Dirac's Equation and the Sea of Negative Energy Link and Notes

Notes on
***Dirac's Equation and the Sea of Negative Energy* by D.L. Hotson**
http://openseti.org/Docs/HotsonPart1.pdf

Updated 8/02/12

Concise Summary
The Dirac Equation is the foundation for Quantum Electro Dynamics, yet it was partially expunged, because it called for the existence of not only positive energy positron-electron pairs, but also undetectable negative energy positron-electron pairs, forming what is called the Dirac Sea. This sea of undetectable negative energy corresponds to the "virtual particles" of the Zero Point field, as well as Lorentz' electromagnetic aether. According to the author, it is also a Bose-Einstein Condensate.

The Dirac Equation, postulating only these four types of electrons, resolves all of the problems with the Standard Theory of particle physics, and provides simple, logical, and natural models of the electromagnetic field, the "photon," the "strong nuclear" force, the Ψ wave, inertia, and gravitation. The "photon" is an electromagnetic wave, carried by electron-positron pairs, which have emerged from the sea of negative energy.

Preface
Dirac's Equation and the Sea of Negative Energy
D.L. Hotson

Dirac's Equation is profoundly important, and the Standard Model of particle physics is profoundly wrong. This paper addresses the nature of the energetic, non-stationary aether that Einstein missed, that Dirac's Equation demonstrates, and that Heisenberg and others destroyed when they modified this equation.

The treatment of Dirac's equation is a lesson in the way modern science works (or rather doesn't). This treatment has more recently been paralleled by the treatment of Reich, Pons and Fleischmann, Halton Arp, and others.

Abstract
Dirac's wave equation is a relativistic generalization of the Schrodinger wave equation. His complete original equation describes a quantum spinor field, which has as solutions four different kinds of electrons; electrons and positrons of positive energy, and electrons and positrons of negative energy.

Such supposedly "fundamental" entities as quarks and gluons have no comparable wave equations; yet they wave. Therefore they cannot be truly fundamental. Since in principle the Dirac field comprises "everything that waves," the equation therefore *predicts* that the entire physical universe can be made from these four kinds of electron.

In addition, direct applications of Dirac's equation provide simple, logical, and natural models of the electromagnetic field, the "photon," the "strong nuclear" force, the Ψ wave, inertia, and gravitation. It provides direct-contact physical models that agree with experiment, as opposed to the purely mathematical models so much in vogue.

The phase-entanglement feature of quantum mechanics, demonstrated by Bell's Inequality and the proofs thereof, requires that our reality be *non-local*. This seems to banish causality. However, Dirac's equation provides causal, direct contact models which are nonetheless non-local.

Yet Dirac's original solutions to his equations were altered.

Introduction (Problems with the Standard Model of Particle Physics)

Notes principles for a successful theory:

The principle criteria for a successful scientific theory would seem to be the following:
Criterion 1. Simplicity. It should embody as few "entities" as possible, preferably only one. (This is William of Ockham's test, known as "Ockham's Razor": "Multiplicity ought not to be posited without necessity.")
Criterion 2. It should have few, preferably no, adjustable parameters. (Also known as fudge factors.)
Criterion 3. It should be mathematically consistent.
Criterion 4. It should satisfy all of the known data, including data unexplained, anomalous, or dismissed as "coincidence" according to previous theories.
Criterion 5. It should obey causality: every effect should have a *proximate* cause, with no "action at a distance."
Criterion 6. It should be falsifiable, making testable predictions

The author holds that all 6 criteria are violated by the current Standard Model of particle physics.

Criterion 1
The trend in science up until 1932 had been toward simplicity. Nonetheless around that time the simplifying trend reversed, and by the end of the century, the accepted Standard Model (SM) of particle physics called for around thirty-six "fundamental" particles, most with an antiparticle, and each with its very own "field": again almost one hundred separate entities, to generate three entities; the electron, proton, and neutron, which are the building blocks of the 92 elements.

(Quantum Field Theory [QFT] in the SM is now so mathematically complex with its thirty-six or so [unobserved] fields that, as Treiman [2000] puts it, "There are no remotely realistic theories that are exactly soluble.")

The universe exhibits conspicuous economy,, even parsimony of means. The DNA molecule; arguably the most complex entity know, is built up from just four components.

Computer science shows that unlimited complexity can be generated from just two binary components.

Criterion 2
In contrast to the ideal of *no* adjustable parameters , the SM requires at least *nineteen* adjustable parameters.

Criterion 3
The SM is not mathematically consistent. The SM calculations of many ordinary values, such as the rest mass of the electron, come out to be infinite. However, from experiment we know the electron's rest mass to be 0.511 MeV.

To get rid of this "impossible result, "renormalization" is invoked: the positive infinity is, in effect, divided by a negative infinity. Since the result of this mathematically forbidden procedure is indeterminate, the desired value of 0.511 MeV is then simply entered by hand.

Feynman, who originated the "renormalization" process (with Schwinger and Tomonaga), himself called it a ". . .shell game. . .Having to resort to such hocus-pocus has prevented us from proving that the theory of quantum electrodynamics is mathematically self-consistent. . .[renormalization] is what I would call a dippy process!" (Feynman, 1985) Asked for what he had won the Nobel Prize, Feynman replied, "For sweeping them [the infinities] under the rug." (Gleick, 1992)

The SM also has a major problem with *mass*. Gordon Kane (*The Particle Garden*, 1995) argues that the Standard Model should really be called the "Standard Theory" because it is *nearly* perfect— just a few minor flaws. He then goes on to mention one of them (p. 117):
"In its basic form, the Standard Theory is a theory for massless particles. All the leptons, quarks, and bosons must be particles without mass, or the mathematical consistency of the theory is destroyed. The photon and the gluons indeed have no mass, but the others do." If values for mass are just inserted into the equations, then calculations start to give infinite values for many ordinary measurements.

The current hope is that two more entities, the Higgs field and its supposed quantum, the Higgs boson, will somehow solve this dilemma.

[On July 4, 2012, an announcement was made of a possible discovery of the Higg's boson. But how do we know this new particle is really fundamental, or just another piece of particle debris generated by the Hadron Super Collider? (HSC)?]

The Equation

Pais (1994) ranks the spectacularly successful Dirac Equation ". . .among the highest achievements of twentieth-century science." It was the first to be Lorentz-invariant, it had electron spin as a necessary consequence, it gave the right magnetic moment, the Thomas factor appeared automatically, and the Sommerfeld fine structure formula was derived with the correct Goudsmit/Uhlenbeck quantum numbers. At low energies, the results of the ordinary Schrödinger wave equation are recovered. It predicted the positron, which was discovered by Anderson soon after. It has since become the very basis of Quantum Electrodynamics (QED) (Pais, 1994).

Despite these successes, the physics community greeted it with alarm and outrage. This was because the equation gave twice as many states as they thought it should have. They expected a Ψ with *two* components; but this equation gave *four*. After the discovery of the positron, it was realized that its *four* solutions call for electrons and positrons of positive energy, and electrons and positrons of negative energy (Pais, 1994).

As Dirac pointed out, this is because the energy-momentum- mass relation

$$E^2 = c^2p^2 + m^2c^4$$

always associated with Einstein and Special Relativity has *two* roots; it calls for both positive and *negative* energy:

$$\pm E = (c^2p^2 + m^2c^4)^{1/2}$$

[The mass-energy relationship $E = mc^2$ was first derived and published by Oliver Heaviside (1890) and further refined by Poincare (1900), but Einstein (1905) first furnished the complete expression including momentum.] Dirac wondered what to do with the negative energy solutions. "One gets over the difficulty on the classical theory by arbitrarily excluding those solutions that have a negative *E*. One cannot do this in the quantum theory, since in general a perturbation will cause transitions from states with *E* positive to states with *E* negative." (Dirac, 1928a)

Since all negative-energy states have lower energy than any positive-energy state, Dirac wondered why there were *any* filled positive states, since according to Hamilton's law all entities tend to seek the lowest-energy state. He suggested that all of the negative energy states must be filled, like the filled electron shells in the Pauli exclusion scheme. Then, unless a "vacancy" occurred, positive energy particles would "float" on the surface of the negative-energy "sea" and stay positive. Dirac's "sea" of filled negative energy states, while it satisfied the equation, didn't at all satisfy the physicists.

Heisenberg had developed the first successful version of quantum mechanics on a Machian basis, and an unobserved, ubiquitous "sea" was anathema. Worse, it harked back to an old war, the "aether" conflict. On largely Machian grounds, Einstein in 1905 had declared the "luminiferous aether," the supposed carrier of light, to be unobserved, hence nonexistent.

[Lorentz's electromagnetic aether (Lorentz, 1904, 1909) answered all of the other objections to a carrier of light, including the results of the Michelson-Morley experiment, so the only remaining objection was the Machian one.]

For a generation, the "Aether War" had raged in every faculty. By 1930 the tide was definitely running with the Relativists, and most remaining aether enthusiasts were dying out. (Lorentz, their doyen, died in 1928.) They were far from forgotten, however. Any reference to a universal substance that undetectably filled space sounded too much like an aether.

The final argument was always that negative energy is impossible, with no imaginable physical meaning. Of course, pronouncements that something is impossible have a long history of looking foolish in retrospect, but this one seemed persuasive at the time.

Heisenberg's Window

The Dirac theory (1934) required every charge to be surrounded by unlimited numbers of the opposite charged ends of electron positron pairs (henceforth "epos") from the negative energy sea. Experiment has verified that the epos actually exist(ie, are not 'virtual', and are necessary. This "polarization of the vacuum" has since become QED's most celebrated success. Using difficult perturbation calculations, the theory computes the electron's magnetic "g" factor to an agreement with experiment of ten significant figures or more.

Dirac used a "zeroth order subtraction", which in turn uses the Grassman elements, to remove the two negative energy solutions to his equations, to simplify calculations, but Heisenberg used this to deny the existence of such negative states. Since the negative energy states were denied, the epos could not come from them.

Therefore the operator that previously called for unlimited numbers of negative energy electron positron pairs to be raised in state (from negative to positive energy), now magically became a "creation operator" of unlimited numbers of positive energy electron-positron pairs, without any high-energy photons, or, indeed, any measurable energy input at all.

By not allowing negative energy states, the concept of vacuum fluctuations around the zero baseline evolved, or "zero point fluctuations"

The state-lowering operator magically becomes an "annihilation operator," producing no high-energy photons or any other detectable energy. This violation of energy conservation was excused due to a seeming "energy window," based on Heisenberg's own uncertainty principle.

Thus, just as position and momentum of a particle cannot both be known with maximal certainty, Delta Energy · Delta time .GE. h/2pi. He took this to mean that if Delta time approaches 0, then the Delta energy approaches infinity.

He therefore decided that these "created" epos must be "virtual" rather than "actual," though the equations suggest no such thing.

One of the handy properties chosen for these unlimited numbers of "virtual" epos is that, although formed of unlimited amounts of energy, they somehow don't gravitate, and thus violate General Relativity, which states that such unlimited energy should curl the universe into a little ball. Every electron, surrounded by unlimited numbers of epos, should be a "black hole."

As Dirac noted, physicists had always arbitrarily ignored the negative energy solutions. If negative energy states were real in some sense, as Dirac's equation insisted, the physicists had all been wrong all these years, ignoring exactly half of reality. And that other half of reality, alarmingly, seemed to resemble the anathematized aether.

The Miracle of Creation

"Created" electron and positron spin energy is real energy. It is the angular momentum needed by the electron to set up a stable standing wave around the proton, and is thus directly responsible for the extension and stability of all matter. Instead of honestly facing this gross abandonment of conservation of energy, current theory dubs particle angular momentum an "intrin-sic attribute, " which means "we don't know where this energy comes from, so let's not talk about it."

Aside from the massive violations of energy conservation, it seems hopelessly naïve to suppose that complex entities such as electrons and positrons, with spin, charge, and a number of other properties, could be "created out of nothing," even if the energy were available.

Wouldn't it have made sense to look at what the Dirac Equation mandates: instead of being "created," electron-positron pairs are merely raised in state from negative to positive energies.

When an electron approaches a positron, they don't just rush together and disappear. They approach until they are at a distance equal to the electronic ground state of hydrogen. At this relatively large distance they start to orbit around each other in the configuration called "positronium." After a short time they emit two or more photons that total all of their positive energy, and are then no longer detectable.

Conventional physics says that their charges and spins have "cancelled" and that they have "annihilated" one another. But doesn't it make more sense to suppose that they still exist, as the Dirac equation requires, merely lowered in state to negative energies?

Arp's Axiom

One wonders if there are any lengths to which scientists will not go in order to save the reigning paradigm. In this case, saving the paradigm would seem to involve the virtual abandonment of science itself.

In this, they obeyed what we might call “Arp’s Axiom.” The astronomer Halton Arp (1998) noted that when facedwith a choice involving a paradigm change, scientists will almost invariably choose the alternative that will save the paradigm, regardless of the evidence.

A few scientists have looked at negative energy: [H. Bondi (1957) Much later, he examined negative energy within General Relativity. Also, T.E. Phipps, Jr. (1976, 1986) explores both negative energy (the “hole theory”) and negative (or “imaginary”) momentum in his “Beta Structure Hypothesis.”]

Evidence that Heisenberg was wrong
Prof. S Treiman shows (2000) that time may be considered quantized. If so, then it cannot be taken in arbitrary increments approaching zero, so Heisenberg’s “ time window” doesn’t exist. But the reigning paradigm escaped through that nonexistent window.

Symmetry
All through science, we observe almost total symmetry between positive and negative. Charges come in positive and negative, forces come in positive and negative, particles are symmetric between matter and antimatter. This last came as a great shock to physicists in the 1930s, but after it was accepted, symmetry became the justification for many of our theoretical structures. Only in energy do we deny that such a symmetry exists.

Science has ignored the negative energy solutions to these equations as “imaginary,” like the square root of a negative number. However, the square root of minus one is not “imaginary”— Mathematically, represented as i, it simply designates a number field, or dimension, at right angles to the “real” component. It is necessary to many disciplines, especially electronics. In the Einstein- Minkowski interpretation of special relativity this “imaginary” dimension is time.

Many of the popular string and superstring theories require, for symmetry, a space of ten dimensions (Sirag, 2000). General Relativity as well calls for ten tensors, or “dimensions of curvature” (Sirag, 1977a). To quote Dirac,
(1963), commenting on the ten tensors of curvature of General Relativity, “The gravitational field is a tensor field with ten components. One finds that six of the components are adequate for describing everything of physical importance and the other four can be dropped out of the equation. One cannot, however, pick out the six important components from the complete set of ten in a way that does not destroy the four-dimensional symmetry.”

[Recent studies in astronomy have shown that space on a large scale is not curved, but appears to be Euclidean to the limits of measurement (Arp 1998, Van Flandern 1998).]

In this case, General Relativity’s ten tensors of curvature become merely linear degrees of freedom, or dimensions.

Dirac (1928a, b) laid the foundations of QED with his relativistic wave equation. In doing so, though, Dirac found that having three dimensions "real" and the fourth "imaginary" didn't work—it violated the symmetry. He took the first derivatives of all four dimensions by introducing i as well into x, y, and z, making them symmetrical by making them all "imaginary." Most physicists have considered this a trick, an "accident of the formalism," and disregarded it.

"Imaginary" (orthogonal) directions give us a place to put Dirac's negative-energy "sea." As we will demonstrate, it also gives us a physical explanation of "negative energy."

The Kinetic Theory of Mass/Energy

What is mass? Recent thought suggests that the energy equation, instead of saying that two different things can somehow be converted into each other, really means that mass is just another form of energy (Haisch and Rueda, 1997)

Mass appears to be the harmonic motion of charged particles "trapped" within an energy well of some kind. This is why the most convenient and most often used unit expresses mass in terms of energy

According to Haisch, Rueda, and Puthoff (1994), mass is caused by an action of the Zero-Point Fluctuations (ZPF) of the vacuum electromagnetic field that resists the acceleration of a harmonically vibrating charge. "Mass is the manifestation of energy in the ZPF acting upon [vibrating] charged particles to create forces." (Haisch and Rueda, 1997) By this kinetic definition, an electron-positron pair vibrating in a direction at right angles to our ordinary four, an *"imaginary"* direction, would have *negative energy*, the negative root of the Dirac equation. *Just as the square root of a negative number merely refers the result to a direction at right angles to our ordinary directions, so the negative root of the energy equation refers to an energy (a vibration of charges) in one of these "imaginary" directions.*

All of the groundbreaking equations of quantum mechanics contain *i* either explicitly or implicitly. The meaning of this has been staring us in the face for seventy years. *These "complex" functions involve vibrations partly in "real" partly in "imaginary" directions.* (And some that are "pure imaginary,"such as the $\pm c$ velocity eigenvalue of the electron/positron.)

The Electron Positron Pair
The negative energy electrons and positrons called for in Dirac's Equation, appear to be permanently associated in pairs-epos. According to Dirac's theory, when an electron and positron combine, they do not annihilate one another, nor do they even come very close together, but rather orbit on another as an entity called a "positronium." They drop into the negative energy sea. What configuration do they assume in the negative energy sea?

Dirac's equation describes a "spinor field." In such a field, rotation of the wave function through 360° does not get it back to its original state, but to its opposite: the electron has to "turn around twice" to get back to where it was. At 360°, its wave function
□Ψ becomes -□Ψ, and it becomes, in effect, a positron travelling backwards,

In QED, a positron is considered to be an electron travelling backwards in time [Feynman, 1985].) So a positron is really only a totally out-of-phase electron.

The equation also says (Huang, 1952) that the electron has an internal vibrational velocity of $\pm c$. Since the electromagnetic wave is the only momentum-carrying entity allowed to travel at *c*, this could mean that this internal vibration is as an *electromagnetic wave*.

The resultant orbiting electron-positron pair might then be configured as vibrating in an imaginary direction while turning into each other every 360°, so they would be "particles" at 0°, 360°, and 720°, and waves in between ("wave-particle duality").

The *period* of this reciprocation would have to be the "quantum of time," τ, equal to $2e^2/3mc^3$, or 6.26×10^{-24} seconds. This is the time required for an "appreciable change" in the wave equation, which therefore only changes in increments of τ. This is Γ_e, the Lorentz-Abraham damping constant of the electron, and in classical electrodynamics, it is called the "damping constant" or the "characteristic time" of the electron.

In particle physics, this is the minimum time taken by any interaction, and interactions that take longer than this seem to require exact multiples of this "quantum of time." Since they travel at *c* as electromagnetic waves, this would make the "length" of an epo (a one-dimensional string, with a "point particle" at each end) equal to τc, $2e^2/3mc^2$, or 1.87×10^{-15} meters. This is the measured diameter of the proton, which, is *not* a "mere coincidence."

Considering negative energy to be an imaginary component (be at "right angles" to the real quantities) is consistent with the fact that the electron's wave function is a *complex* variable, with "real" and "imaginary" parts, and with the fact that the electron's angular momentum is also complex.

The Quantum Field

In his book *The Odd Quantum*, Sam Treiman (2000) introduces a very simple "model field": a single, scalar field f (*x*,*y*,*z*,*t*) which classically obeys the linear differential equation:

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} - \left\{\frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} + \frac{\partial^2\phi}{\partial z^2}\right\} + \rho^2\phi = 0.$$

He then goes on to quantize the field, and solve for the eigenvalues. He finds that the allowed momentum eigenvalues *p* form a continuum, and for any given momentum *p* there is a particular state with energy

$$E = [(cp)^2 + (mc^2)^2]^{1/2}, \text{ where } m = hp/c.$$

"This is just exactly the relativistic energy-momentum relation that holds for a material particle of mass *m*." [The above expression should read "plus or *minus E*." The one-particle state can have either positive or *negative* energy.]

The remarkable thing is that, starting with a simple *field*, *particles* emerge as quanta of the field.

This particular "model field," deliberately chosen for its simplicity, describes as its quanta *neutral, spin-zero bosons*.

It turns out that this simplest possible quantum field would *necessarily* be populated with all possible numbers of *strictly identical, neutral, spin-zero bosons*: Gribbin notes (1998b), "In the quantum world a field *must* give rise to particles."

No such field of unlimited numbers of neutral, spin-zero *positive*-energy bosons exists.

However, as we have argued above, a "sea" of *negative*-energy, neutral, spin-zero bosons is a requirement of quantum mechanics itself: of the energy equation, and of the Dirac equation of the electron.

Two of the Dirac Equation solutions call for negative-energy electron-positron pairs, which would necessarily associate as neutral spin-zero bosons.

We have now approached this from three different directions, and they all point to the same result.

In this model field there are no interactions; it is called a free field theory.

Start with a state in which two particles approach as for a collision, and in fact they won't collide (because both electron and positron are waves at this time) because the classical field equation on which it is based is linear: the sum of any set of solutions is also a solution.

(For this reason, quantum field theory, with its multiple fields, one for each "fundamental" particle, requires non-linear terms in the differential equations that describe them in order for there to be interactions, and this is why none of the theories are exactly soluble.)

In laboratory ultra-cold studies, we remove "positive" energy and achieve lower temperatures to come closer and closer to "zero absolute," a state of no positive energy.

Apparent energy and activity decline rapidly as temperature drops. One would think that at temperatures near absolute zero matter would lose its cohesion and fall apart.

But as we approach the zero-point, some curious things happen. First, centered at about 2.73°K, we find an immense number of photons. At 0°K, the equations of QM tell us that there is immense energy (hv/2).

Bose-Einstein Condensate

Matter binds closer and closer together until at even lower temperatures the individual molecules function as a single unit; ie a Bose-Einstein Condensate, in which superconductivity and superfluidity occur. These are very energetic states, in which negative (binding) energy has overcome the tiny residual positive (freeing) energy, so that all particles are all governed by the same wave function.

The author suggests that the negative energy sea of bosons (epos) called for by the equations must exist in the form of a BEC. According to the equations and everything we know, our reality is surrounded by and immersed in a vast, all pervasive Bose-Einstein Condensate.

This is supported by Bell's Theorem, which suggests that our universe must be non-local, connecting quantum objects anywhere in the universe instantaneously.

Non-local or faster than light action also must be a property of the electromagnetic field, according to a whole series of experimental results starting with the Sherwin-Rawcliffe experiment (1960) and continuing with those of the Graneaus (1982, 1983, 1985, 1987, 1993) and Pappas (1983, 1990A, 1990B). These experiments all show that changes in the electromagnetic field must propagate nearly instantaneously, so that a moving charge has no "left-behind potential hill."

The same is true of gravitation, as was shown in the classical Laplace demonstration based on the absence of any change in the angular momentum of the earth's orbit (Laplace, 1966), and as has been repeatedly demonstrated by Van Flandern (1993, 1996, 1998). He shows that even in a static field, propagation of gravity merely at light speed would result in a "couple," which would measurably increase the earth's angular momentum. He further shows that General Relativity, supposed to be a local theory, nonetheless assumes and requires instantaneous changes in the "curvature of empty space," and so is non-local.

The BEC is apparently the only extended structure that exhibits this non-locality. If you insert an electron into one end of a BEC, however large, an electron emerges from the other end faster than light can travel that distance—this is the phenomenon of superconductivity

These non-local actions are not literally instantaneous, but take the finite time tau.

We have looked at three equations, the energy equation, Dirac's equation, and this very simplest quantum field, which we might call the "Zeroth Quantum Field" (ZQF). Each of them seem to be describing this same object, a universal BEC negative energy "sea" composed of unlimited numbers of spin 0 neutral negative-energy bosons, which have to be one-dimensional electron-positron pairs.

Physics Through the Looking Glass

That there is a negative-energy "sea" balancing the positive energy of our reality restores the symmetry between negative and positive energy called for by the energy equation and Dirac's equation. Moreover, there are indications that negative energy is primary.

The Electromagnetic Field

An ionic electron must instantly be surrounded by a sphere of the positron ends of polarized epos, as has been verified by experiment. The positrons must form a sphere of diameter tau c. But this takes no energy, since in the infinite sea there is already a positron and an electron at the exact points necessary to make that sphere of polarized epos, each radial to the ion. The only difference is that these are now positive energy epos, as their vectors point in real directions.

Each positron in the inner sphere has a potential induced by the ionic electron.
This would unbalance the epo, inducing a potential between the positron and its electron, which would again force the electron end to polarize another epo, and so on indefinitely, forming chains of polarized epos. These chains would continue into space until they terminated at a charge of opposite polarity, as in Figures 1 and 2

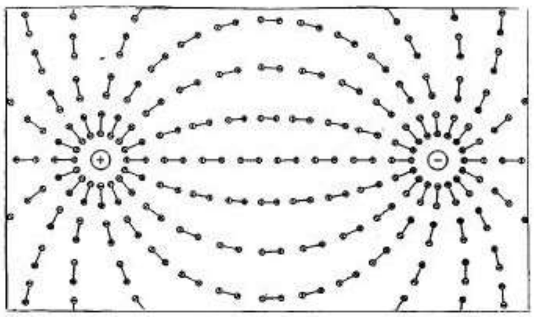

Figure 1. "Vacuum polarization" around unlike charges.

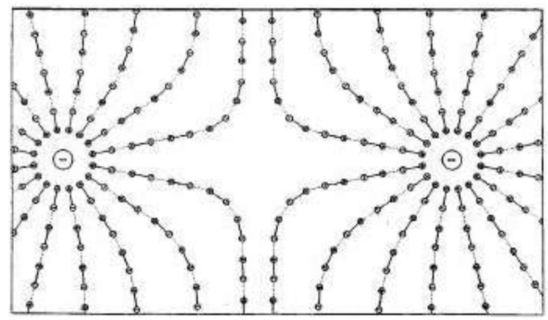

Figure 2. "Vacuum polarization" around like charges.

Charge is carried by proxy by these chains of epos. The strength of the charge measured anywhere would vary as the inverse square of the distance, as the Coulomb gauge requires. (This strength would be measured in "epo chains per unit area," just as Faraday would have us measure "lines of force per unit area.")

Since this pattern duplicates every aspect of the electromagnetic field, we submit that this IS the electromagnetic field, much as Faraday or Maxwell would have drawn it, with Faraday's "lines of force" exactly duplicated by chains of epos. The epos are the quanta of the EM field.

In this "epo model," the "tension along the lines of force" is supplied by the attraction between the aligned unlike charges in the epo chains. The pressure in all directions at right angles to the epo chains is supplied by repulsion between the like charges in different chains lined up roughly parallel to each other. This also accounts for the repulsion between like charges of "real" ions, as seen in Figure 2.

Taylor notes: "In quantum theory, the electromagnetic field behaves exactly as an assembly of arbitrarily many massless particles."

Further, we note that what had been taken to be a mathematical abstraction, the "electromagnetic field," now has a definite physical reality.

Conservation of Angular Momentum (aka the Photon)

As a single electron of hydrogen orbiting the proton at some energy level above its ground state jumps to its ground state, it must lose angular momentum—spin—in the amount of hv. In the conventional view, the electron "emits"—instantly creates—a "particle" called the "photon," which is an electromagnetic "wavicle" traveling at velocity c, which delivers the angular momentum intact to some other electron and then vanishes.

Since Einstein banished the aether, however, the question has been "what is waving?" The photon has no rest mass, and contains no charges—so it violates our kinetic definition of energy.

In order for a “real” object to get rid of spin angular momentum in the macroscopic world, that real object must set some other real object spinning. The author holds this to also be true in the macroscopic world: what is more natural than that it set spinning those objects closest to it, the polarized epos that surround it? They have charges, and are pointing in “real” directions, so they can absorb the “real” (positive) spin energy that the electron has to get rid of.

When the electron goes to the ground state, the epos are left “holding the spin.” [some more than others, because the lost spin is a vector quantity, and its energy will go primarily to epos that are pointing in the vector direction.] The epos are no longer in chains, and the spin energy will travel up the epo “string” (at velocity c)

The “photon” at this point would be a wave, carried by epos, which can be termed an epho.

Feynman could not explain why a “path” should have phase, he merely asserted that it did. We can now see that it has phase because each epho on each “path” is itself an electromagnetic wave with phase. Together they form a coherent wavefront. Ephos on the “least action” path will reinforce each other, and any epho that takes a “wild” path gets out of phase with the wavefront, suffers destructive interference, its angular momentum is cancelled, and it drops back into the epo “sea.” Thus the only ephos that continue to carry energy are those that are close to the (least action) “classical” trajectory.

In the famous “two slit” experiment, many of the paths comprising the epho “wave” which represents the “single photon” go through each slit, and interfere with each other, forming the well-known Ψ wave “interference pattern.” At the screen, one of them is randomly selected according to $|\Psi|^{2,}$ the probability, to deliver all of the wave’s angular momentum to a single electron in the screen.

This amounts to an analog-to-digital conversion, with the sum of the angular momentum of the entire wave being delivered to a single electron, a “point event.”

Note that this model gives physical meaning both to Feynman’s path integral version of QM and to the Ψ wave. Further, it should be noted that since each epho wave individually travels at *c*, the velocity of light would be independent of the velocity of the source, and the same in any frame of reference. It would in fact be Lorentz’s electromagnetic aether (Lorentz, 1909). The transmission of light would agree with Lorentzian relativity, which meets all the tests devised for Special Relativity (Ives, 1946, 1949, 1950, 1951), including those that SR fails, such as the Sagnac effect (Sagnac, 1913) and the Silvertooth effect (Silvertooth, 1987, 1989, Silvertooth and Whitney, 1992).

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