Navigating the Positron and Electron Mysteries

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Abstract

*The **positron** is the acknowledged anti-particle of the **electron**. Electrons are plentiful, particularly in metal conductors, and can readily be generated by an **electron gun** or by the **Photoelectric Effect**. Positrons, on the other hand, are relatively rare in Nature, and high-energy processes are required to generate useful quantities. The mystery around positrons started with their discovery as a by-product of radioactive decay, and they were called **positive beta particles**. That label remained for 34 years until they were re-discovered in cosmic particles by Carl Anderson in 1932.*

Because pair-production, the main mechanism put forward for the creation of electrons and positrons, create them in equal numbers, why are electrons more plentiful and readily available? Why do electrons, defined as a structureless point-form monopole particle, have an electric charge of -1e and positrons a charge of exactly +1e? How do positrons relate (if at all) to 'normal' matter? With positive charge carriers required to fully explain semiconductor current generation, is it possible that positrons are mobile positive charge carriers rather than the static cations referred to as 'positive holes'? These are some of the questions associated with the mystery that surrounds electrons and positrons as explored in this paper.

The Positron Back-Story

Positrons were first observed by Ernest Rutherford in 1898 from Beta Plus (β+) decay, but they were called **positive beta particles** and were considered to be a form of weird radiation from the radioactive decay of Uranium. Electrons from Beta Minus (β-) decay were similarly called **negative beta particles**. It wasn't until 1932 that Carl Anderson officially (re)discovered positrons by accident when conducting experiments related to cosmic radiation. Anderson's discovery was hailed as providing a validation of Paul Dirac's earlier theoretical prediction of the existence of the positron, the **anti-particle** of the electron. Neils Bohr's nuclear model, developed around 1913, evolved into Erwin Schrodinger's Quantum Mechanics model by 1926, but positrons do not readily fit into either model because they both contend that the only source of positive charge within matter relates to protons within the atomic nucleus.

Electrons are plentiful, and can be readily generated low-energy processes such as **electron guns** and the **Photoelectric Effect**, whereas positrons are relatively rare. Although β^+ decay produces low level concentrations of positrons, and provides a positron source as commonly used for medical probes and scanners, high-energy brute-force techniques (e.g. the 200 MeV high-energy Large-Scale Collider at CERN or Petawatt-plus lasers) are needed to synthetically generate useful quantities of positrons.

However, having a positron source does not provide an insight into their creation. There would seem to be three possible alternative explanations for the means by which positrons are created; namely:

1. Positron creation is an example of the direct dynamic and spontaneous creation of matter from gamma ray radiation via pair production.
2. Positrons are generated by the high-energy impact conversion of electrons into positrons.
3. Positrons pre-exist within atoms and simply require high-energy impact to release them.

Each alternative explanation will be discussed in turn in its own chapter.

Explanation 1: Pair Production

Electron-positron pair production is the most quoted example of the claimed dynamic creation of matter from photon energy in the gamma ray frequency range. The probability of pair production increases with photon energy, with the minimum net photon energy required being 1.022 MeV (which equates to the combined rest mass equivalence of an electron and a positron).

Breit–Wheeler pair production is the process by which a positron–electron pair is created from the collision of two photons in the gamma frequency range, with each gamma ray photon having a minimum energy of 0.511 MeV. It is represented by the following equation:

$$\gamma + \gamma \rightarrow e^- + e^+ \text{ (spontaneous simultaneous electron/positron creation)}$$

Despite being lauded within Physics communities and the wider press as an example of matter creation from electromagnetic radiation, the Breit–Wheeler process has never been observed in practice because of the difficulty in preparing colliding gamma ray beams and the very weak probability of such collisions. It is now widely interpreted as the possible splitting of one photon of energy greater than 1.022 MeV. Certainly, the actual pair production mechanism is speculative, and far from being well established, with there being wide variety of diagrams intended to represent and clarify the process. Figure 1 shows just four of these.

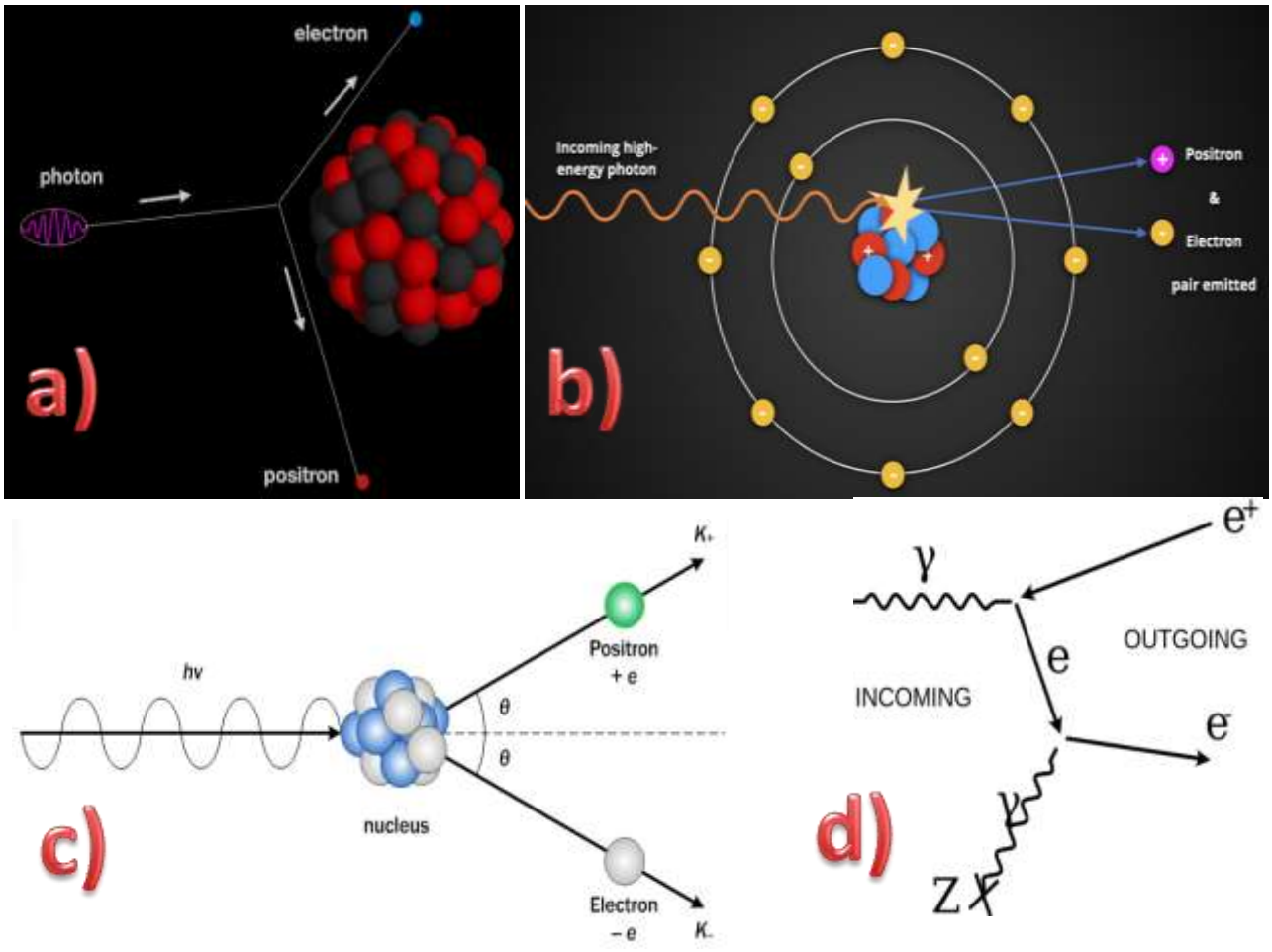

Figure 1: Electron-Positron Pair Production

So, does the claimed Breit–Wheeler pair production occur due to the magical splitting of a single photon by an atomic nucleus (as in figure 1a or 1c); the collision of a photon with an atomic nucleus (figure 1b); or the collision of a pair of photons (figure 1d)? It all seems to be very confused and confusing. And note that, only in one diagram (figure 1b), the presence of orbital electrons is acknowledged and represented (albeit simplistically). However, for all such interpretations, the possible and highly likely interference between existing orbital electrons and the newly generated particles is totally ignored.

Should pair production be the only (or even the main) means of electron and positron creation, it raises the question as to *why electrons and positrons aren't present in equal numbers in Nature* (or 'normal' matter). Electrons and positrons are created in equal numbers by pair production and conversely are destroyed (i.e. converted into gamma radiation) in equal numbers (i.e. pairs) by electron–positron annihilation. Should pair production be the main mechanism for electron and positron production, then both should be present in Nature in approximately equal numbers, but they are not. So *where have all the positrons gone*?

The 2013 article by Sarri (reference [11]) describes one of the first Petawatt (1015W) laser setups used to generate a positron stream (see figure 2). It provides a detailed discussion of the results and attempts to explain the creation process in terms of pair production.

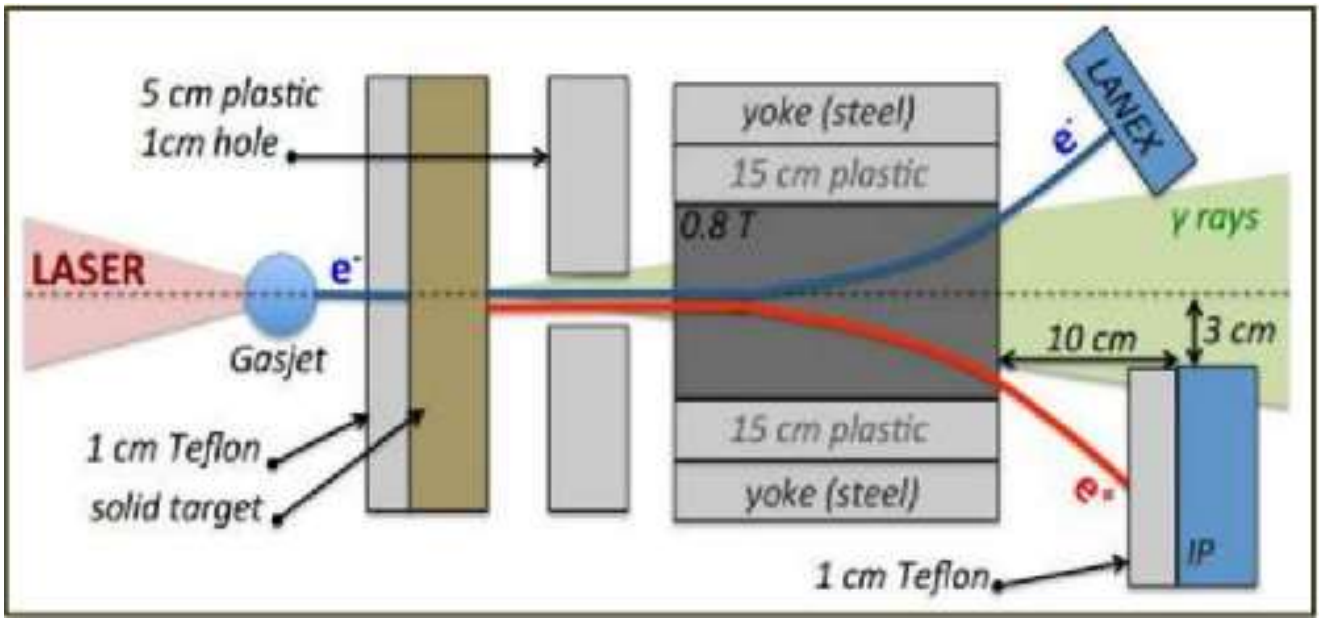

Figure 2: Benchtop Laser Setup for Electron and Positron Generation

The laser approach to positron generation involves bursts of light energy that bombard a solid target to produce an **electron stream** of energy in the 80-200 MeV range. The Sari paper suggests that **gamma photons** are generated by Bremsstrahlung, which is caused by the slowing down of the incident electrons. Bremsstrahlung is more effective for target atoms with a high Z number (atomic number) and packing density. The resulting gamma photons are then considered to create an electron--positron pair spontaneously via Breit–Wheeler pair production. These newly-created energised electrons and positrons escape from the host material and separated to generate separate electron and positron streams.

This explanation relies upon a quite complex process, with electrons being energised by the laser, that via Bremsstrahlung then produce gamma rays that, in turn, somehow interact or convert into an electron-positron pair. The Sarri paper is technically excellent, and a good read, but its convoluted multi-process interpretation of the positron creation process is, in the author's opinion, unduly complicated and far from convincing.

The question remains that, if the dynamic pair production process is the main means of electron and positron production, and electron–positron annihilation is the main way they are destroyed, then *why is there such a scarcity of positrons in Nature*? There are three possibilities that could explain this quandary:

a) There is another process, as yet unidentified, that generates the vast quantity of electrons we find within matter without generating an equivalent number of positrons (or conversely, a process that destroys large numbers of positrons but not electrons),

b) There is a large number of positrons within matter that, as yet, has not been identified, or

c) Large numbers of positrons exist within anti-matter (as opposed to 'normal' matter), orbiting around negative-charged nuclei, somewhere else in the Universe (this is a most unlikely option).

Explanation 2: The Creation of Positrons from Electrons

Is it possible that high-energy impact can convert an electron into a positron and vice versa? The knee-jerk reaction is that 'it is simply not possible' because there is no mechanism that allows a negative charge to be converted into a positive charge, or vice versa. However, *is the proposition any more unlikely than the proposition that gamma ray photon energy can dynamically convert into an electron-positron pair*? Such a proposition certainly raises questions related to what exactly is the cause of electric charge and its related electric field, and exactly what is the structure of the electron and the positron.

Quantum Mechanics (**QM**) defines an **electron** as a **point-form monopole particle** (often referred to as the Dirac point particle) that carries a negative charge and which satisfies the **Dirac wave equation**. When the point-form particle carries a **positive** charge it is considered to be a **positron**, the **anti-particle** of an electron.

From a purely theoretical point of view, QM electrons and positrons have exactly the same structure, which is an infinitesimally small jot of fundamental electromagnetic material that has an inherent charge, being negative for the electron and positive for the positron. Although they are usually represented as small spherical particles, as point-form particles, QM-defined electrons and positrons have no width or radius: thus their known spin momentum is called 'intrinsic', which is magic code for 'let's not worry about it'.

Although the QM definition of electrons and positrons work well with the theoretical mathematical models that piggy-back onto the wave equations, it is predicated by the assumption that electrons and positrons have the properties of **intrinsic spin** (up or down) and **electric charge** (negative or positive). These assumptions preclude the possibility that electrons can be converted into positrons and vice versa. And remember, these spin/charge concepts are assumptions of convenience to facilitate the development of QM related theory that rightly or wrongly, according to Erwin Schrödinger, "... enforces its entire departure from classical lines of thought".

But *what if electrons and positrons have a structure that is subtly different to each other and which dictates whether they are perceived as having negative and positive charge respectively*? By having a physical structure, electrons and positrons would have finite dimensions and thus their spin momentum would be real rather than intrinsic. And *what if such a model fits perfectly with the wave equations of QM*? Surely such an approach needs to be explored thoroughly.

Let's start by considering a structure for the electron and asking *what **electric charge** is* and *why it has an associated **electric field***? Also, along similar lines, *why is positive charge different to negative charge*; and *is the charge difference due to composition or structure, or both*?

A well-documented alternative model to QM-based point-form model for the electron is the **Toroidal Solenoidal Electron** (**TSE**), which defines the electron as a spinning electric charge that moves at high speeds in a solenoidal pattern around a torus-shaped pathway (references [1] to [6]). The mathematics developed for the TSE model for electrons (references [7] to [10]) would appear to provide as good a fit for the wave equations as the monopole point-charge model.

In 2015/2016, D Bowen and R Mulkern (references [12] and [13]) developed the toroidal-based **Charged-Electromagnetic-Wave-Loop** (**CEWL**) model that, unlike the TSE model, does not have a solenoidal spin around the torus. CEWL considers an **electron** to consist of a sinusoidal electromagnetic wave (the **blue** wave-form in figure 3) moving at the speed of light around a toroidal path to generate the electron's charge and magnetic field (**green** in figure 3). For a **positron**, the electromagnetic wave (the **red** wave-form in figure 3) is considered to move around the toroid in the opposite direction to that of the electron, but generates a circular magnetic field (**green** in figure 3) in the same direction as that generated by the CEWL positron.

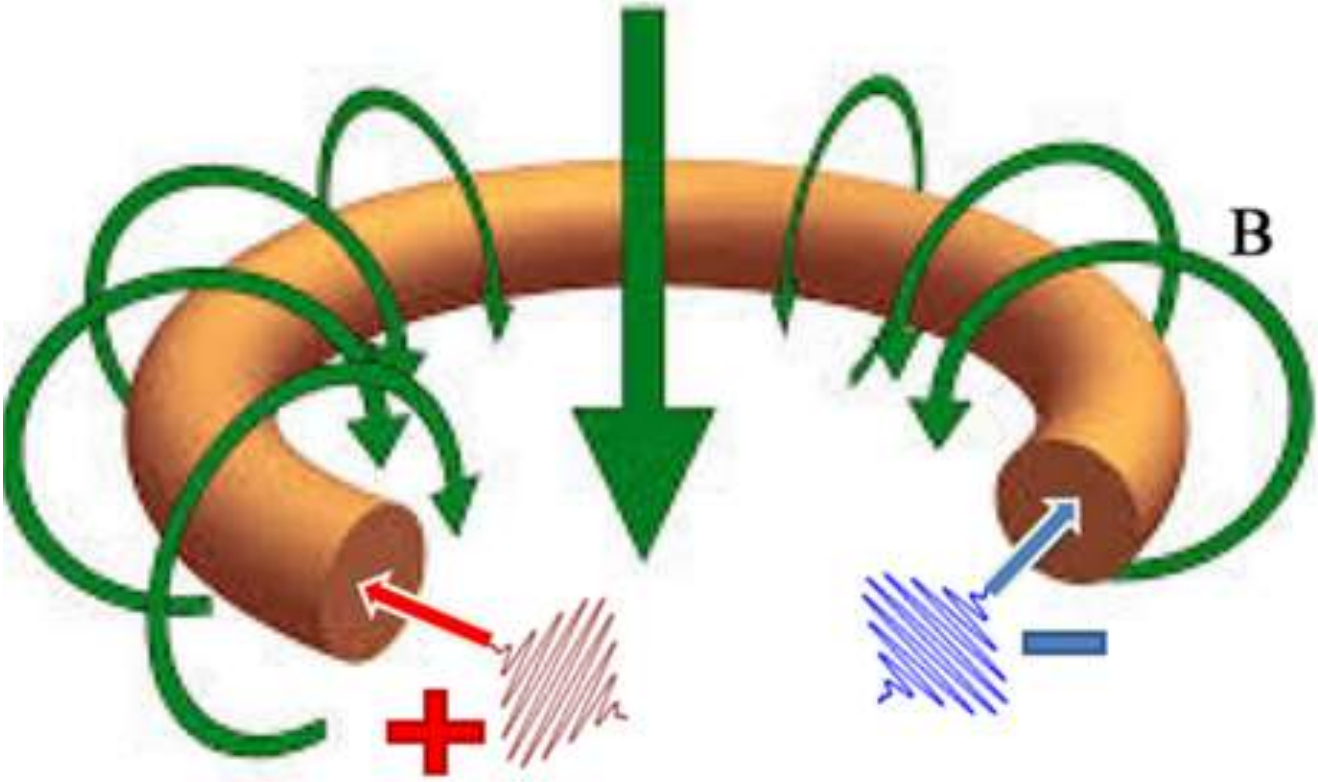

Figure 3: The CEWL Electron/Positron Toroidal Model

The CEWL model thus contends that the main difference between electrons and positrons is the different chirality of the waveform that moves at the speed of light in a circular pattern to present as a torus.

Another approach is the **Spin Torus Energy Model** (**STEM)**. For STEM (references [14] and [15]) the electron and positron are subtly different to the CEWL model. STEM contends that all electromagnetic waves (light, gamma rays etc.), fundamental particles (electrons, positrons, nucleons etc.) and matter consist of the same material, which is called **energen**. The structure developed for the electron is a central torus called the **energy core** which consists of concentrated energen that moves (or rotates) at close to the speed of light. The energy core, which defines the physical size of the electron, has a surrounding atmosphere-like sleeve of less concentrated energen referred to its **field energy** (or electromagnetic field), which dictates how the electron interacts with the outside world. The field energy of an electron has left-handed chirality, whereas a positron is exactly the same as a STEM electron except that its field energy has right-handed chirality.

> **Note**. The Appendix of this paper provides a detailed explanation of left and right-handed chirality with respect to the STEM electrons and positrons.

The main difference between the CEWL and STEM models is that the inner core of the CEWL electron has chirality whereas the inner core flow (or spin) of the STEM electron is not chiral, but its surrounding atmosphere-like sleeve, the field energy, is chiral. For the STEM approach, the material from which an electron is made and toroidal structure of an electron is the same as that of a positron: it is only the right-handed chiral flow pattern of the field energy (that determines its electromagnetic characteristics) that classifies it as a positron.

The paired grey circles of figure 4 represent a cross-section of the energy core of a STEM electron and positron, with the maroon arrow-tip (out-of-page) and arrow-quill (into-page) showing their toroidal flow direction of the concentrated energen. The outer field energy presents as an outer torus of less concentrated energen whose **toroidal** flow direction is compatible with that of energy core's energen which, combined with a **poloidal** flow component (around and through the torus core), results in a twisted chiral flow pattern and the formation of an **inflow** and **outflow vortex**. It is the field energy that provides the different electromagnetic characteristics of the electron and positron, whereas the energy core provides the backbone that allows electrons and positrons to have particle-like characteristics.

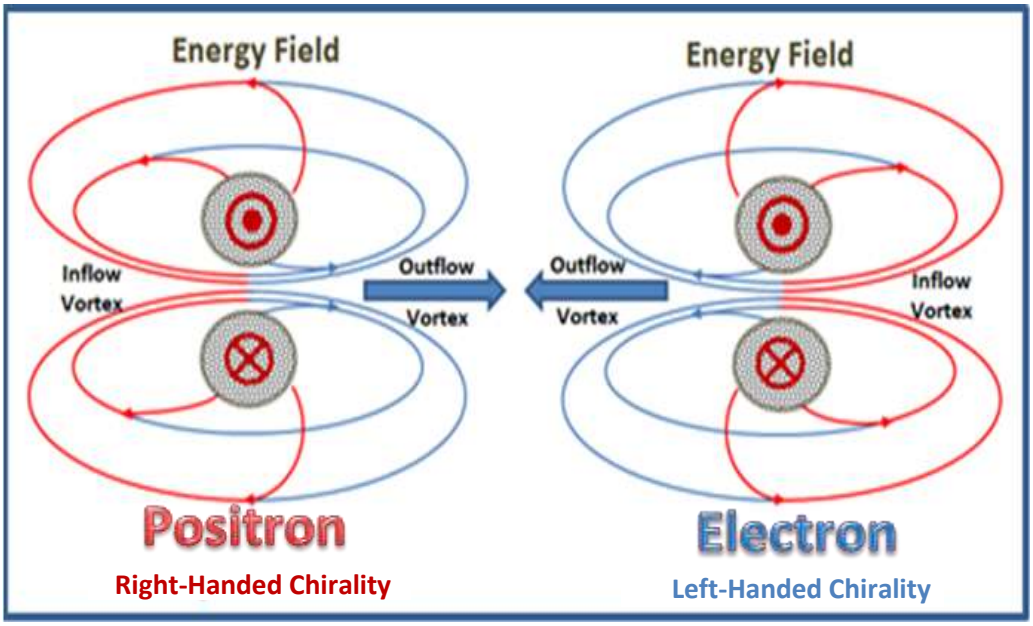

Figure 4: The Chiral Energy Field Patterns of STEM's Electron and Positron

STEM electrons and positrons are considered to move with their outflow vortices foremost. Should two electrons approach each other head-on, their outflow vortices push against each other and their toroidal flow direction of their energy fields are in opposite directions so as to push against each other: the result is strong repulsion between like-charge particles. Should the speed of the approaching particles be sufficiently high relative to each other (e.g. a laser-energised electron approaching an orbital electron), same-charge electric repulsion may not be sufficient to prevent a head-on collision. Rather than simply deflecting or bouncing off each other, such high-speed head-on collisions can cause the compression of the outflow vortex field energy that, in turn, triggers the forced reversal of the poloidal flow direction of one or both electrons. The collision outcome is the instantaneous conversion of one or both electrons into positrons.

The electron-to-positron conversion process would not necessarily just be in terms of electron-to-electron encounters: it could also be an electron-to-nucleus interaction, with the newly create positron bouncing off at a high angle from the nucleus (which would be unaffected apart from increased energisation in terms of an increased level of vibration). STEM also suggests that this latter type of interaction is more likely to be accompanied by proton-to-neutron conversion and the creation of an electron neutrino (i.e. the Beta+ or electron capture decay process).

With the STEM approach, high-energy impact can convert an electron into a positron. It would not be an unexpected outcome, and it would certainly provide a simpler and more feasible explanation of laser generated positrons than that involving Bremsstrahlung of with laser-energised electrons generating gamma rays that somehow magically interact or convert into an electron and positron pair.

Although the reverse process is possible, it is far more likely that any newly formed energised positron would encounter another electron and undergo electron–positron annihilation before it could become re-converted back into an electron. However, annihilation removes both an electron and a positron and thus in no way explains the over-abundance of electrons that we find in Nature. But could there be lots of positrons hidden in plain sight within matter? That intriguing proposition is addressed in the next chapter.

It should be noted that chirality is a phenomenon with widespread relevance in fundamental physics, material science, chemistry, optics, and spectroscopy. Although, for some complex molecules, chirality is in terms of bond-geometry, for particles, atoms or photons (EMR), chirality is usually in terms of their electromagnetic field pattern. It is thus not unexpected that an electron and positron would have different electromagnetic field chirality. However, what is different is STEM's contention that field energy chirality dictates the electromagnetic characteristics of particles and that, in the case of electrons and positrons, this chirality can be reversed by high-energy impact. This conversion phenomenon has been extended by STEM (reference [15]) to include proton-to-neutron conversion (and vice versa) associated with radioactive decay.

Explanation 3: Positrons Pre-Exist within Matter

As mentioned earlier, electrons abound within 'normal' material and are readily released from metals by photons within and close to the frequency of visible light. This process is called the **photoelectric effect**. Positrons, on the other hand, can only be produced from 'normal' material by high-energy impact of electrons, gamma radiation, or via radioactive decay. This option explores the possibility that, as for electrons, positrons might also **pre-exist** within matter but, unlike electrons, can only be released by high energy interactions such as the impact of high-energy photons or electrons.

Should positrons pre-exist naturally within 'normal' matter, an obvious question is: *why haven't Scientists identified their existence within matter (i.e. in situ within matter)*? For positrons to exist within matter there would need to be a mechanism to keep them well apart from electrons so as to prevent mutual annihilation. It defies common sense to suggest that, without a feasible electron-positron separation mechanism, positrons could co-exist with electrons within matter. And certainly modern atomic Physics has never suggested that any such separation mechanism was needed or could possibly exist, and contends that the only source of positive charge within an atomic structure is from protons within the nucleus.

Positrons have always sat uneasily with nuclear atomic models, and still do. It took 34 years from Rutherford discovery of positive beta particles in 1898 to 1932 when Carl Anderson re-discovered and renamed them positrons. As well as suggesting an electron-to-positron conversion process (see Explanation 2 above), STEM suggests that positrons could exist within 'normal' matter and has provided a mechanism that would keep positrons and electrons separated from each other, even within metal conductors. It claims that positrons may well be present in plain sight and simply require high-energy impact to eject them from their host media. It also suggests a reason why they are so difficult to eject from their host medium, but that is beyond the scope of this paper, but is addressed in STEM's Atomic Structure paper (reference [15]).

Let's start by looking at the electron-positron separation mechanism suggested by STEM. Rather being shell-like and fully encompassing the atomic nucleus, STEM suggests that electron orbitals are more likely to be planar above and/or below the nucleus, and calls them **ionic orbitals**. In comparison with the weird and wonderful 'spdf' orbitals (figure 5d) suggested by QM, STEM's ionic orbitals are about as simple a pattern as one can imagine (however, geometrically, they are eerily similar to QM's $3d_1$ and $4f_2$ orbitals).

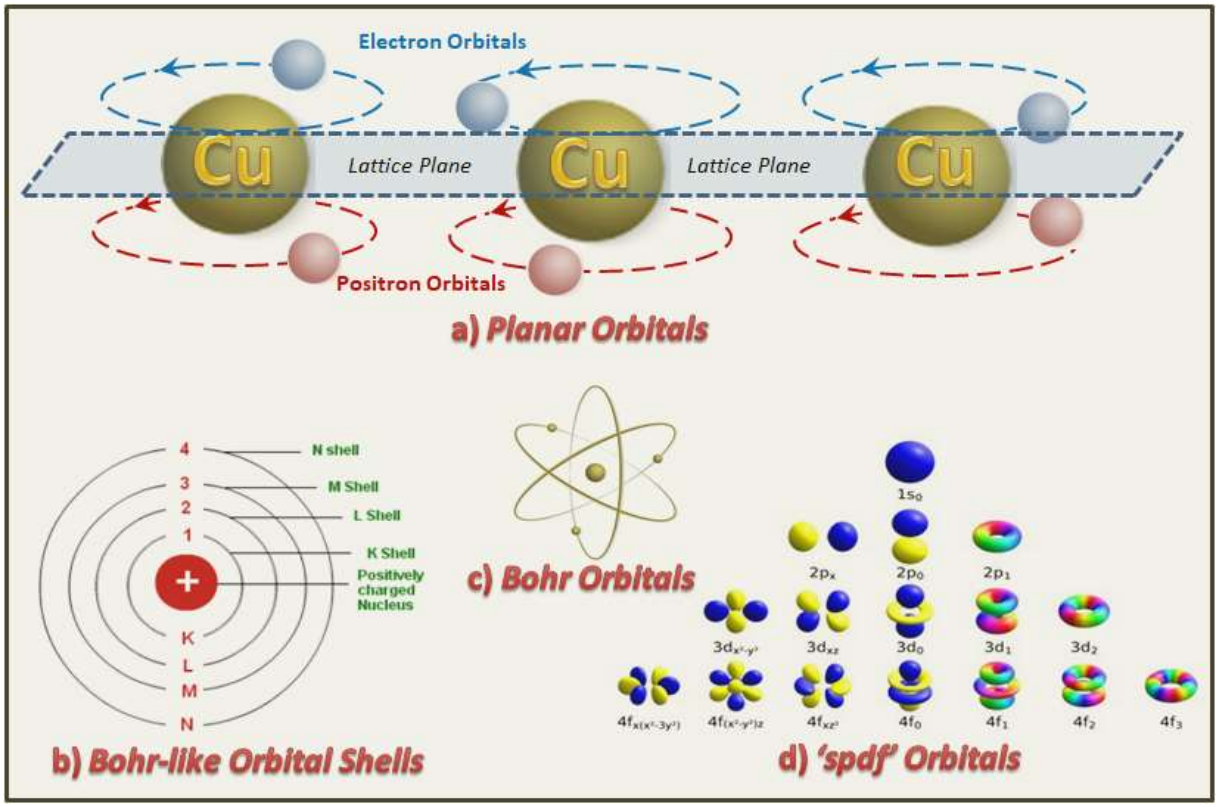

Figure 5: Alternative Atomic Orbital Schemes

STEM suggests that good conductors such as the metals and carbon have ionic orbitals above and below their atomic nucleus, with one orbital (e.g. the upper as shown in figure 5a) possibly supporting electrons and the other supporting positrons, so keeping electrons and positrons well separated at the atomic scale. STEM has also developed a structure for the atomic nucleus that can support ionic orbitals but, even without such a nuclear structure, ionic orbitals are just as feasible as the hypothetical 'spdf' or shell orbitals.

The possibilities unlocked by a simple change in orbital pattern are amazing. So let's now explore some of the implications of the suggested orbital change and the evidence supporting such a change.

One implication is that **positive 'holes'** are no longer required to explain electric current, particularly in the context of semiconductor current. Positive holes are simply static (i.e. atoms locked into a lattice structure) neutral atoms that can readily lose an electron to become a **temporal cation**, and be returned to the neutral state by gaining a passing free electron. Although positive holes are immobile, the suggestion that they can move as mobile positive charge carriers, as widely promoted by educational institutes and resources (as well as within the wider Physics community) is dubious and quite misleading. So, rather than using a positive hole as a virtual (or imaginary) positive charge carrier, the positron provides a physical (or real) positive charge carrier that is perfect for charge transfer balance in the opposite direction to negative charge carrier (the electron) movement.

Figure 6 is an idealised representation of how electrons and positrons, under the influence of an applied or induced emf, readily move (or stream) in opposite directions to each other by skipping between orbitals (not necessarily adjacent). The applied emf simply pushes many of the ionic electrons and positrons from their orbitals so that they stream and eventually end up being accommodated by another ionic orbital. Should the emf direction suddenly change, as for AC electricity, they start skipping back in the opposite direction, exiting from the opposite side of their ionic orbitals (i.e. at a point 180^{O} distant).

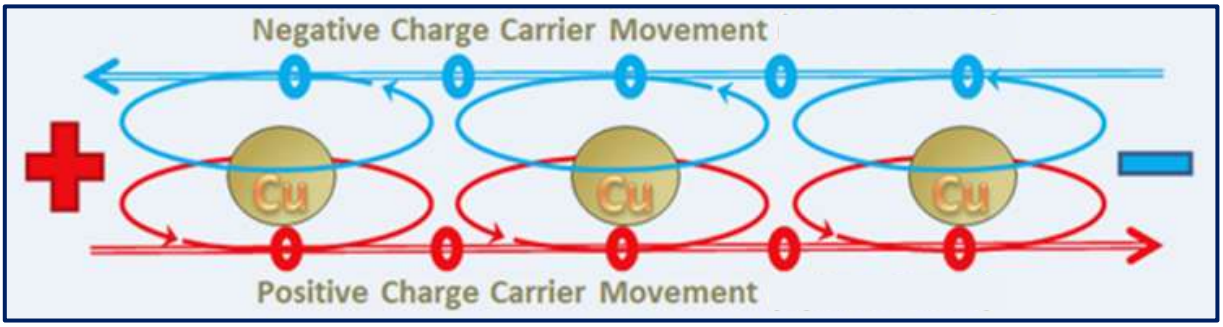

Figure 6: Positive and Negative Charge Carrier Movement as an Electric Current

Note that when electrons and positrons stream in opposite directions, the toroidal component of their field energy is in the same direction, and their poloidal flow components cancel each other out, which produces a **circular magnetic field** around a current-carrying wire conductor. Whenever the applied emf is removed, the streaming electrons and positrons quickly assume an ionic orbital around a nearby atom, causing the circular magnetic field around the wire conductor to disappear.

Also, the streaming of electrons and positrons under the influence of an applied emf causes the central flow of their field energy to merge and concentrate as represented for positrons in figure 7 (the same effect occurs for streaming electron, but in the opposite direction).

Should a wire carrying an electric current be cut, but the emf being applied be maintained, then the streaming movement of electrons and positrons ceases but many of the electrons and positrons remain held in their stream rather than relocating to an ionic orbital. The result is that an electric field analogous to that of a monopole electric charge is generated at the cut wire ends: a positive electric field on the positive end from the aligned positrons and a negative electric field on the negative end from the electrons. Should flat metal plates be attached to the ends, and the plates brought close together parallel to each other, then we have a capacitor-charging setup.

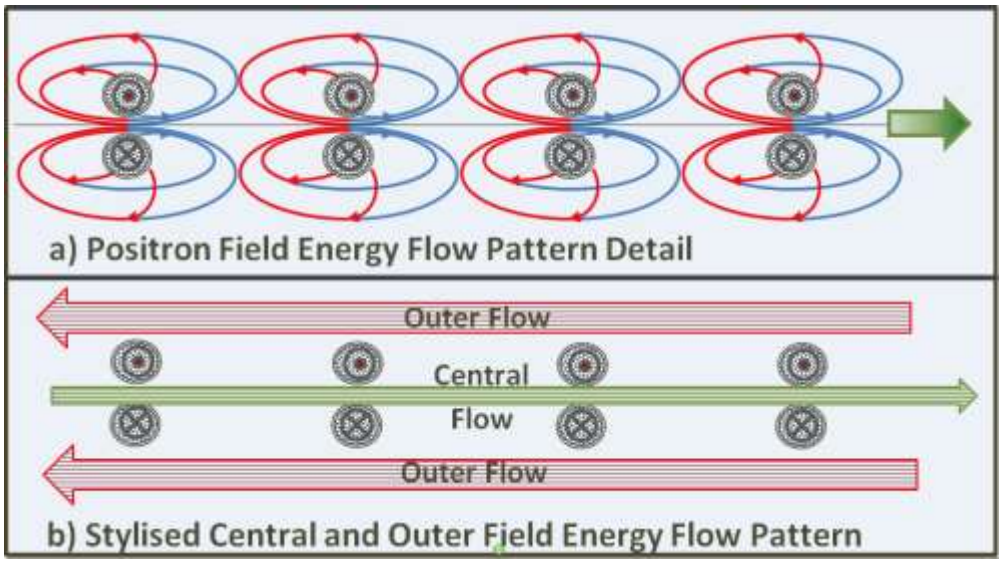

Figure 7: Field Energy Flow Patterns of Streaming Electrons and Positrons

An important aspect of the STEM approach is that the central and outer flows of field energy travel at very high speed (close to the speed of light), and is responsible for the almost instantaneous activation of an electric circuit once the power source is turned on. On the other hand, the average speed and distance travelled by the streaming electrons and positrons is significantly less.

And, should you be a smidge sceptical about the concept that electric current relies upon both electrons and positrons (and *what avid believer of the Bohr and/or QM nuclear atomic models wouldn't be*?), then peruse some of the cool videos on fractal wood burning such as this linked video. Fractal (or Lichtenberg) wood burning involves the burning of Lichtenberg figures into a piece of wood using high voltage (in the order of 2,000 volts) **DC electricity**. The outer surface of the piece of dry wood is first lightly dowsed with a weak electrolytic solution (typically a dilute sodium bicarbonate solution) and then a positive and negative electrode is attached well-spaced from each other and the DC current applied to start the burning process.

As can be seen in all the videos, the different Lichtenberg figures **develop simultaneously** from both the positive and negative electrodes as the electric current follows leader lines within the wood that represent the pathways of least resistance. However, due to the high resistance of the wood, it heats up and burns to form carbon, which is a good conductor, and which allows the burning to move outwards from the electrodes. Multiple burn paths quickly develop and **expand from both electrodes** to produce quite stunning and unique Lichtenberg figures such as those in the referenced video and in figure 8.

Figure 8: Typical Lichtenberg Figures from Fractal Wood Burning

The big question with these wood burning demonstrations is *why do Lichtenberg figures develop simultaneously from each electrode if the burning is caused by electrons moving from the negative electrode*

to the positive electrode? Surely, if the electric current consists of the one-way movement of electrons then a single Lichtenberg figure should grow only from negative electrode. The fact that the Lichtenberg figures emanate from both electrodes simultaneously can only be explained by charge carriers moving outwards from each electrode: electrons being pushed from the negative towards the positive electrode, and positrons moving in the opposite direction from the positive towards the negative electrode.

Challenge. If you can provide a different explanation in terms of the one-way movements of electrons alone, then please contact the author directly and put your case: he will be all ears.

Another implication of the STEM approach is that there are far less low-level orbital electrons than suggested by current nuclear atomic models. For example, these models claim that a **gold atom**, which is a stable inert atom, has an unbelievable **79 orbital electrons**, all whizzing around the nucleus in particle or wave-form (nobody is sure which applies) without any mutual interference or collisions taking place. For such a neutral atom, all the lower level electrons are required to balance the positive charge associated with the number of nucleon protons. However, for the STEM approach, most protons become neutralised within the structure of the nucleus, significantly reducing the electron charge-balancing requirement, with only the equivalent of the outer (or conduction band) electron orbitals being necessary.

Support for the claim that there may be significantly less orbital electrons than suggested by modern nuclear models can be found in the area of nanoparticle research. Low temperature (close to absolute zero), low energy nanoparticle-related research uses powerful state-of-art devices such as high-resolution electron tunnelling microscopes, which are capable of mapping the outer surface crystalline silicon/hydrogen surface topology atom-by-atom, and atomic tweezer related technologies, to manipulate individual atoms and electrons. Motivated by the prospects of developing quantum computers, **qubit research** and development is providing new insight into the sub-atomic world.

University of New South Wales (UNSW) researchers have developed techniques to place individual phosphorus atoms within an ultra-pure silicon substrate to represent a qubit as a single **phosphorus anion** (references [16] and [17]). They use nuclear magnetic resonance (**NMR**) techniques to selectively change and detect the nuclear spin of the atom to represent a binary 0 or 1, with the orbital electrons being manipulated to entangle a pair of qubits.

According to the **'**spdf' model, a phosphorus atom has 15 orbital electrons: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ with the outer 3 electrons having a common spin direction; or according to the Bohr model, it has [2, 8, 5] electrons in the [K, L, M] shells. The single phosphorus atoms used are phosphorus anions (P^-) but, rather than pairing with one of the $3p^3$ electrons or joining the other five M-orbital electrons, the extra ionic electron apparently ignores the other orbital electrons to take up its own conduction band orbital that can be readily manipulated and controlled via microwave bursts of the appropriate frequency.

At close to absolute zero, electron orbitals (including the lower level ones) could be expected to be de-energised and easily manipulated, and any lower level orbital electrons could be expected to make their presence felt by interfering significantly with any added ionic electron. However, the UNSW team does not report any such interference: lower level orbital electrons never seem to make their presence felt as they delicately manipulate the orbit of added ionic electron around a phosphorus nucleus. This strongly suggests that the lower-level orbital electrons exist in reduced numbers or are even be non-existent as per the suggested STEM approach.

Another implication of the STEM approach is that it opens up more possibilities for Redox reactions. **Oxidation** is considered to occur to an element or complex participating in a chemical reaction loses one or more electrons; and **reduction** occurs when electrons are gained. STEM extends the scope of Redox reactions by claiming that oxidation can also come about by the gaining one or more positrons and reduction by the loss of positron(s).

Discussion

Three different alternative explanations for the creation of positrons have been addressed. Although the Breit–Wheeler electron-positron pair production approach (alternative 1) is the stock answer that most Physicists would put forward, it is highly speculative. And, assuming that it is the only means that electrons and positrons are created, electron-positron pair production should lead there being equal numbers of electrons and positrons in Nature; but there is not, with positrons being quite rare. Also there is a lot of confusion as to whether pair production is due to the magical splitting of a single large photon in the gamma energy range; the collision of a photon with an atomic nucleus; or the collision of a pair of smaller photons.

The other two alternative explanations are predicated upon a toroidal structure for electron-like particles, with the chirality of their field energy (i.e. electromagnetic field) determining whether they present with a negative charge (electrons) or a positive charge (positrons). These two alternatives are not mutually exclusive, and both processes described could be at play: new positrons may be generated from high-energy electron-to-electron or electron-to-nucleus collisions; and many positrons may pre-exist within matter, and simply require the impact with high-energy photons or electrons to release them.

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Appendix: Understanding Left and Right-Handed Chirality

Possibly to help counter the expected adverse reaction to the concept that positrons might pre-exist with electrons within matter, STEM refers to a 'normal' electron as a **cetron electron**, or simply a **cetron**; and a positron-like electron as an **aptron electron**, or simply an **aptron**. Because it considers both electrons and positrons to be 'electrons', but whose field energy has a different chiral form, an electric current is still defined by the movement of electrons, but with the two chirally different electron types moving in opposite directions simultaneously, thus providing electric charge balance across an electric circuit.

Your left and right hands are chirally different in terms of the direction in which your thumb points and the corresponding direction in which your fingers wrap. It is also the same type of chiral difference that applies to left and right hand screw threads.

Both electrons and positrons move with their outflow vortex foremost, with their field energy flowing through the central hole of the toroidal energy core. Using the left hand for cetron electrons with your thumb pointing in the direction of movement, your finger-wrap direction indicates the toroidal flow direction of both the field energy and energy core. The same applies using your right hand for positrons.

This technique also works in reverse: by pointing your thumb (left hand for electrons; right for positrons) in the direction of the toroidal flow anywhere around the energy core circumference, as shown right in figure 9, your finger wrap-direction indicates the poloidal flow direction of the field energy around and through the centre of the toroidal energy core. Chirality is unique and consistent regardless of orientation.

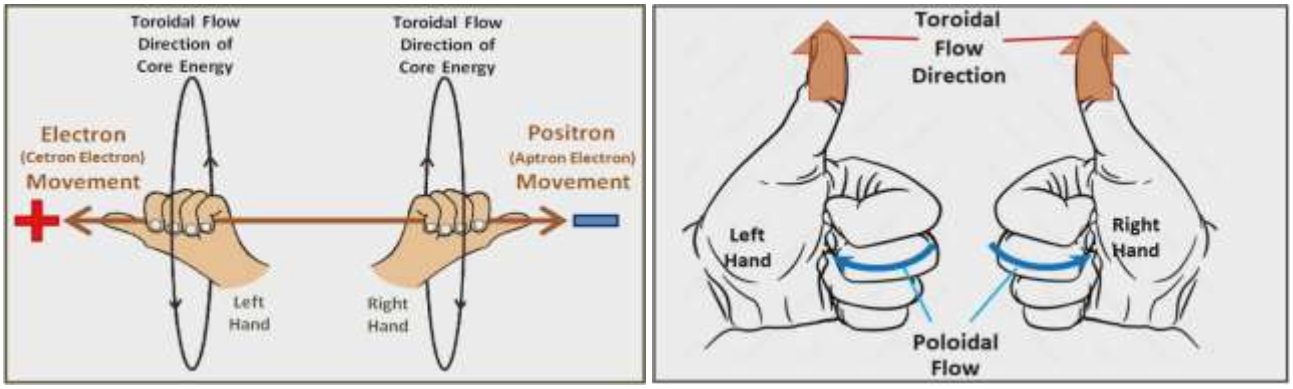

Figure 9: Left and Right Chirality of Electrons and Positrons

The toroidal (**T**) and poloidal (**P**) outer flow components of the field energy of cetron and aptron electrons moving under the influence of an applied emf is shown in figure 10. Note how the poloidal components of the two types of electron cancel each other out, whereas the toroidal components are additive to create the circular magnetic field.

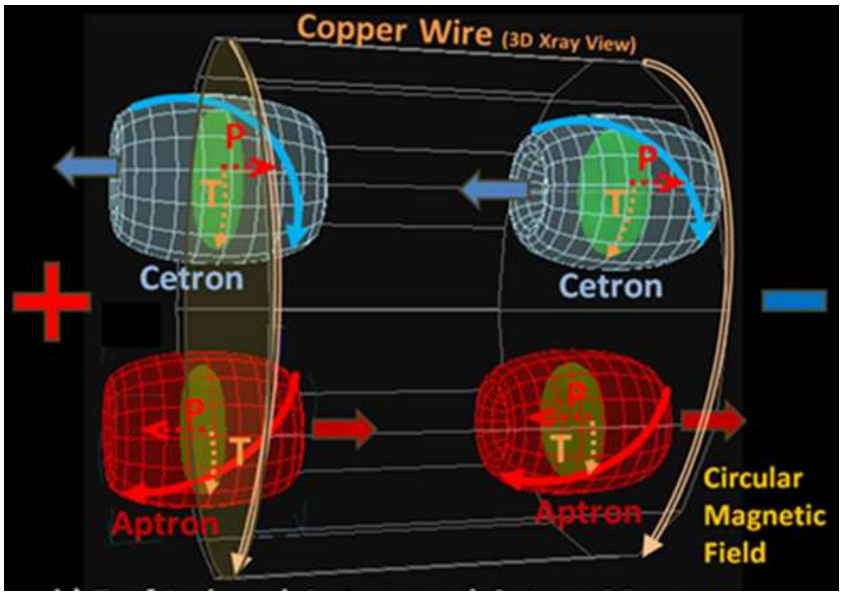

Figure 10: Interaction of Chiral Energy Fields of STEM Electrons Moving as an Electric Current