org/wiki/Vacuum_polarization); 2) the photons break up at the encounter and become part of the non-photonic zero-point energy of the universe (https://en.wikipedia.org/wiki/Vacuum_energy); and 3) if the conditions are right, the photon can break up in a unique manner (as described herein) and form the real electron-positron pair that has been observed. This latter process is that of separation of oriented dipoles composing the photon and constitutes a rectification of the AC photon. How this process actually separates the neutral photons into unit charges depends on how charge and photons are defined.

Electron condensation from a 'charged' photon

If the long sequence of photonic cycles pass by the charge, then a large number of 'circles' with a common central axis would be added sequentially to form a helix. However, they would redistribute themselves to reduce the total energy by contracting and forming a sphere as they move away from the bending charge (the nucleus).

In the very beginning of the photon bending, the field lines of the electron are joined to the nuclear Coulomb field lines, thus causing an attraction between the photon and nucleus. The nuclear electric field weakens the dipole-dipole bonds of the electrets of the photon and they begin to separate. Alternating electrets move in opposite directions along the nuclear field lines. As the momentum of the fractured photon carries it beyond the nucleus, those lines of the attracted portion of the photon (that are attached to the nuclear lines) stretch and 'thin' until they are no longer closely attached to the nucleus. The 'detached' field lines do not easily reattach to the now bent photon that has had its alternating electrets (polarized charge) removed. The photon, divided into two equal portions, is still net neutral. However, all of the electret dipoles in each of the new, now spherical, portions are oriented in the same direction (outward) and the self binding between electrets of a photon no longer exists. What holds the new structures together with the dipole-dipole attraction of adjacent electrets reversed? The answer must be deeper. It probably resides in the nature of the electret dipoles, of their spherical orientation, of 4-space, and of spin.

We would propose that the unit spin of the photon is now shared between the new pair (each spin ½, both aligned). The spin of the inner poles, at a critical geometry, must form a stable structure that connects the pair. We would propose that, just as the spin (angular momentum) of a Falaco soliton[10] connects two hydraulic vortices, both on the surface and under water, the paired parts of the fractured photon are connected by a vortex. In the Falaco soliton (Fig. 3), the underwater connection is in a 3rd dimension between two structures also connected in a 2-dimensional surface. In the lepton pair, the connection in a 4th dimension is between two 3-dimensional surface structures. In this case, the pair is connected in 3-space (as indicated by the electric fields) and again in time.

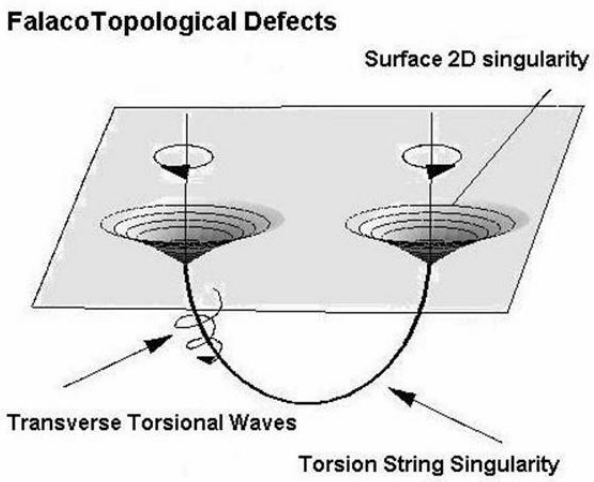

Fig. 3 Falaco soliton (a joined vortex pair) in the surface of water.

Photon division in 4-D

As in the Falaco soliton, the vortices are not created instantly. When a paddle moves through the water, the vortices are not created in their stable form abruptly, but continuously over a short period of time. In the case of pair production, the surface effects of electric field **E** and potential V are matched by the subsurface effect of mass M. We could leave the description here, but the analogy can be carried further. The pair of hydraulic vortices together form a soliton. If the underwater link is broken by a plastic sheet, the vortices and surface pattern disappear. Nevertheless, the angular momentum involved takes time to dissipate and if the sheet is removed, the vortices will reform. It is proposed that, similarly, the lepton pair is a soliton. However, if the link is 'broken', either by the connection being spread between other charges or another mechanism, the lossless medium of sub-atomic space allows the individual leptons to remain as solitons. The vortex into time represents mass, the distortions of space are kinetic and potential energies, and the 3-D surface distortion is the charge. Thus, all of these terms: mass, potential, kinetic energy, and charge, are aspects of the same quantity, a distortion of 4-space. While they are not the same, each can lead or contribute to another.

Light to lepton: Linear to helical to spherical

In the continuation of the photon-to-lepton conversion process, we look at the front field lines of the photon that are stretched and replaced by field lines from later in the incident photon. The stretching of the field lines puts a torque on the curled portions of the fractured photon that is moving beyond the nucleus and forces it to precess so that, as it curls and more wavelengths are added, it does not remain in a plane but becomes a helix. Then, over time and space, it becomes a spherical shell, rather than a circular bundle of waves.

The transition of the helical EM wave into the spherical shell of waves (the ball of yarn model) relieves some of the field line congestion away from the center and allows more wavelengths to be added without increasing the diameter of the ball. A problem with the model is that, as the curls move away from the nucleus and the new structure becomes a closed, spherical, shell, the central field lines are no longer able to curl around to join the outgoing lines. The outer lines connect to the outer lines of the other lepton and join the nuclear Coulomb field lines. The inner lines still exist because the connection through time (https://en.wikipedia.org/wiki/Wormhole) between the leptons is a potential that allows the spatially-confined field lines to carry angular momentum and to close without ever penetrating the 3-space surface (a closed sphere).

We have described the fields, potentials and charges involved in the conversion of a photon into a lepton pair. Of particular importance is the need for an electric potential inside of the electron to be consistent with the photonic-electron model. This potential is provided as a means of satisfying the Poincare stresses[11] or non-electromagnetic forces required to explain the stability of the collection of negative charge called an electron. It eliminates the disruptive forces imposed by like charges confined into a small region and replaces them with an attractive force defined by a potential (that, while being a sink and source of electrical field lines, may not be truly electrical).

5. OPTICAL CONFINEMENT

If we assume that the bent and curled charged photon fractions are somehow reconfigured into charged photons,[12] then they each can be confined to a separate self-generated optical potential well. How does this develop? The concept of a charged photon is alien to the physicists' minds that are trained o consider the photon to be net neutral. However, as described in the electret-photon model, the dipoles within the photon are rectified (selectively separated) and reoriented by a nuclear Coulomb potential so that all the charge of each type (+ or -) is aligned on only one side. Nevertheless, the resulting leptons are both still EM radiation. However, they are now, both 'charged' photon structures (as defined by Maxwell's equations and by our electret-photon model). The charged photons cannot be stable except under special circumstances. What could provide such stability?

There is a special form of photo confinement that may be applicable. An optical microsphere, Fig. 4A, (https://en.wikipedia.org/wiki/Optical_microsphere), providing total internal reflection (https://en.wikipedia.org/wiki/Total_internal_reflection), Fig. 4B, in a whispering-gallery mode (https://en.wikipedia.org/wiki/Whispering-gallery_wave#Whispering-gallery_waves_for_light) can trap light in a nearly lossless (high-Q) mode. Much theoretical work has been carried out to indicate that an electron is a photon captured into a circle or volume with radius of either $1/2\pi$ of the Compton wavelength of an electron or ½ of that. This would imply that the photon would encounter a surface either once or ½ of every wavelength. Assuming this, how does it happen?

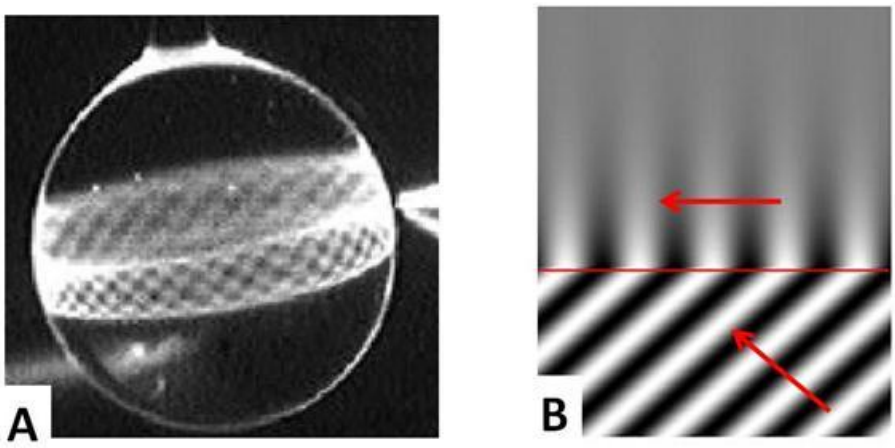

Fig. 4 Confinement of light by A) the curved surface of an optical microsphere and by B) total internal reflection from inside a flat surface indicating the external evanescent wave normal to the interface

We have postulated that the electron is a charged photon that is held together by a potential provided by a distortion into time. Such distortion will alter the speed of light in its vicinity and with a central potential it will give a variable refractive index with high-n in the center and tapering to n=1 at the low distortion regions away from the center. Just as light bends on close proximity to a star and an optical waveguide, both of which have gradients of n, rather than the abrupt changes of a microsphere index, light of a specific wavelength will have a unique value for a particular gradient index of refraction. Thus, even though different energy photons will have different radii and different index gradients for single wavelength circumferences, there will be a unique combination that provides stability for the electron. This unique value is termed resonance in classical physics or a quantum level in quantum mechanics. Either way it provides for a specific energy, charge, and radius for the electron. The fact that it is photonic means that it is also relativistically invariant, and will transform accordingly.

Information from the optical microsphere that could pertain to the resonance and confinement of the charged photon comes from some effects of total internal reflection. When a light beam is internally reflected from a surface, it appears to be reflected from a point beyond the surface. Thus, when the reflected wave is measured, its reflection point and phase relation with the incident wave is shifted. In the case of linearly polarized light this is called the Goos-Hänschen effect (https://en.wikipedia.org/wiki/Goos%E2%80%93H%C3%A4nchen_effect). Since the electron proposed here has no discrete surface and the interaction with the surface is limited to a single encounter, no present models exist for such a case. It could explain the 180^{o} phase shift require to keep the field lines pointing outward all of the time. There is an Imbert-Fedorov shift (https://en.wikipedia.org/wiki/Imbert%E2%80%93Fedorov_effect) for circularly polarized light that is equivalent except that the shift is lateral (outside of the incident light plane) rather than in the incident and reflected light plane. Since this effect involves a lateral shift, the internal reflection from a spherical surface, which is smaller than the shift, can be much more difficult to calculate. Furthermore, even in the simple case, there are questions about the agreement between theory and experiment. This must be an area of future work.

6. CONNECTION IN TIME

We have proposed that the lepton pair created from a photon are connected (at least for a while) by a wormhole (Fig. 5). Wormholes, while still hypothetical would satisfy the requirements for entanglement, since energy can traverse them in zero time. Furthermore, like a string joining two points on a sheet of paper, a wormhole can connect two points in 3-space independent of the distance between them. In a

companion paper,[6] we have described charge and potentials in the context of EM radiation as conditions alternating in time. In this paper, we have electrons as objects with fixed mass and charge, but composed of a photon that still has oscillations in time. It is the wormhole (composed of, and joining, two vortices) that provides the unchanging potential and resonance condition (a gradient refractive index) that give it unique and unchanging properties. The evanescent waves of the rectified and bound photon convey the charge interaction of the electron and positron. (The AC fields of the evanescent waves are 'DC' shifted as a result of the rectification process and this shift is maintained by the 'vortex' resonance in spacetime.)

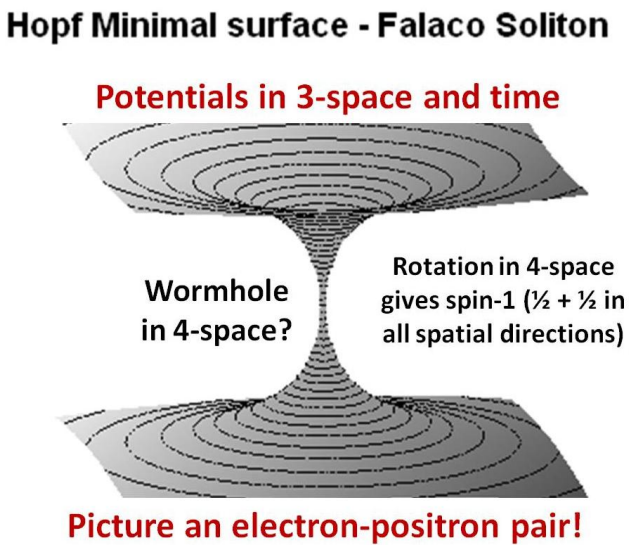

Fig.5 Representation of an electron/positron pair as a vortex in a 3-D surface, folded so that the connection (a wormhole) can be seen as a continuation of the same structure for both leptons.

7. SUMMARY

We have described the fields, potentials, charges, and a wormhole involved in the conversion of a photon into a lepton pair (electron and positron). We have postulated that the electron is a charged photon constrained to a spherical orbit, e.g., one that has all high-field regions polarized in the same direction (outward) rather than alternating directions as in a free photon. As a photon, albeit a charged one, it is relativistically invariant. It is held

together by a potential provided by a distortion into time, the wormhole. The electron energy (mass), radius, and refractive-index gradient are uniquely determined to provide for single-wavelength circumferences for stability of the electron. Higher-order resonances can be muons.

We have proposed that the lepton pair created from a photon are connected (at least for a while) by a wormhole. This linked distortion in space causes the unique fixed mass and charge of the leptons and perhaps even the entanglement phenomena.

8. ACKNOWLEDGEMENT

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