

White Paper VI

What does the Dirac Negative Energy Sea Mean
and
Why Has Todays Orthodox Physics Neglected it?

By:

William A. Tiller Ph.D.

The William A. Tiller Foundation

What does the Dirac Negative Energy Sea Mean and Why Has Today's Orthodox Physics Neglected it?

By: William A. Tiller Ph.D.

Introduction

In White Paper V⁽¹⁾ we learned from a combination of QM & RT that the de Broglie particle/pilot wave concept required that (1) the group velocity, v_g , of the wave group surrounding the positive mass particle of velocity, v_p , gives $v_g = v_p$ and (2) the waves that actually create the wave group and perpetuate this pilot wave as the particle moves along at v_p , in turn, have a velocity $w = c^2/v_p$. Thus, this fundamental driving wave is always superluminal at

$$w = c \left[1 + \left(m_0 c / p \right)^2 \right]^{1/2} = c^2 / v_p. \quad (1)$$

Here, m_0 = particle rest mass, p = particle momentum and c = the velocity of EM light. Further, since this fundamental driving wave is providing essential guiding information to the moving particle/pilot wave system, it is reducing the entropy of this system and, on the surface, appears to violate RT. This author has proposed⁽²⁾ the existence of another entity in nature, beyond spacetime and therefore the reach of relativity theory (RT), that can act as a coupling agent between the positive mass particle, its pilot wave and the fundamental driving waves. This new entity, labeled “Deltrons” is the real pilot of the particle/pilot wave vehicle.

From the foregoing, three uniquely different kinds of “stuff” have been implicated or required, to make the de Broglie concept, one of the two key foundation stones of today's QM, viable. But where do they all come from? Let us start first with “where do all the elementary physical particles physicists have discovered to date come from?”

Dirac⁽³⁾ was the first to propose an answer for the electron and this, in turn, led to his prediction for the existence in nature of the electron's antiparticle, the positron. At the time, it was well known that the total relativistic energy, E , of a particle is given via

$$E^2 = c^2 p^2 + \left(m_0 c^2 \right)^2, \quad (2)$$

Which seems to allow both positive and negative energy solutions for E . A model consistent with Equation 2, which was used by Dirac, is illustrated in Figure 1. Here, we see a plenum of negative energy states separated from a plenum of positive energy states by a band gap of disallowed states with the zero energy origin located in the middle of this band gap. Dirac's key assumption was that the physical vacuum consisted of a plenum of negative energy states; i.e., the physical vacuum is not empty but consists of unknown “stuff”.

Before going forward with our continued discussion of Dirac's model, there are three “sidebar”

discussions that it is useful to lay on the table first. These are:

1. Terletski⁽⁴⁾ showed that, within the framework of relativistic kinematics and dynamics, the theory of relativity admits solutions for three types of essentially different systems: (a) systems of positive proper mass, $m^2 > 0$, $E > 0$, (b) systems with negative proper mass, $m^2 > 0$, $E < 0$ and (c) systems with imaginary proper mass $m^2 < 0$, . Systems of the second and third kind appear to be forbidden by our present understanding of macroscopic causality.

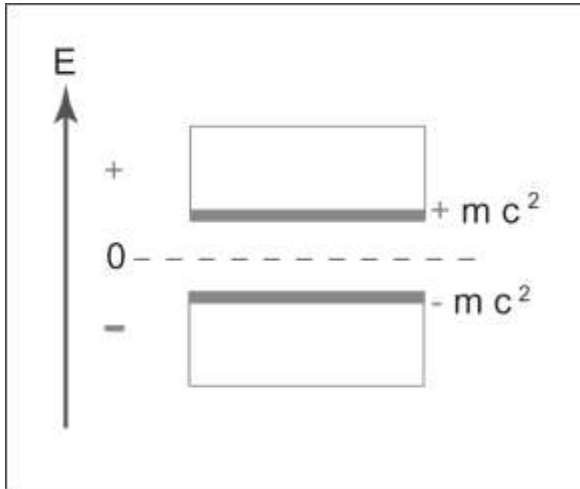


Figure 1. Schematic energy spectrum associated with the Dirac Equation.

2. A number of famous theoretical physicists, Wheeler, Bohm, etc. have calculated that, for RT and QM to be internally self-consistent, the physical vacuum must contain $\sim 10^{94}$ grams per cubic centimeter of mass energy ($E=mc^2$ type), which is an extraordinarily large number. To put this number in perspective, let us consider a simple comparison. For the approximation that the universe is flat in a curvature sense (and astronomers say that this is an ok approximation) then, if we compare the latent, physical vacuum energy contained within the volume of a single hydrogen atom to the total mass energy contained in all the planets, stars, asteroids, cosmic dust, etc., within the volume of our detectable universe (a sphere of radius ~ 15 billion light years), we find that the former is more than a million times the latter. From this, one can conclude that the details of the vacuum level of physical reality must become a very important aspect of any new paradigm and
3. Figure 1 looks remarkably like the upper valence energy band, the conduction energy band and the band of disallowed energy states for intrinsic semiconductors like perfect Germanium or Silicon single crystals. However, from thermodynamics, we know that this is not the most stable thermodynamic state for these two materials. The most stable state is a crystal containing an equilibrium concentration of point defects because these provide configurational entropy to the system and are kinetically achievable. Although there is always a formation energy, ΔG_F , cost to create a j-species defect, at low concentrations of a j-species, the configurational entropy change, ΔS_{cj} , can significantly outweigh the formation energy effect so that the net thermodynamic free energy change for the crystal by the addition of such defects is negative. The question is always “Is there a viable kinetic mechanism available for the formation of such defects in a reasonable time”?

For completely pure, intrinsic semiconductors like Si and Ge, the simplest possible point

defects are two-fold, (1) electronic defects of the – and + type and (2) point defects of the interstitial, I, and vacancy, V, type. The electronic defect can form only by breaking a covalent bond in the valence band, having the electron be energetically lifted across the forbidden band gap into an available state in the conduction band and have the valence band dangling bond move to an adjacent site by receiving that site's bonding electron. This allows the “electron hole” to wander off in the valence band.

If the band gap is small enough and the crystal temperature is high enough, thermal activation of the covalent bonds to higher energy levels via “hot” lattice phonons is generally sufficient to accomplish this event. If the band gap is too large or the temperature is too low, thermal activation is insufficient and direct EM photon collision and absorption is needed for this electronic event to occur.

The second most important point defect generation event is the displacement of an atom from a lattice site to either an interstitial site or a surface site. This generally creates an interstitial – vacancy pair of sites and the two wander off in different directions, one via an interstitial site pathway and the other via a lattice site pathway. The presence of impurity atoms, temperature and formation energy affect the kinetics of such point defect formation.

The actual thermodynamics is very straightforward in this example. The change in Gibbs free energy, G , for the system as a function of concentration, c_j , of the j -species is qualitatively illustrated in Figure 2a for several values of formation energy, ΔG_F ,

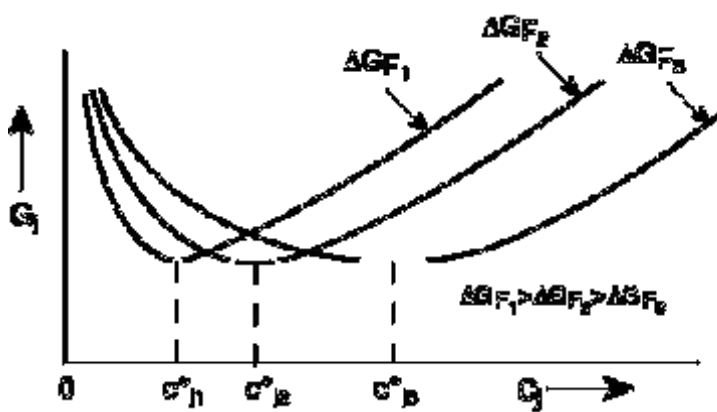


Figure 2a.

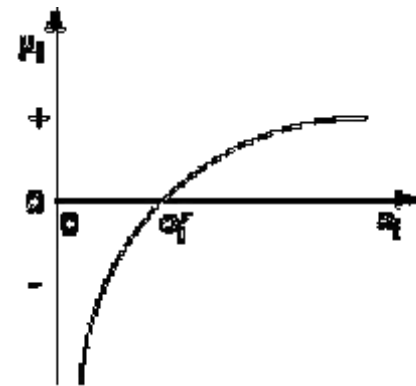


Figure 2b.

Where c_j^* is the equilibrium concentration given by

$$c_j^* = c_0 \exp\left(-\Delta G_{F_j} / k_B T\right). \quad (3)$$

Here, μ_j is the chemical potential of the species ($\mu_j = 0$ at $c_j = c_j^*$), k_B = Boltzmann's constant, T = temperature and c_0 is the number of possible sites per cc at which the event could possibly occur. Since $c_0 \sim 10^{22}$ - 10^{23} /cc and $\Delta G_{F_j} \sim 10^{-1}$ - 10 eV, at room temperature $k_B T \sim 25$ meV so $c_j^* \sim 10^{21}$ to 10^{14} per cc. Now let us use all of this as a metaphor to try and understand Dirac's concept, more fully.

Returning to the Dirac Concept

Now, let us return to Figure 1 and our discussion of the Dirac Model. He proposed that, by

stimulating the negative energy plenum via an EM photon with sufficient energy, a particle (electron, say) may be photo-ejected across the band gap into one of the positive energy states and become physically real; i.e., detectable via our present-day instrumentation. The holes, left behind in the negative energy plenum are considered to be the antimatter particles (positron, say). Thus, Dirac proposed that we live in a sea of virtual (unobservable via our present-day instrumentation) “stuff” (particles or waves), the Dirac sea. Since all physical observations represent finite fluctuations in energy and charge with respect to the vacuum state, this leads to an acceptable model. For example, if one negative energy particle (electron) is extracted from the Dirac sea, we have a “hole” in that plenum relative to the normal vacuum and

$$\text{Energy of the "Hole"} = -(\Delta E_{\text{neg}}) = \text{positive magnitude.} \quad (4a)$$

$$\text{Charge of the "Hole"} = -(\Delta Q_{\text{neg}}) = \text{positive magnitude.} \quad (4b)$$

Thus, the absence of a negative energy bit of “stuff” leads to both a positive energy particle in the observable world (electron or some other particle) and the presence of a positive energy bit of “stuff” in the non-observable world (positron or some other antimatter particle). To date, antimatter particles have been discovered for all the particles known to today's physics.

With respect to the initial Dirac equation for the electron, it gave the correct spectrum for the hydrogen atom at the time. However, there were some difficulties when it was applied to more complex problems. About two decades later (the 1940's), more exact measurements of the hydrogen spectrum were made by Lamb (the Lamb Shift) showing that an indisputable discrepancy of 0.1% existed relative to the spectrum calculated by the Dirac equation. Somewhat later, a similar sized anomaly was detected in the magnetic moment for the electron. These anomalies arose because Dirac neglected the electron/photon interaction, which everyone did at that time because it came out to be infinite in all the existing theories.

Physically, the Lamb Shift is a consequence of the fact that the self-energy of an electron in the Coulomb field of the hydrogen atom is different from its self-energy in free space and depends on its specific quantum state. The difference in these state-dependent self-energies is just the Lamb Shift.

Via quantum electrodynamics (QED), self-energy is said to be a consequence of the ceaseless emission and absorption of “virtual” photons in the vacuum as well as the ceaseless creation and annihilation of electron/positron pairs in the vacuum (with vacuum polarization consequences). The self-energy mass adds to the mechanical mass of the electron to produce the observed (renormalized) electron mass. Likewise, the observed (renormalized) electron charge includes the vacuum polarization effects. Although this important correction to the Dirac equation set in motion a flurry of intellectual activity that ultimately led to a satisfactory QED and several Nobel prizes, Dirac's central concept concerning the appearance of a positive energy electron ejected from a negative energy plenum of the physical vacuum still maintains its integrity and utility today, even though it is no longer fashionable to use it in today's theoretical physics community!

This aspect of fashion in physics is a very subjective thing and often fluctuates with time when we don't see the “whole picture”. The qualitative Dirac picture corresponds physically to the process of e^+e^- pair creation so we now have a many-particle theory which is essentially equivalent to quantum electrodynamics. In quantum field theory, the apparent asymmetry of the filled negative-energy sea is not present (since this sea is not observable via today's instrumentation).

Some Ways of Interpreting a Negative Energy

From our earlier three sidebars, we learned that (1) the vacuum is full of “something” that

manifests an energetic nature of a magnitude that dwarfs our familiar electric atom/molecule substance which exhibits positive mass and positive energy and travels at velocities less than electromagnetic (EM) light, c , and (2) if this “something” has negative energy, as suggested by Figure 1, it still satisfies the mathematical constraints of relativity theory (RT). Further, from White Paper V⁽¹⁾ and Equation (1), we see that a fundamental wave exists in nature that creates and drives the de Broglie pilot wave that, in turn, guides positive mass/positive energy electric particles. This fundamental wave in the vacuum must travel at velocities, $w > c$. This is undoubtedly why our present-day EM instruments and human cognition systems for most individuals cannot detect their presence.

The first thing to note about Figure 1 is that the origin of energy ($E = 0$) was placed by Dirac in the middle of the band of disallowed energy states in order to be consistent with classical mechanics which didn't take the vacuum into account in its deliberations. Thus, the position of this origin in Figure 1 and Equation 1 is arbitrary and could be shifted to a much lower level by common agreement among some future physics community. The present situation is all about internal self-consistency relative to a historically set frame of reference.

A second possibility to consider is that all the unknown “stuff” of the vacuum has a fundamental wave-like character and that the amplitude of the wave, for some presently unknown mathematical reason, has a phase angle of π multiplying it. This would introduce a minus sign multiplying a positive amplitude.

A third possibility to consider is that all of nature is functioning within a master non-spatial, non-temporal potential well of some unknown kind. We are certainly familiar with the space-time analogue that occurs between two or more atoms or molecules as a function of separation distances. The thermodynamic equilibrium condition in such a case yields a binding energy relative to the infinite separation condition which we take as $\Delta E = 0$. The thermodynamic equilibrium condition is a negative energy state relative to this large distance separation condition.

A fourth possibility is the one that is presently fashionable with today's physics community⁽⁵⁾. We start with Schrödinger's wave equation for a positive energy, non-relativistic wave function and, moving to the Klein-Gordon (KG) equation, relativity is added to the picture. However, now negative energy solutions appear and negative probability currents appear. This led to the abandonment of the KG equation⁽⁵⁾. Dirac's wave equation solution⁽³⁾ generated a positive-definite probability density and anti-commutation relationships (non-Abelian algebra) but still retained both positive and negative energy solutions. Although Dirac's mathematical solution was quite beautiful and was a brilliant solution for spin $-1/2$ particles, it could not be applied to spin -0 particles because Bosons are not subject to the exclusion principle⁽⁵⁾. Instead, physicists chose to use Feynman's prescription for handling the negative energy solutions. His approach has the advantage that one is able to obtain the correct Feynman rules for Fermions and for Bosons by means of a single interpretation. The simplest statement of Feynman's prescription is “negative-energy particle solutions propagating backward in time are equivalent to positive-energy anti particle solutions propagating forward in time”. Aitchison and Hey⁽⁵⁾ provide a convenient description to demonstrate the Feynman prescription.

From a Materials Science perspective, the vacuum is assumed to have all of its states filled so it is analogous to a perfect Si or Ge crystal wherein the Gibbs free energy of the system would be lowered by the introduction of any kind of point defects. A thermodynamic driving force thus exists to create any kind of configurational entropy. However, since energy of these non-observable vacuum states is of the negative kind, should we also assume that the substance mass is of the negative kind and that the normal entropy also takes on a negative sign? And what about configurational entropy due to e^+e^- pair formation and, in fact, all the many, many types of particle/antiparticle pair formation that have been discovered in the last almost 80 years? In this case $\Delta G_{Fj} \sim 10^6 - 10^{10}$ times larger in magnitude than found for the silicon crystal metaphor. Of course, since E is negative, T_v will also be negative and

$k = k_v$ in Equation 3 ($k_v \neq k_B$) should be positive because $k_v T_v$ is a measure of the average energy in the statistical ensemble of the vacuum plenum at any particular temperature. Collectively, this requires that ΔG_F also be of negative magnitude so that c_j^*/c_0 is much less than unity. It wouldn't do to have more equilibrium charged defects per unit volume than sites per unit volume where they can be created! Finally, on this topic of thermodynamics, although in the positive energy domain of Figure 1, nature seeks a minimum free energy, in the negative energy of the vacuum plenum, nature appears to seek a maximum free energy (less negative).

Although a number of individuals have proposed that the vacuum substance consists of e^+e^- pairs, this is very unlikely because (1) each has positive mass and positive energy, (2) each is thermodynamically stabilized via configurational entropy and (3) Equation 1 shows that fundamental waves of the vacuum travel at w greater than c and are therefore non-observable. However, both e^+ and e^- are observable with present day instrumentation. Whatever might stabilize $e^+ - e^-$ pair formation without annihilation should also be observable but to this author's knowledge, no such stable matter/antimatter pair has been detected.

What is to be Gained by Expanding the Dirac Concept?

This author has proposed that we consider expanding Figure 1 to include the higher dimensional domains of emotion and mind as illustrated in Figure 3^(6,7). Such an expansion allows one to provide a possible explanation for the following five phenomena:

1. Why the matter/antimatter ratio in physical reality is different than unity,
2. The origin of dark matter in nature,
3. The origin of dark energy in nature
4. Why the outer envelope of our physical universe is accelerating rather than decelerating and
5. Why levitation of objects and humans might be possible.

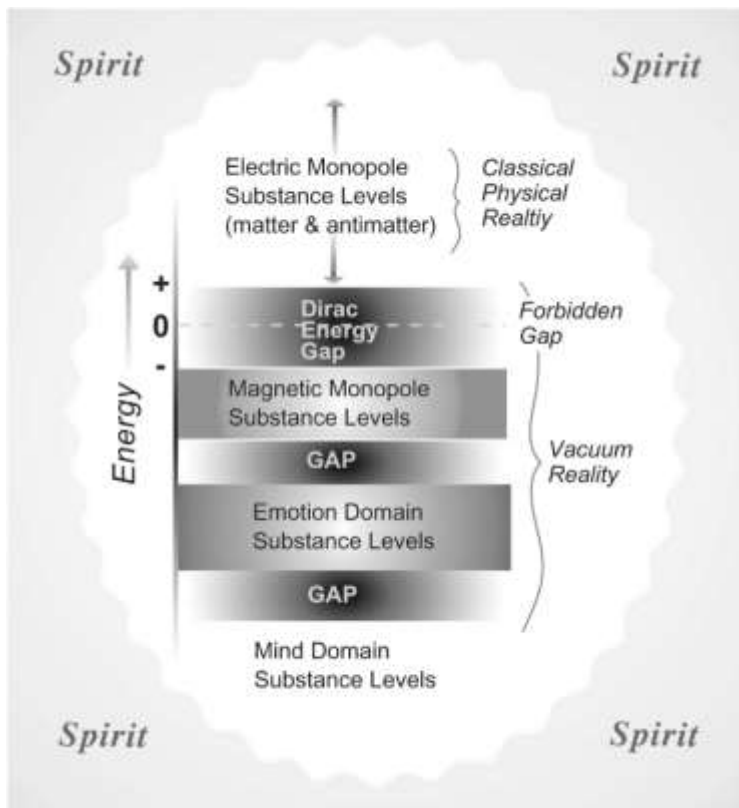


Figure 3.

An energy level diagram embracing both classical physical substances and "unseen" vacuum substances.

Explanations

1. Physicists have experimentally observed that the matter/antimatter ratio for various fundamental particles in nature is greater than unity. However, the Dirac concept for their original creation based on Figure 1 is 1:1. Utilizing just the Figure 1 picture, it is difficult to provide an explanation for such a result. Taking into account the intrinsic silicon model of Figure 2, there is a remote possibility that limited “hole” reconstruction could produce an additional set of unique configurational states in addition to unreconstructed “hole” states in the vacuum plenum. However, a more realistic possibility comes from consideration of Figure 3^(6,7) wherein activation of some moiety from the lower emotion domain band (and less likely from the mind domain band) to jump upwards and fill some of these antimatter sites (hole sites) originally created via the Dirac – proposed process. This would definitely annihilate some but not all of these antimatter sites and produce a matter/antimatter ratio of greater than unity. Such a proposed process would, in principle, allow deltrons to react with information wave substance converting it perhaps to a magnetic charge-like character that can still interact across the $v = c$ light barrier with electric substance.
2. Both relativity theory and experiment have taught us that spatial energy density variations locally alter the curvature of space and that this gives rise to gravitational forces. With their telescopes, astronomers have for centuries visually observed the effects of standard gravitational forces on the movements of celestial bodies. However, in the past half-century, astronomers have also begun to observe celestial body movements associated with “unseen” attractors. They have observed gravitational-type force effects that cannot be correlated with the presence of an observed celestial body so, to quantitatively account for their observations, they have postulated the presence, first of dark matter and later also of dark energy, with both of these having produced spatial curvature effects without any correlated electromagnetic instrument detection. Ultimately, these experimental observations indicated that the majority of the mass and radiant energy present in our universe was of the dark matter and dark energy type and not of our EM mass and EM energy type. Today's orthodox physics community seems somewhat confused as to the origins of such effects; however, Figure 1 alone should “shout out” an obvious candidate.

Traditional gravitational forces involve positive mass – positive mass interactions of the $m_1 m_2 / r$ -type plus EM radiation acting as the communication vehicle between positive masses. This is due to the $E > 0$ region ($E^2 > 0$) of substance in Figure 1. This region of substance with $v_p < c$, is instrumentally observable via today's EM technology.

Non-traditional gravitational forces involve negative mass – negative mass interactions of the negative mass x negative mass type plus a different type of radiation acting as the communication vehicle between this negative mass substance that this author has labeled “magnetoelectric (ME) energy (moving magnetic charges inducing electric fields in the physical vacuum)”. This is due to the $E < 0$ region ($E^2 > 0$) of substance in Figure 1. This region of substance, with $w > c$, is not instrumentally observable with today's EM technology.

3. If one now adds some level of activated deltrons to the cosmic mix of positive mass substance and negative mass substance, the $w > c$ substance can interact with the $v_p < c$ substance

to produce repulsive gravitational forces rather than just attractive gravitational forces. If one also accepts the small amount of experimental data suggesting that $w > c$ substance and energy of the physical vacuum speed up rather than slow down on entering dense matter, whereas the opposite is true for the EM counterpart, then dark matter and dark energy in the cosmos should tend to partition to those regions of space that are densest in EM substance. Thus, such accumulation regions of dark matter and dark energy should not be at the outermost regions of the cosmos but, rather, somewhere well within the outermost envelope. Also, the dark matter mass and energy to normal matter mass and energy ratio is significantly greater than unity so that the gravitational force at the outermost envelope of observable planets and stars will be repulsive rather than attractive. This should lead to acceleration rather than deceleration of the observable planets and stars at the outer envelope of the cosmos. Of course, the population distribution of activated deltrons in the cosmos will change the calculated numerics of the above concepts.

4. In the human body, just as in inanimate bodies, Figure 1 and Figure 3 should hold and experimentally human intention has been shown to interact with this $w > c$ vacuum information wave substance. Thus, one should expect that sufficiently inner-self managed humans should, in principle, be capable of intentionally drawing into their body, from the outside environment, a sufficient amount of the $w > c$ substance so that the net gravitational force interaction between their body and the Earth shifts from a strongly attractive force to a neutral force and ultimately to a repulsive force. Then the human will be observed to be levitating relative to the Earth. One might also speculate that, when these new concepts are ultimately accepted by orthodox physics and understood in a quantitative way, technology will be developed to make the levitation of inanimate objects a practical industry.

Some Closing Comments

- At the outset of this white paper, Equation 1 tells us that a wave of velocity w , which travels faster than c in the physical vacuum and thus is a non-observable moiety via today's EM instrumentation, creates and guides the de Broglie particle/pilot wave construct functioning in electric, physical reality traveling slower than c which is thus an observable moiety by this same type of instrumentation. For convenience we shall call this fundamental vacuum wave a magnetic, information wave for reasons to be unfolded later⁽⁸⁾.
- Because of the $v_p < c$ interaction, via the pilot wave group at $v_g = v_p$, with this magnetic information wave traveling at $w > c$. serious conflict would develop with RT without the postulated "deltrons" from deeper in the vacuum (the emotion domain – see Figure 3) to serve as a coupler between the observable $v < c$ moieties and the non-observable $w > c$ moiety (see Equation 1)^(7,6).
- In Dirac's original model for the creation of an electron, he proposed that an EM cosmic ray, with sufficient energy, created an e^+e^- pair defect which separately became experimental observables via today's EM instrumentation because they both traveled at $v < c$. However, in the beginning of our spacetime cosmos, there was no electric physical matter and thus no EM cosmic rays to create the first bits of positive mass, positive energy stuff. This conclusion impacts our currently accepted model for the "Big Bang" which, as we know, requires an early stage "inflationary" period (velocities of "stuff" at

$v > c$). Thus, something from the vacuum stuff of Figure 3 (all non-observable and therefore all $v > c$) was needed to trigger the e^+e^- pair formation event and the beginning of positive mass, positive energy moieties in nature.

- By the time e^+e^- pair formation could be discriminated, it is already electric, physical stuff at $v < c$ to satisfy RT. Before that, it was $v > c$ stuff and thus “formless”. This implies that some $v > c$ moiety in the vacuum plenum reacted with it in such a manner as to split off a fragment and somehow endow it with electric charge much as orthodox physics proposes the presently searched-for Higgs particle is supposed to endow electric physical stuff with positive mass. In fact, one could imagine a Higg’s particle set of variants that endow some vacuum-type fragment stuff with (a) electric charge and positive mass at $v < c$ and other vacuum-type fragment stuff with (b) magnetic charge and negative mass at $v > c$. This means that, unless one is able to lift the EM gauge symmetry state from its normal U(1) level to the SU(2) level, one will never be able to detect such a moiety with any traditional EM instrumentation.
- From the foregoing it should be clear that the Dirac sea needs great attention from all of us as our present working models are all erroneously built on the $v \leq c$ concepts. There will be no quick fix but we will, as a society, evolve significantly during such a process!

References

1. W. A. Tiller, “Why Has Orthodox Physics Neglected the Superluminal Velocities of the Fundamental Wave Components that Create and Sustain the De Broglie Pilot Wave?”, www.tiller.org
2. W. A. Tiller, Science and Human Transformation: Subtle Energies, Intentionality and Consciousness (Pavior Publishing, Walnut Creek, CA, 1997) pp 30, 63-69, etc.
3. P.A.M. Dirac, “Proc. R. Soc. 1931, A133, 60.
4. Y.P. Terletski, Paradoxes in the Theory of Relativity (Plenum Press, New York, 1968)
5. I.J.R. Aitchison and A.J.G. Hey, Gauge Theories in Particle Physics (Adam Hilger Ltd., Bristol, 1982) Ch. 1
6. W. A. Tiller, Psychoenergetic Science: A Second Copernican – Scale Revolution (Pavior Publication, Walnut Creek, CA, 2007, p155.
7. W. A. Tiller, W. E. Dibble Jr., and M. J. Kohane, Conscious Acts of Creation: The Emergence of a New Physics (Pavior Publishing, Walnut Creek, CA, 2001).
8. W. A. Tiller, White paper VIII.