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Strong-Force Quark Bond Patterns within Nucleons

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According to the Standard Model, nucleons consist of three up/down quarks confined by strong-force interactions as mediated by gluons. The net effect of these interactions is a nucleon model that has an equilateral-triangular form with a strong-force bond between each quark pair.

However, this model assumes that strong-force interactions are equally likely between two same-charge quarks (which would otherwise be expected to repel each other) as they are between opposite-charge quarks.

Should strong-force interactions only take place between opposite-charge quarks, then the nucleon model changes from an equilateral-triangular to a quark-chain model that involves only two strong-force bonds, each connecting the central quark to an oppositely charged quark.

The quark-chain nucleon model leads to some interesting possibilities related to the structure of atomic nuclei, to electron orbitals and related covalent bonding patterns, and to the cause of radioactive decay in unstable elements.

Quarks and the Atomic Nucleus

According to the **Standard Model** (**SM**), nucleons consist of three up/down quarks confined by strong-force interactions between each other as mediated by gluons. Putting aside the colour charge dynamics required to prevent an infringement of the Pauli Exclusion Principle, the net effect of such interactions is the equivalent of three equal strong-force bonds between each of the quarks as shown in figure 1a, with the three quarks being held in an equilateral-triangular pattern.

This nucleon model assumes that strong-force interactions exist equally between **like-charge quarks**, which would otherwise be expected to repel and thus avoid each other, and **unlike-charge quarks**, which would attract each other. Although electrical attraction is not the basis for strong-force interactions, it would seem likely that mutual attraction would reduce opposite-charge quark separation and facilitate strong-force interaction between them; and that the reverse effect would apply to like-charge quarks. This notion leads to the hypothesis that '***strong-force interactions do not form between like-charge quarks'***, which in turn infers that internal structure of baryons would be more chain-like than triangular, and thus be more flexible. This paper looks at some of the implications of this simple hypothesis.

In the case of nucleons, the removal of strong-force bonds between like-charge quarks (the '*unlikely strong-force bonds*' of figure 1a), a nucleon would consist of a **central** down or up quark bonded to a pair of up or down quarks to produce a proton or a neutron respectively. A two-bond nucleon would have a geometry that could vary from a **linear** pattern and a **right-angled isosceles triangle** as shown in figure 1b and, due to like-charge repulsion, the end-member quarks would be well separated so that nucleon structure would never adopt an equilateral-triangular pattern.

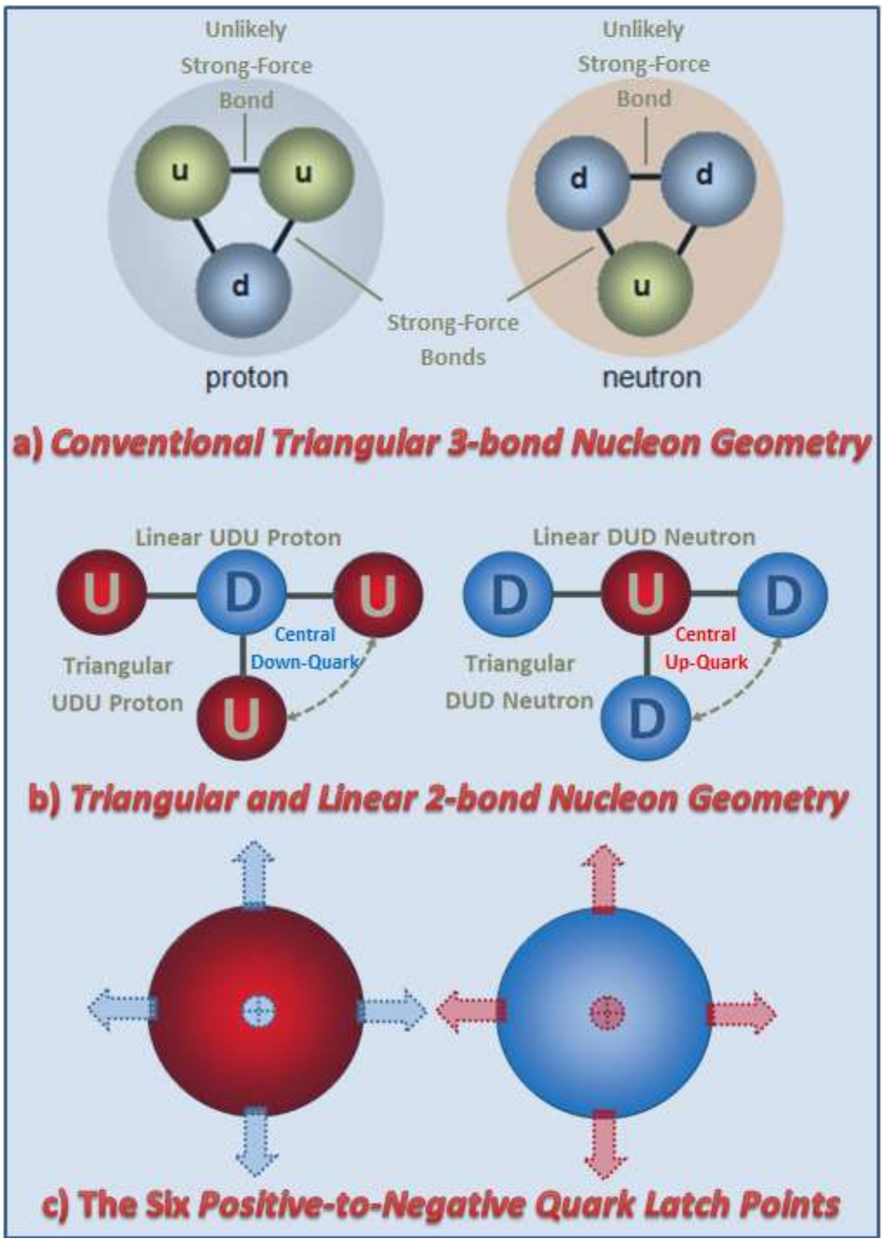


Figure 1: Quarks and Nucleon Structure

Should the initial hypothesis be refined by proposing that positive (up) and negative (down) quarks are only be able to form strong-force bonds with each other at six orthogonal **latch points** such as those shown in figure 1c (a discussion as to why this may be the case will be provided later in this paper), nucleons would have either a **linear** or a **right-angled triangular** geometry rather than connect at any angle in between. It would also mean that, purely on the basis of geometry, there would be an 80% probability that a nucleon would be triangular, and a corresponding 20% probability of it being linear.

Should linear and/or triangular nucleons join to create nucleon chains, many patterns are possible, with some of the common resultant join patterns shown in figure 2. Note that each quark has two strong-force bonds to opposite-charge quarks, except for end-members that only have one.

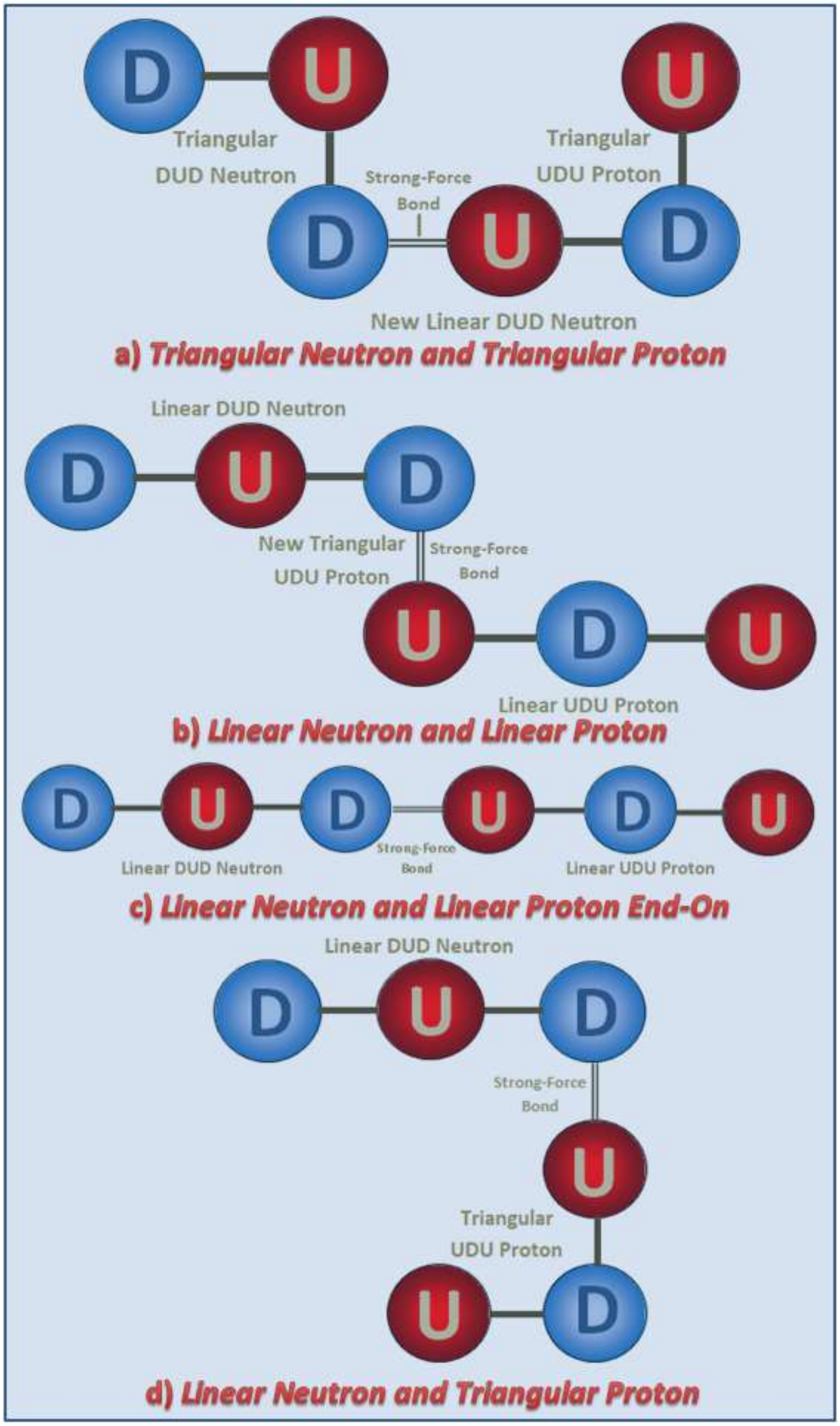


Figure 2: Nucleon Strong-Force Bond Patterns

Nuclear astrophysical understanding of the creation of the elements [1] is incomplete and far from being exact. Although the inter-mixing and re-cycling of material between different processes complicates matters, the origins of elements with atomic numbers less than or equal to three (i.e. lithium and below) can be attributed to fusion processes associated with the **Big Bang**, with elements above atomic number three considered to have been variously generated by star-related processes (i.e. the merging of **neutron stars,** exploding **massive stars**, dying **low mass stars**, and exploding **white dwarfs**).

Whatever environment created and/or recycled elements might be, it would most certainly have been a violent, chaotic, energised fusion environment. In such hostile environments, linear chains three or more quarks long (such as those in figure 2), which have no swivel-related flexibility, are more susceptible and would regularly be broken down and re-cycled. The arms of triangular nucleons present less of an impact target and they would tend to roll or tumble with the blows rather than break up, and be thus more robust: such robustness would increase the percentage of available triangular nucleons from the 80% mark (due to geometry) to well over the 90% mark. On this basis, albeit quite speculative, it would be likely that the bulk of the nucleus building blocks would be triangular nucleons and that these would have a propensity to join in patterns similar to that of figure 2a, with any linear segments so generated being the chain's structural weak points.

Should triangular nucleons join, the first significant structures to evolve would be simple **nucleon chains** such as shown in figure 3a, to which other nucleons and minor quark groups could strong-force bond. These nucleon chains would be continually and violently buffeted within their hostile environment but, for those with sufficient flexibility and good luck to remain intact for a reasonable length of time, their opposite ends may meet and become strong-force joined together to create a **polygonal structure** (e.g. figure 3a chain → figure 3b polygonal form) that is relatively robust and could provide the basic framework for an evolving atomic nucleus.

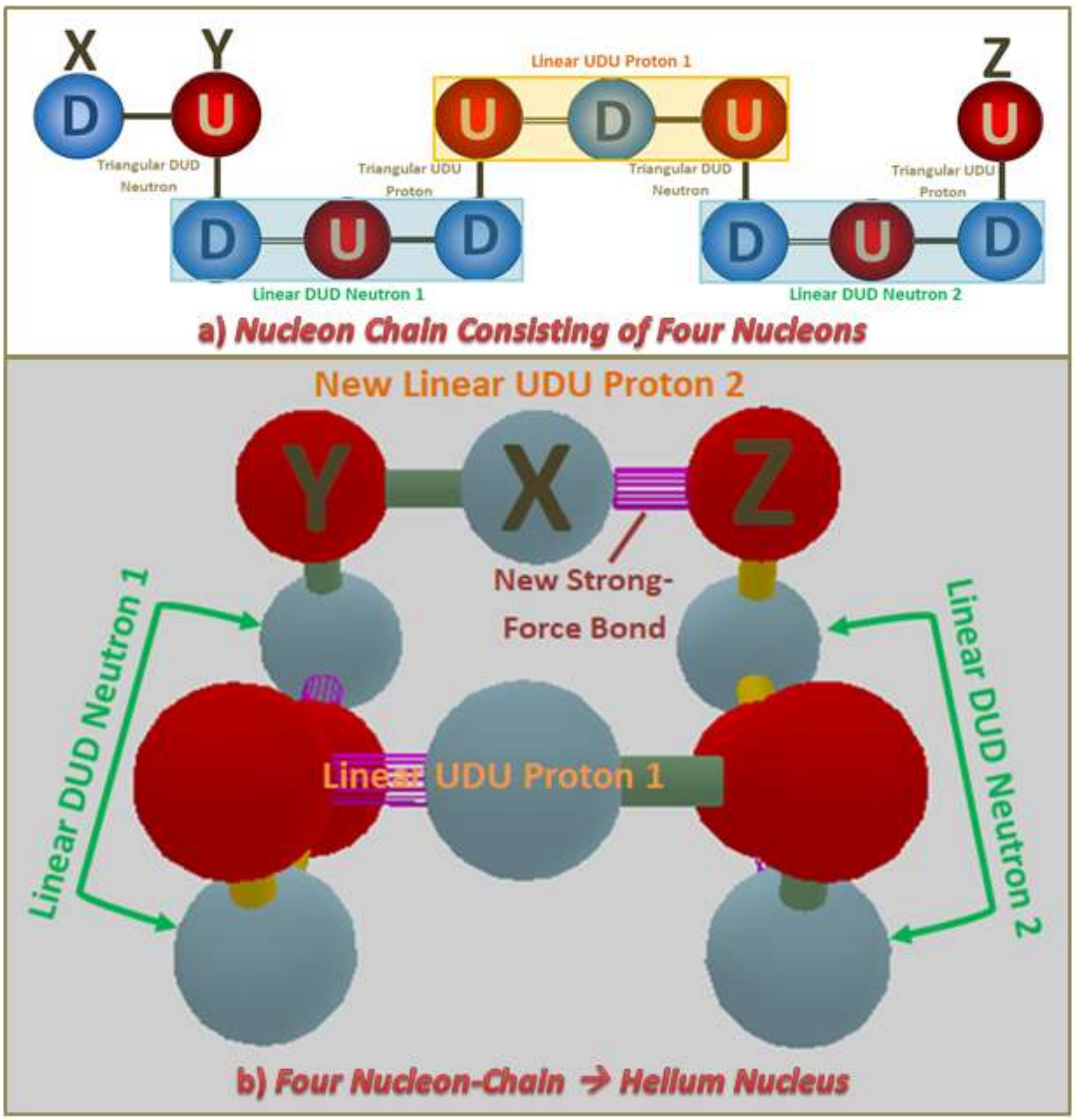


Figure 3: Helium Nucleus Creation from Four-Nucleon Chain

In broad terms, the nucleus-creation process being described here is that triangular nucleons join to create nucleon chains, the ends of which may eventually bond together to create a nucleus that has a lattice-like polygonal structure. It is a feasible process that fits quite well with a quark-based nucleon model and the fusion-based element formation environments.

The **nucleon-chain** building process, and ultimately the entire atomic nuclei building process, may simply be an extension of a simpler **quark-chain** building process that does not actually require or need the prior building of nucleons. The simplest quark-chain is a meson-like bonded positive and negative quark pair, which would be very short-lived before acquiring another quark to become a nucleon. The newly formed nucleon can then grow with the addition of more individual quarks that bond to the available appropriate latch point, and/or by the addition of other quark-chains. On this basis, nucleons would simply represent the shortest quark chain that is relatively stable.

The closed-off nucleon-chain of figure 3b represents a **helium nucleus**: it has a paired ∩-U structure that is strong and very robust, with each quark being held in place by two strong-force bonds. Its nucleon structure can be interpreted as consisting either of strong-force bonded linear nucleons, or of similarly bonded triangular nucleons. Without electrons, the helium nucleus represents a positive charged cation that commonly presents as **alpha radiation**.

Conventionally, the helium nucleus is represented as two spherical protons (that, due to their positive charge, should mutually repel each other so as to cause the nucleus to explode, but do not due to strong-force interactions), plus two neutrons that apparently do nothing apart from providing a degree of separation for the protons. As for all other nuclei, the helium nucleus is portrayed as being spherical in shape, consisting of an amorphous aggregation of spherical nucleons that presents without any discernible structure. Should the '***strong-force interactions do not form between like-charge quarks***' hypothesis prove to be true, then it provides for a distinct lattice-like structure for the helium nucleus and all elements with a higher atomic number.

A hydrogen atom is simply a single proton but, with the nucleon-chain approach, it is far more likely have a triangular rather than linear form, or a spherical form (its conventional representation). The framework of the nucleus for all other elements would be lattice-like, consisting of one or more polygonal forms (cubic, hexagonal, octagonal etc.) to which additional extra nucleons can randomly attach so as to convert it into a different element or isotropic form.

The lattice-like polygonal geometries for nuclei suggested by the nucleon-chain approach would most likely influence the physical characteristics of atoms such as their strength and bonding patterns with other elements and compounds. It also opens up a range of other possibilities related to electron orbitals and energy transfer and distribution within matter.

Some Unanswered Questions

Currently, the gluon mediation theory of Quantum ChromoDynamics (**QCD**) provides the most strongly supported explanation for strong-force interactions within and between hadrons. The QCD explanation is heavily reliant upon the gluon, a mathematically defined massless vector boson that is considered to be the elementary particle that mediates strong interactions between quarks.

To date there would seem to be no research to confirm or refute the basic and quite simple hypothesis that '***strong-force interactions do not form between like-charge quarks***', or the concept that orthogonal latch-point locations are associated with up and down quarks. There are many questions, such as *why might up/down quarks have the six proposed orthogonal latch-points,* that remain unanswered related to this approach; and certainly QCD, or theoretical models derived from QCD, do not address such questions at this point in time. However, the fledging and still evolving atomic theory called the **Spin Torus Energy Model** (**STEM**) [2] does provide feasible answers to many such questions; and it will thus be over-viewed next.

STEM is an **energy-centric approach**, which is underpinned by the hypothesis that '***there is only one type of energy-generating material***'; and that material STEM refers to as **energen**. The whole STEM approach is built around the claimed behavioural patterns and characteristics of concentrated energen.

Within the Science community, opinion varies as to whether up/down quarks are fundamental particles[1]; or whether even smaller fundamental particles called preons combine to create up/down quarks. STEM adopts the latter view: that up/down

[1] **Fundamental** (or **elementary**) **particles** are defined as *a subatomic particle that is not composed of any other particles*. With the STEM approach, a fundamental particle is composed of a quantised concentration of energen.

quarks are built from preons, and are thus not fundamental particles. In order to distinguish a STEM preon from other definitions and uses of the term 'preon' [3], STEM refers to them as **Concentrated Energy Sources** (**CES**), with all matter being considered to be directly or indirectly derived from energen-based CES.

Both CES and the electron are considered to be fundamental particles that have the same structure consisting of a central toroidal **energy-core** of concentrated energen which flows or spins at close to the speed of light. The energy-core carries with it an **outer torus** of **less concentrated energen** which presents as its **energy-field**, and is responsible for the electromagnetic characteristics of CES and electrons. As shown at close to true relative scale in figure 4, the estimated outer diameter of a CES's energy-core is 5.6 pm (1 pm = 10^{-12} m), whereas that of an electron has been estimated to be 1.2 pm [4].

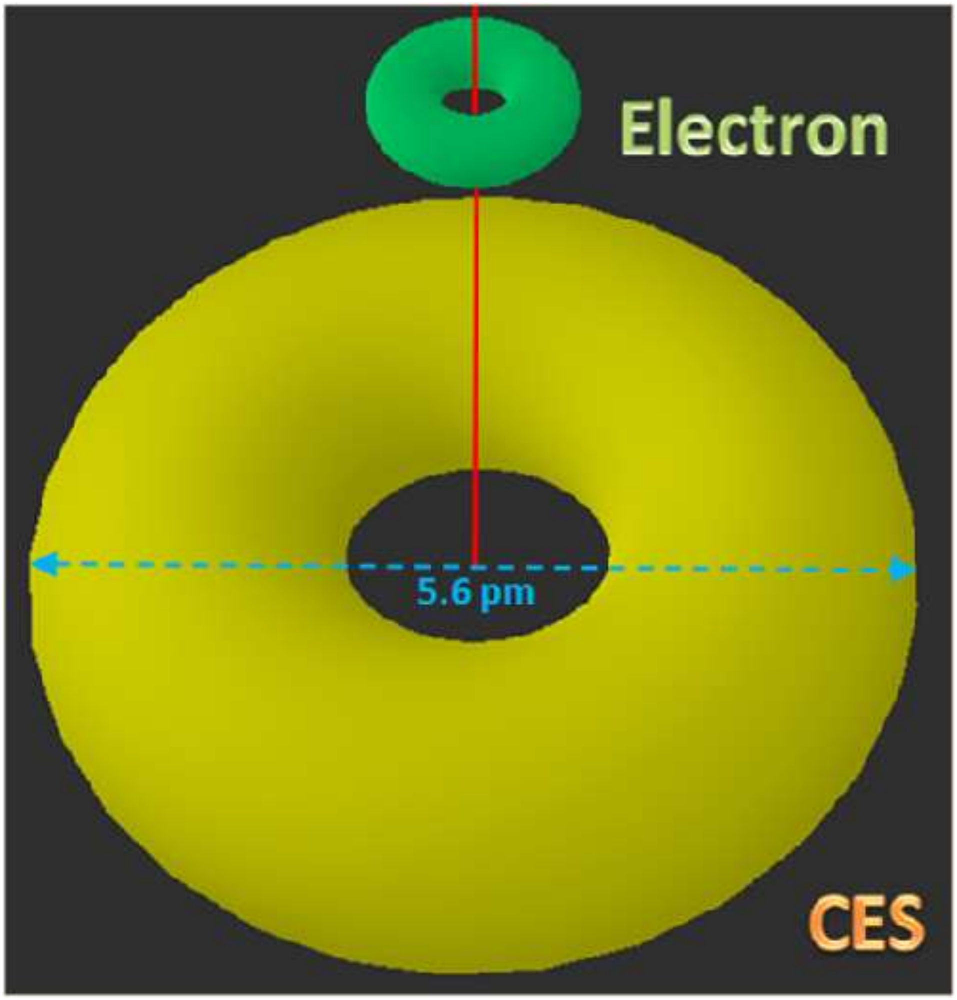


Figure 4: Energy-Core of A CES and an Electron (True to Scale)

The concentrated energen of the toroidal **energy-core** of these fundamental particles may be semi-solid and spin; or may be more fluid-like and have linear flow: either way, the effective spin or flow rate of the energy-core energen is considered to be close to the speed of light. On the other hand, the outer torus-shaped **energy-field** around the energy-core is considered to have both **toroidal** (large circle) and **poloidal** (small circle) flow components, and is thus **chiral**. The term chiral means that, just as a carpentry screw can have either a left-handed or right-handed thread, field energy has either a **left-handed** or a **right-handed** twist, with the toroidal and poloidal component flow rates each being considered close to the speed of light.

An electron-sized fundamental particle whose energy-field has left-handed chirality (or helicity) is simply called an **electron**, whereas one with right-handed chirality is called a **positron**, the **anti-particle** of the electron. In keeping with the chirality of an **e-**lectron and a **p-**ositron, a CES with left-handed chirality is an **e-CES**, as represented by a **blue** coloured field-energy torus in figure 5a; and a CES with right-handed chirality is a **p-CES**, as represented by a **red** coloured field-energy torus in figure 5b. And importantly, the energy-field energen flows through the central hole of the energy-core torus as indicated by the 'in' (or I for inflow) and 'out' (or O for outflow) notation of figure 5, so creating an in- and outflow **vortex** on each side.

With chirality already being a major factor in many Sciences (e.g. particle physics, astrophysics, photonics, chemistry and biology), a chiral-based model for the energy-fields of CES, electrons and positrons seems reasonable and appropriate, with the added bonus that the toroidal form of their energy-cores are compatible with the Wave equations

Fundamental particles such as CES and electrons are considered to interact with matter via their electromagnetic field-energy, which results in **force** (friction, attraction, repulsion, deflection etc.) being applied to each participant that results in the expenditure of what we refer to as **work**. There is nothing surprising or new here.

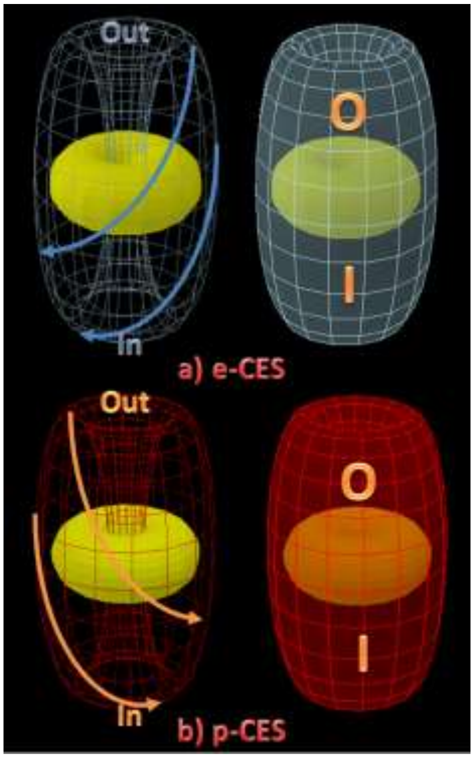


Figure 5: CES Energy-Field Flow Patterns

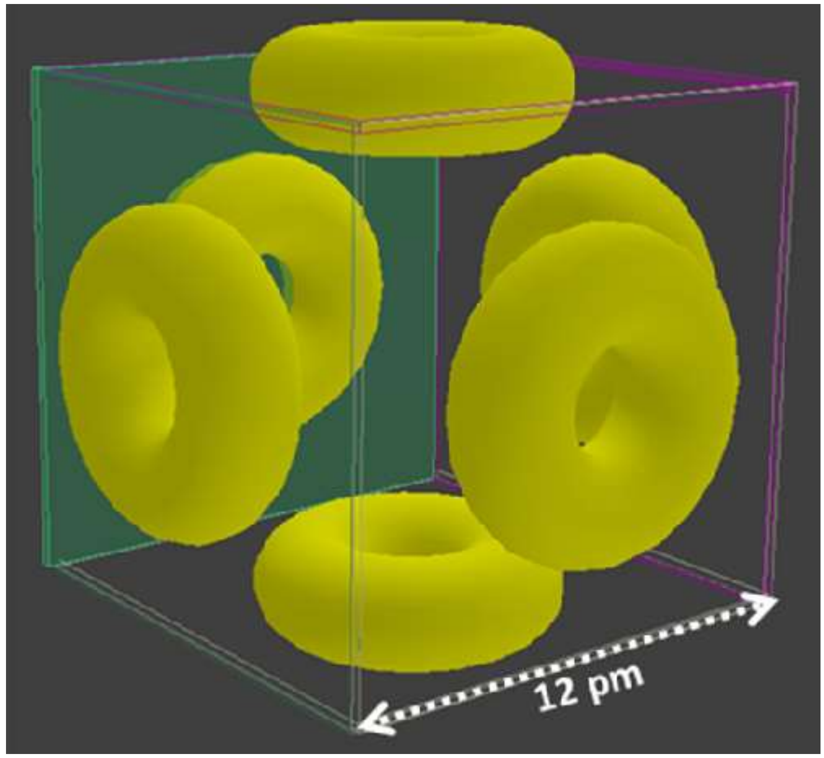


Figure 6: STEM CES-based Quark Structure

The up/down **quark structure** proposed by STEM consists of a three-dimensional octahedron array of six CES (or preons), as shown in figures 6 and 7. The geometry of an up/down quark is that of a **face-centred cube**, with the edge length of the unit cube (defined by the intersection of the equatorial planes of each CES) being 12 pm[2]. Having six outward facing CES, the STEM quark model provides for six potential orthogonal latch points for the formation of strong-force inter-quark bonds.

A STEM **down quark** consists of two p-CES and four e-CES as shown in figure 7a, and an **up quark** consists of five p-CES and one e-CES as shown in figure 7b. By allocating a nominal net charge of +1/6 e to a p-CES and -1/6 e to an e-CES, a down quark would carry an effective electric charge of -1/3 e (calculated as 2 * +1/6 + 4 * -1/6), and an up quark an effective electric charge of +2/3 e (calculated as 5 * +1/6 + 1 * -1/6).

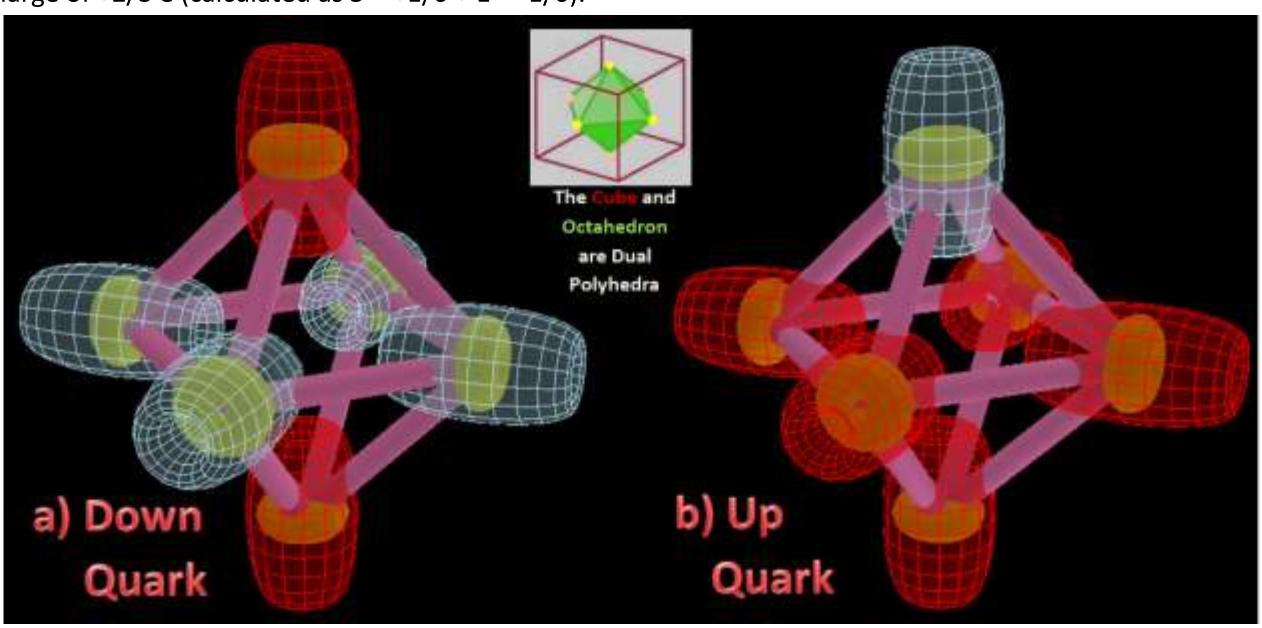


Figure 7: Up and Down Quark CES-based Models

[2] Note that a 12pm quark size leads to a larger nucleon size than current electron-deflection estimates suggest, but the larger nucleon size still produces molecular bond lengths consistent with those measured experimentally (e.g. the H_2O molecule example of figure 11).

Although the STEM quark model is possibly overly-detailed and speculative, it provides a relatively simple gluon-free explanation for strong-force bonds. A strong-force bond is considered to form when the outflow vortex (**O**) of the field-energy of one CES is forcedly brought close to (in the 1 to 3 pm range) the inflow vortex (**I**) of another **same-type CES**. The strong-force nature of the bond is claimed to result from the balanced two-way exchange and sharing of field-energy between the bonded CES pair as represented in figure 8.

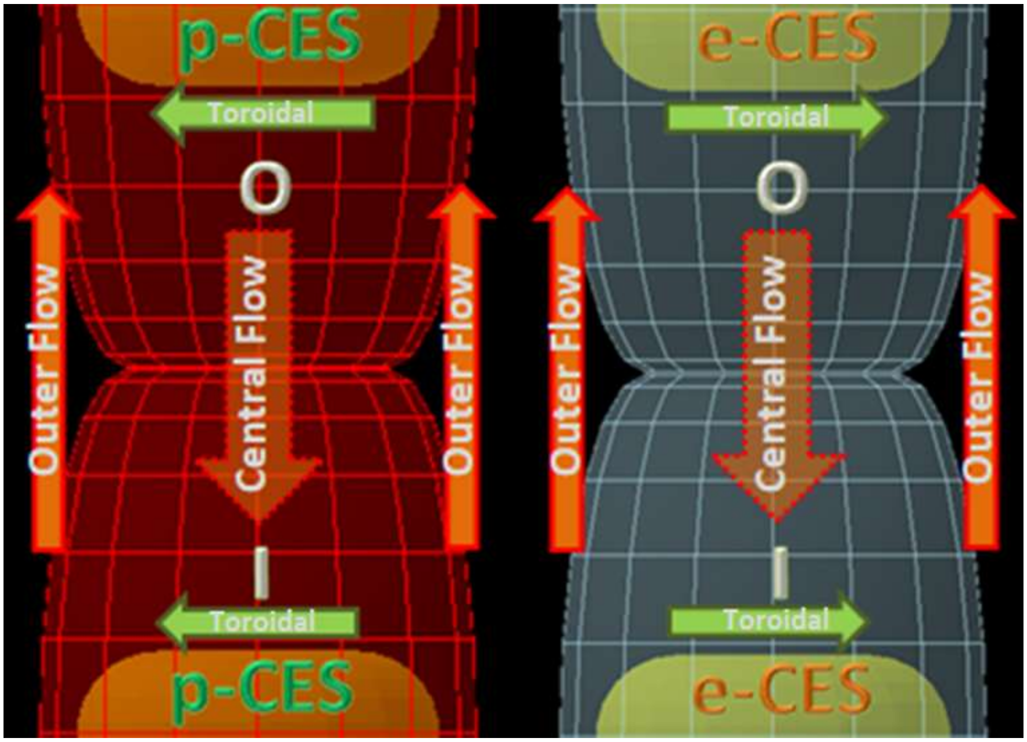


Figure 8: Strong-Force Bond Formation

STEM acknowledges triangular and linear nucleons, referring to them as **L-form** and **I-form** nucleons respectively. It also identifies two subtly different types of nucleons (type 1 and type 2) that differ only by the opposite direction (**IO** versus **OI**) of energen flow across their inter-connecting strong-force bonds, as evident in figure 9 (which corresponds to nucleon chains diagram of figure 3a). Figure 9 also highlights how L-form nucleon building blocks can produce an I-form **nucleon layer** affect within a nucleon-chain, and figure 10 shows the corresponding atomic nucleus should the nucleon chain close.

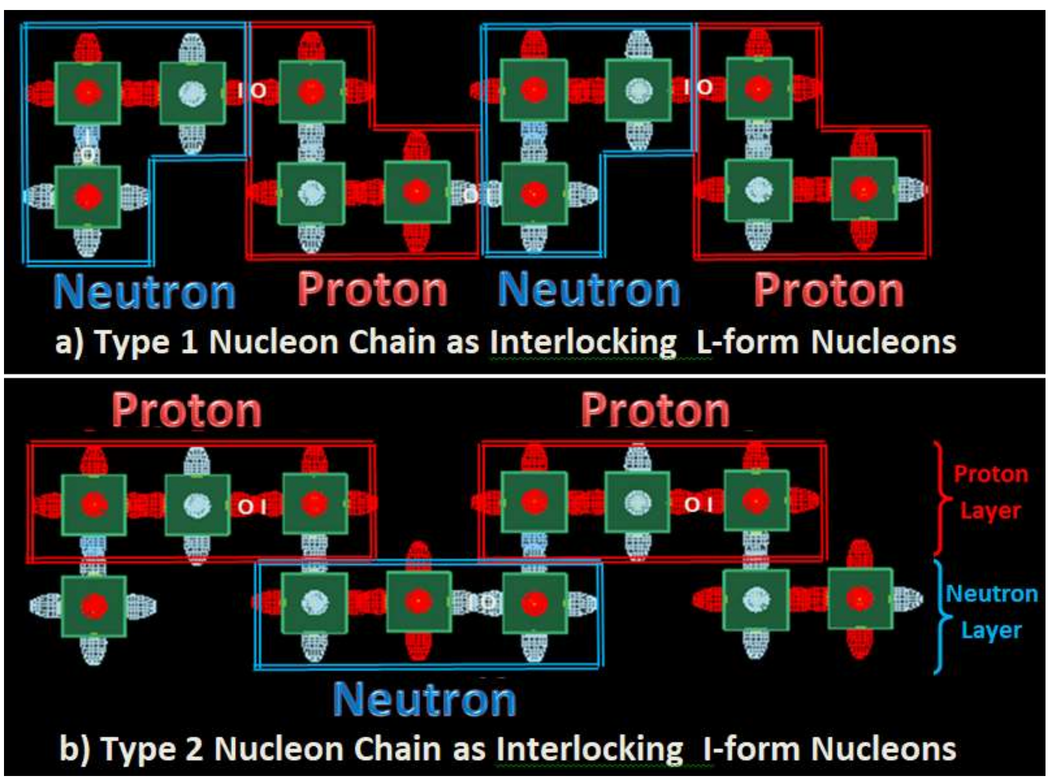


Figure 9: Type 1 and 2 Quark Chains

Figure 10 is a detailed STEM quark-model for the helium nucleus that corresponds to the model of figure 3b and 9.

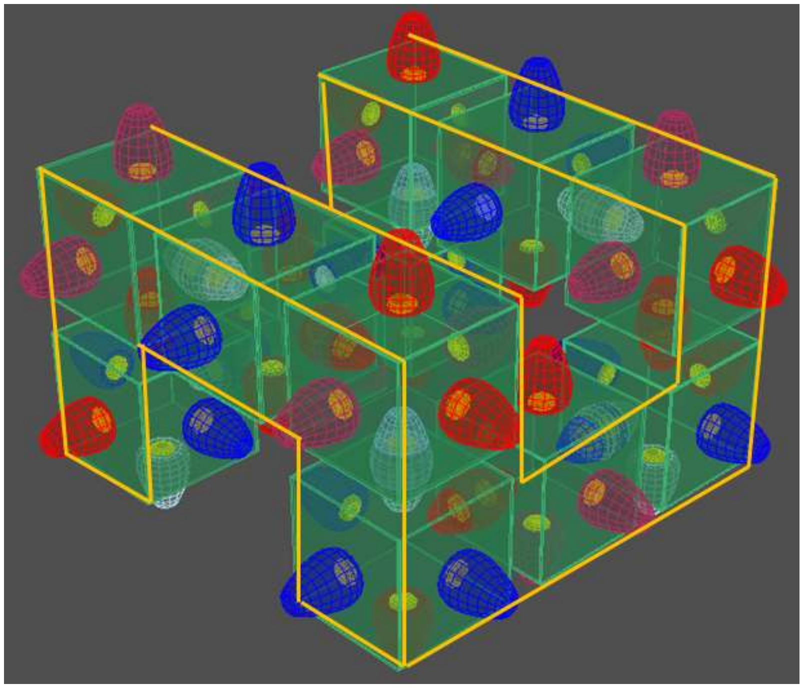


Figure 10: Quark-Model of a Helium Nucleus

Figure 11 is a detailed STEM quark-model for a **water molecule** (**H_2O**). This close-to-scale model is based upon the quark unit cube 12 pm long per side and, although the model looks much like a Moon-landing craft, the H-O-H bond angle (called 'bend') is set to 104.5^{O} and the O-H bonds correspond to the known bond length of 95.8 pm as measured experimentally to high precision. This model also provides an explanation for how, due to inter-molecular buffeting within steam, the hydrogen atoms, attached to swivel quarks (see page 12) within the oxygen atom, vibrate significantly back and forward to produce a bend angle average of 104.5^{O}, and why the length of the O-H bond can appear to vary (or 'stretch') when in fact it does not. The conventional Science approach provides no explanation for these two well documented phenomena.

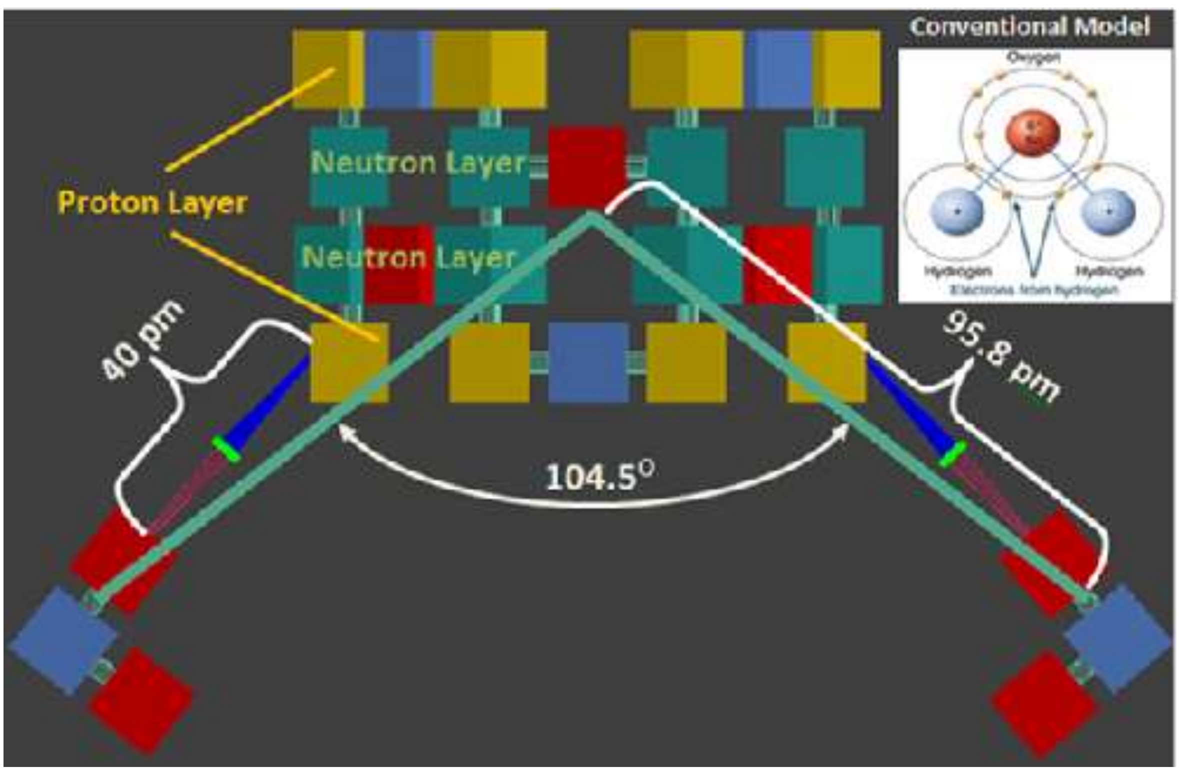


Figure 11: Quark-Model of a Water Molecule (True to Scale)

Another claimed advantage of the STEM nucleon-model is that it provides a feasible and relatively simple explanation for the **nucleon-type conversion** (i.e. of neutron ↔ proton conversion) process, which leads to an explanation of **electron capture** and **beta decay**, and their associated by-products (beta radiation and neutrinos).

The Angular Momentum of Electrons

In keeping with textbook portrayal of quarks and nucleons as spheres, electrons are usually considered to be spherical. In order to avoid the unwanted generation of singularities and to satisfy the **Wave equations**, the spherical electron is reduced to a dimensionless dot, referred to as a **point-form definition**. A consequence of this mathematical expediency is that all the electron's energy and mass is concentrated at a dimensionless dot, which has no radial width, and thus the point-form defined electron cannot have conventional angular momentum. Because of this anomaly, the electron's observable angular momentum (or spin) is considered to be **intrinsic** (i.e. an inherent property that defies explanation) or abnormal.

The STEM toroidal electron, on the other hand, has nothing at its geometric **centre-of-mass** (apart from a negligible amount of energen), and so can validly be treated as a dimensionless hypothetical dot without its concentration of energen having to be physically located at that dot. However, due to its energen-based energy-core and energy-field, the toroidal electron certainly has a physical width and, due to its contained energen, it has a mass equivalence; thus its angular momentum is **real** and doesn't need to be considered intrinsic or abnormal. A claimed added bonus is that the toroidal electron so defined satisfies the Wave equations.

As well as suggesting a lattice-like structure for the nucleus, a strong-force interaction mechanism, and an electron model that has real angular momentum, the STEM approach has implications for electron orbitals and radioactive decay processes that need to be factored in. But first, a closer look at the back-story of the electron's anti-particle, the positron.

The 'Positive Hole' and Positron Back-Stories

Before the 1950's, electrons were deemed sufficient to fully explain electric current flow and there was no perceived need for **mobile positive charge carriers**. However, with the development of semiconductor technologies in the 1950's, it became abundantly clear that there was a need for mobile positive charge carriers to explain how semiconductor-based electric currents and the newly discovered Hall Effect worked.

One of the main problems would seem to be that, for all mainstream atomic theories and their related models, positive charge within 'normal' matter can only be derived from nucleus-based protons. This means that the only way in which a positive charge can be produced is by the removal of outer orbital electrons from electrically neutral atoms, and hence the reliance upon **temporal cations**. Temporal cations are static atoms (i.e. atoms with a fixed location within an atomic lattice) that can be toggled between an electrical neutral state into a positive state (i.e. become a **cation**) by the removal of one or more electrons; and then back into the neutral state by the cation acquiring the required number of electrons.

Possibly to mask their static nature, these temporal cations were called '**positive holes**'. However, the reality is that the positive charge of a positive hole does not move: the charge is simply toggled between its 'on' and 'off' states. Positive holes are simply a convenient (but much needed) workaround, and the often-claimed assertion that *temporal cations can move as mobile positive charge carriers* is tantamount to a misleading sleight of hand. Despite this, the 'positive hole' concept has been mindlessly adopted and presented as fact by a majority of Physics courses and texts, and is supported by misleading diagrams and clever animated-gifs (e.g. this simple gif or this diagram of the Hall Effect) suggesting that positive holes can, on cue, move in the opposite direction to electrons to form an electric current.

A much more likely, but overlooked, contender for the much-needed mobile positive charge carrier is the **positron**, the **anti-particle** of the electron. A positron is a 'real' particle, whereas a 'positive hole' is immobile temporal cation that is treated as if it were a mobile pseudo-particle. However, the positron option is rarely considered because, according to current mainstream atomic theories, positrons do not and cannot exist within 'normal' matter. So we are left with the unsatisfactory 'positive holes' explanation that is under-pinned by the LWL (little white lie) that immobile temporal cations can physically act as positive charge carriers.

To explore the possibility that **positrons**, rather than 'positive holes', might be the much needed positive charge carriers, we need to know more about positrons. 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**. However, in 1932, 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 electron's anti-particle, the positron. So, although the official story is that positrons were first discovered by Carl Anderson in 1932, he only discovered a different natural source of positrons some 34 years after Rutherford originally discovered them.

Whereas Beta plus decay and cosmic radiation are 'natural' sources of positrons, from 1989 onwards (some 57 after Anderson's 'discovery'), the Large Electron–Positron (LEP) Collider at CERN could 'synthetically' generate positrons via high energy impact for use in particle collision experiments. It has only been since about 2012 (some 80 years after Anderson's 'discovery') that it has been possible to generate positrons synthetically by the bombardment of metallic targets such as nickel or gold film with high energy (petawatt) lasers [5], which has allowed positron experimentation to be more widely available. However, it remains that, although the Science community describes the Beta decay process in detail, it does not provide feasible explanations of how or why positrons are generated either naturally or synthetically.

The lack of an explanation for the generation of positrons leaves the unanswered question as to whether positrons already **pre-exist** within matter and require high-energy impact to release them; or whether they are both created and released by high-energy impact processes. Should they pre-exist within matter, which would seem to be the most simple and logical explanation by far, then positrons would potentially qualify as the positive charge carriers much needed to fully explain the nature of electric currents and related electromagnet phenomena. If they do not pre-exist, then a feasible explanation of exactly how and why are they created is very much needed but, as yet, is not forthcoming.

Should positrons pre-exist naturally within matter, an obvious question is: *why hasn't their existence they been physically identified within matter (i.e. in situ within matter)*? The most likely reason for this is that, although electrons can readily be released from a host medium by low level energy (e.g. via heat or exposure to radiation in the visible light spectrum range), the release of positrons from a host media experimentally requires high-energy processes such as laser or collider bombardment techniques, which have only been available since 1989 (i.e. for the last 34 years) on a limited basis in a few large-scale facilities with set agendas.

Another important reason is that, should an electron and a positron meet each other head-on, they are highly likely to mutually self-destruct generating **gamma radiation**: this process is called **electron-positron annihilation**. Should positrons pre-exist within matter, rather than being dynamically created, they would need to be able to co-exist with electrons that are also present, which would be particularly difficult within electrical conductors that have a ready supply of very mobile electrons. So, should positrons exist in matter, there would need to be a mechanism to keep them well apart from electrons to prevent mutual annihilation. Without a feasible electron/positron separation mechanism, it is understandable why, even over the past 11 years that bench-top laser-based synthetic positron generation setups have been readily available, Physicists have not been actively looking for positrons within matter, let alone within electrical conductors.

Overcoming the Co-existence Problems of Positrons and Electrons

Once released from their host medium, free electrons and positrons are easy to separate by an electric field, wherein they are deflected in opposite directions. Alternatively, as mentioned above, should an electron and a positron meet each other head-on, they are highly likely to mutually self-destruct generating **gamma radiation**: this process is called **electron-positron annihilation**.

Should positrons pre-exist within matter, rather than being dynamically created, they would definitely need to be able to co-exist with electrons that would also present. For a good electrical conductor such as copper, which contains a ready supply of mobile electrons, the electrons and positrons would need to be kept well separated to avoid widespread electron-positron annihilation.

The STEM approach suggests that, within an atom, electrons and positrons could be kept well separated by populating separate **planar orbitals** on opposite sides of the nucleus, such as shown as figure 12a. The planar orbital concept is quite innovative, and yet represents a feasible and far simpler orbital configuration than the rather complex probabilistic 'spdf' orbital patterns or the spherical planet-like Bohr orbital shells (figures 12b to 12d).

For Bohr and 'spdf' orbitals, electrons fully encircle the atomic nucleus, and are considered wave-like within orbitals and, to explain EMR emission and absorption phenomena, particle-like when changing orbitals. Despite widespread adoption, neither of these orbital patterns has been physically confirmed: they still remain as feasible, but mutually incompatible and unproven theoretical concepts. Planar orbitals simply represent another feasible but unproven theoretical pattern: they also require STEM to provide an alternative explanation (which it allegedly does) for EMR emission and absorption spectra.

A recent article ‘Qubit Research and Atomic Orbitals’ reviews a UNSW a **quantum bit** (**qubit**) R&D project using single **phosphorus** (**P-31**) **anions** and argues that, at close to absolute zero, the only electron orbital evident is that of a single conduction band electron. The orbit of the lone electron is manipulated and controlled via microwave bursts of the appropriate frequency, but the other 15 de-energised inner-orbital electrons have no presence or interaction within this setup. This raises the question as what happens to the 15 inner orbital electrons at close to close to absolute zero, and lends support to the possibility that they, in fact, might not exist at all, which would appear to be the STEM point of view.

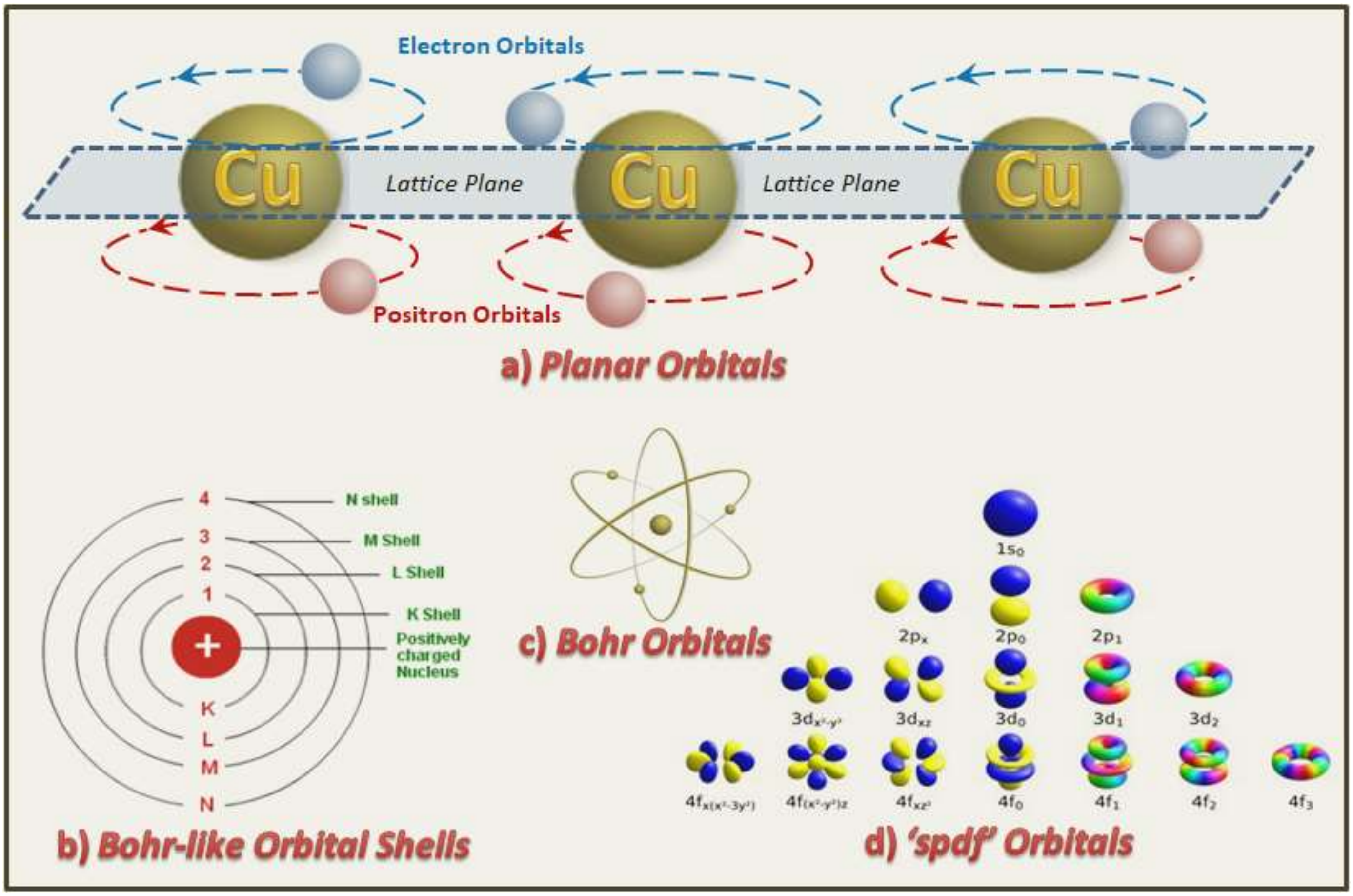


Figure 12: Alternative Atomic Orbital Schemes

The planar orbital concept raises questions as to *how and why are the electromagnetic fields, needed to support planar electron and positron orbitals on opposite sides of an atomic nucleus, generated*? The answer to such questions can be found by considering the development of multiple proton and neutron layers (figures 9b and in more detail as figure 13) within neutron chains that end-on-end join to form the polygonal structure of a STEM atomic nucleus.

The central quark of each I-form nucleon within a nucleon chain is called a **swivel quark**, as highlighted by the double-lined circles in figure 13. The outward-facing faces of swivel quarks consist entirely of e-CES or p-CES and, if unconstrained, these spin continuously at high speed so as to generate a strong negative or positive field respectively. As can also be seen in figure 13, neutron layers contain positive (or up) swivel quarks, and proton layers contain negative (or down) swivel quarks.

All complete I-form nucleon layers within atomic nuclei present as proton and neutron layer pairs with the swivel quark charges balancing each other so that, internally, the nucleus is electrically neutral. However, the top and bottom outside nucleon layers can have a +-, ++ or -- charge pattern, which is somewhat at odds with the conventional view that the nucleus presents with an even spherical positive-charge distribution. Furthermore, it is claimed that the strong external fields, generated by the out-facing swivel quarks in the outermost top and bottom layers of the polygonal nucleus structure, combine to support the planar electron and positron orbitals above and/or below the nucleus. Such planar electron and positron orbitals are called **ionic orbitals**.

Complete nucleon layers come in neutron and proton layer pairs, and for elements with an **odd number** of nucleon layer pairs, the top and bottom layers generate fields of the opposite polarity (the **+-** pattern, which approximates to an electric dipole); and for those with an **even number** of nucleon layer pairs, the top and bottom layers have the same polarity, with **++** and **--** having an equal probability of occurring unless there is some environmental control that biases the 50:50 ratio.

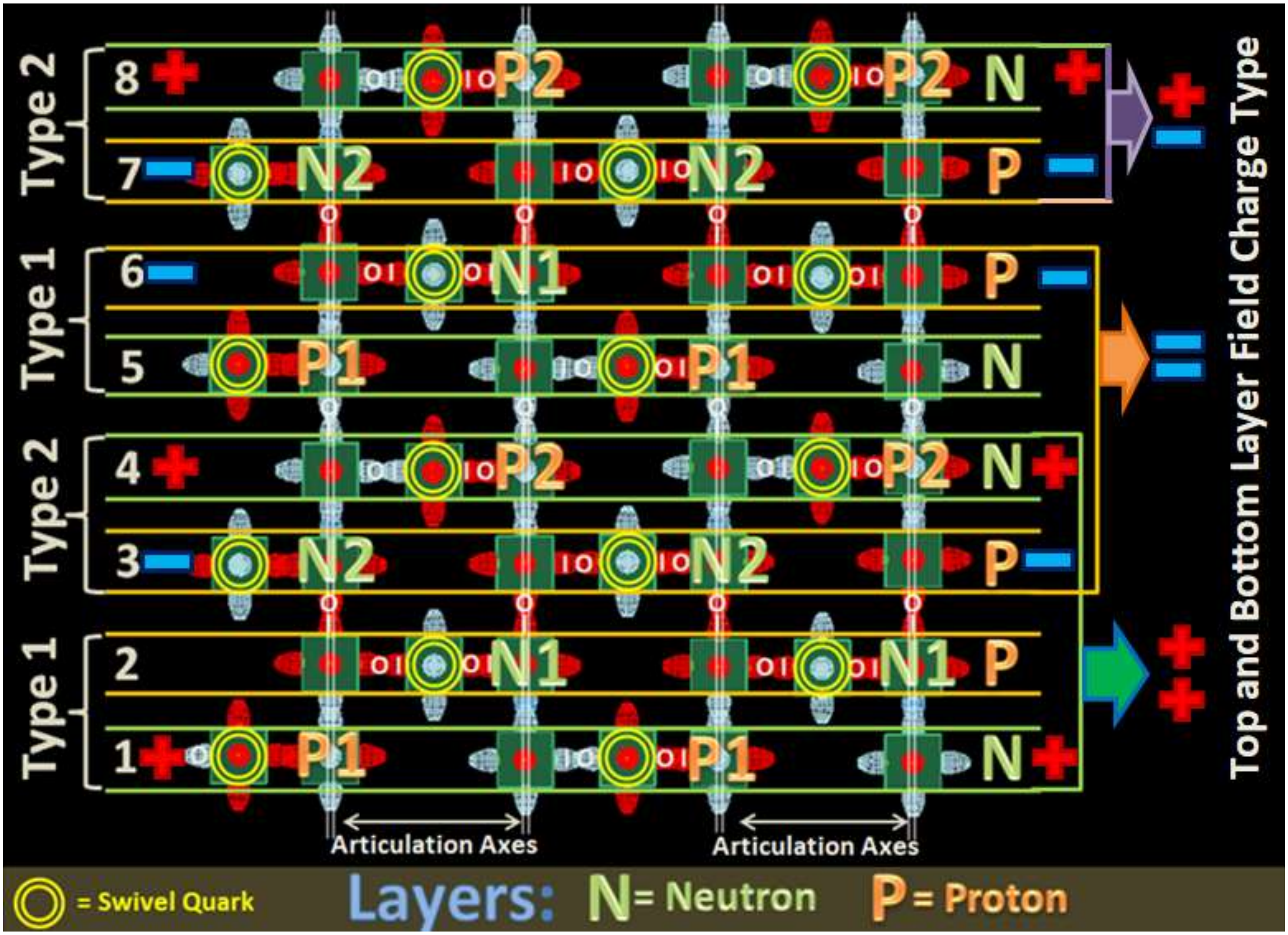


Figure 13: Multiple Nucleon Layer Characteristics

Implications of Ionic Orbitals for Electric Currents

Ionic orbitals would mean that, for electrical conductors (e.g. copper atoms within copper wire or plate), atoms are appropriately aligned within a lattice-like structure so that their electrons and positrons would have separate orbitals above or below an atom group's lattice plane, and are thus kept be well separated from each other as shown in figures 12a and 14. This would also mean that they would have the ability to readily move or stream in opposite directions to each other by skipping orbitals under the influence of an applied or induced emf. Certainly the existence of such planar orbitals would mean that positrons, rather than dubious 'positive holes', would be the elusive positive charge carriers required to fully explain electric current within semiconductors and the Hall Effect.

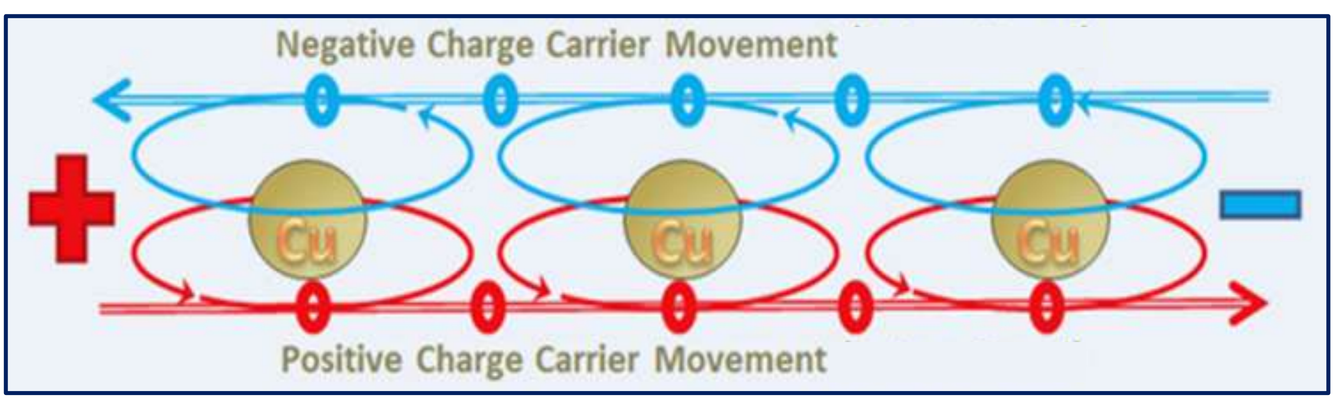


Figure 14: Positive and Negative Charge Carrier Movement as an Electric Current

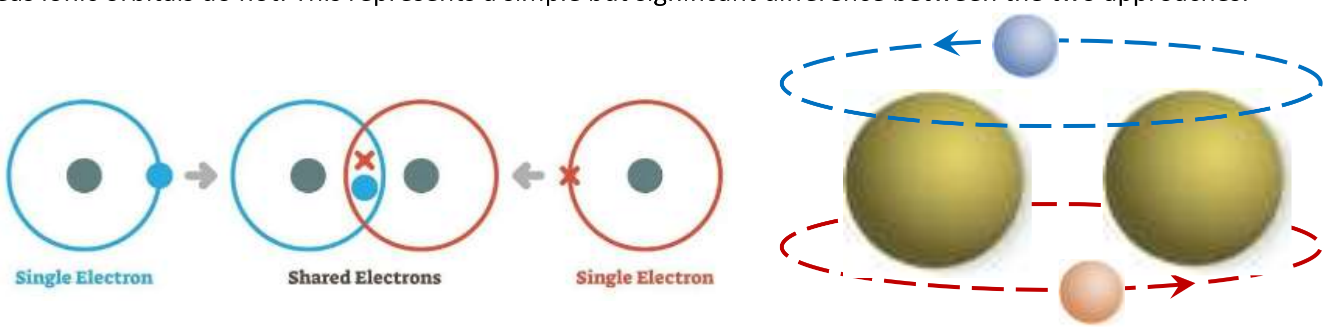
As electrons and positrons stream, hopping from one orbital to another compatible orbital in response to an applied emf, their electromagnetic field energy would combine (as shown by arrowed double lines in figure 14) to produce a field-energy based circuit activation that acts at close to the speed of light, whereas the average stream-speed of electrons and positrons themselves would be significantly slower.

The best electrical conductors are those elements such as copper, silver and gold that, according to STEM modelling, have an odd number of proton and neutron layer pairs and thus a +- dipole structure. However, this does not mean that some metals with a ++ or -- monopole charge pattern cannot also be good conductors.

As evidenced by localised surface plasmons (LSPs) in thin metal sheets and nanoparticles, and by the formation of magnetic domains in ferromagnetic materials, atoms would seem to have a propensity to form small nano-sized groupings of atoms having like-polarity pole orientations within crystalline structures. Such like-polarity groupings could explain LSPs and suggests that even atoms with a ++ or -- monopole charge pattern could support the movement of electrons and positrons, with conductance being dependent on how easy the electrons and positrons can skip between like-polarity domains and overcome naturally occurring structural discontinuities within the conductor.

Implications for Covalent Bonds and Radioactive Decay

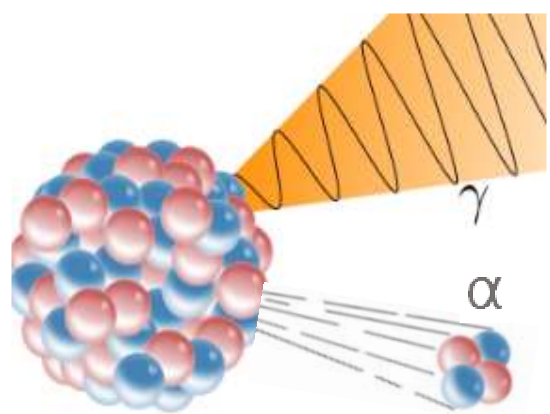
STEM also suggests that, as well as keeping electrons and positrons apart within atoms, the planar ionic orbital model makes a lot of sense when it comes to explaining **covalent bonding**. For covalent bonding, the conventional shell-based orbital approaches involve mystical electron cross-overs between the bonded nuclei as in the schematic diagrams of figure 15, whereas ionic orbitals do not. This represents a simple but significant difference between the two approaches.



Simple Conventional Covalent Bond **Simple Planar Orbital Covalent Bond**

Figure 15: Covalent Bond Formation Alternatives

For radioactively-stable elements (e.g. copper), STEM contends that their crystal structure keep the electrons and positrons well separated from each other because they have well aligned ionic orbitals. On the other hand, for **radioactive elements** and compounds, it is claimed that the separation of electrons and positrons via ionic orbitals is poor. This lack of adequate separation results in frequent and ongoing random electron-positron annihilation events that produce gamma radiation, which in turn initiate a range of radioactive decay processes such as alpha radiation, beta radiation, more gamma radiation (via Bremsstrahlung), and neutrinos.



Gamma ray (γ) and Alpha (α) emission from an atomic nucleus (Conventional view)

With the STEM approach, it is thus claimed that it is random electron-positron annihilation events that release gamma rays, which in turn leads to a range of other forms of radioactive emissions.

Although Physicists have documented the sources and effects of radiation quite well, the three basic forms of radiation (i.e. gamma, alpha and beta) still remain as mystical phenomena, with a feasible explanation either being non-existent or over-simplistic (such as the Wikipedia-derived diagram shown right which creates more questions than it answers).

Summary

A simple modification to the structure of nucleons that entails the elimination of strong force bond interactions between like-charge quarks, results in a quark-chain structure for nucleons. When combined with the toroidal electron/positron/CES model, the quark-chain structure opens up a wide range of possibilities regarding the formation of nucleons and leads to a polygonal crystalline structure for atomic nuclei and to the concept of ionic orbitals.

The proposal that positrons (or their equivalent) pre-exist within matter prior to their release from a host medium, rather than being created-and-released by unspecified high-energy interactions, means that positrons may well be the positive charge carriers that are needed to explain electric current generation within semiconductors and the Hall Effect. With this scenario, ionic orbitals are quite important: they keep electrons and positrons well separated, which prevents the widespread occurrence of electron-positron annihilation, and lead to simpler models for covalent bonding and to feasible explanations for the cause of radioactive decay in unstable elements and compounds.

This paper has made many references to the STEM approach to provide a theoretical rationale to support the hypothesis that '***strong-force interactions do not form between like-charge quarks***', and the orthogonal quark latch-point concept in particular. The STEM approach is in its infancy but, even at such an early stage of its development, it provides consistency across many areas of Physics and Chemistry; and it certainly supports the nucleon-chain nucleus building process put forward in this paper. However, should STEM fail to gain traction or prove to be a flawed approach, it does not necessarily negate this paper's initial hypothesis, or the possibility that positrons exist within matter and represent the positive charge carriers much needed to fully explain the nature of electric currents.

As a footnote to the STEM approach, the **STEM Development Group** (**SDG**) has used the toroidal CES model to develop true-to-scale models form many atoms and for important molecules such as hydrogen (both para and ortho forms), water (including for the hexagonal form of ice crystals) and a range of hydrocarbons. SDG contends that, as for semiconductor-based electric current, electric current for all commercial DC and AC electrical applications consists of the simultaneous duplex movement of ionic electrons (negative charge carriers) and positrons (positive charge carriers) in opposite directions to each other. It also provides explanations for how and why negative and positive electric fields are different; for how magnetic fields differ from electric fields and interact with each other; and for the nature of EMR (including that in the visible light frequency range).

Should you wish to find out more about the STEM approach, you may find the two page pdf STEM Overview (1 Mbyte pdf) of interest, and possibly have a closer look at the three quite detailed SDG position papers:

- Atomic Structure: STEM and the Orbital Model (5.4 Mbyte pdf)
- The Duplicit Electron: Applying New Spin to Electricity and Electromagnetism (3.8 Mbyte pdf)
- The Nature of Light based upon a Physical Model for EMR (3.5 Mbyte pdf)

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