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Quarks and the Atomic Nucleus

By David Johnson

(David.Johnson.Pivot@gmail.com)

Abstract

According to the Standard Model, nucleons consist of three quarks bound together by three strong-force bonds, with protons containing two up-quarks and one down-quark, and neutrons two down-quarks and one up-quark.

However, this model involves a strong-force bond between the two same-charge quarks, which is most unlikely. A quark-chain nucleon model involving two strong-force bonds connecting a central quark with a pair of oppositely charged quarks is much more feasible and leads to some interesting possibilities for the structure of atomic nuclei.

Quarks and the Atomic Nucleus

According to the **Standard Model** (**SM**), nucleons consist of three quarks, with **protons** containing two **up-quarks** and one **down-quark**, and **neutrons** two down-quarks and one up-quark, bound together by three strong-force bonds as shown in figure 1a. With up-quarks having an electric charge equivalent of +2/3 e and down-quarks -1/3 e, the net charge equivalent of a proton is +1e and zero (0e) for neutrons.

SM considers that nucleons have involves three strong-force bonds binding three quarks in an equilateral triangle quark pattern (figure 1a). However, it is most likely that like-charge quark pairs would repel each other and resist coming together to form a strong-force bond. So, with the removal of 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 be more flexible, and result in a geometry that could vary from a **linear** pattern and a **right-angled isosceles triangle**, as shown in figure 1b.

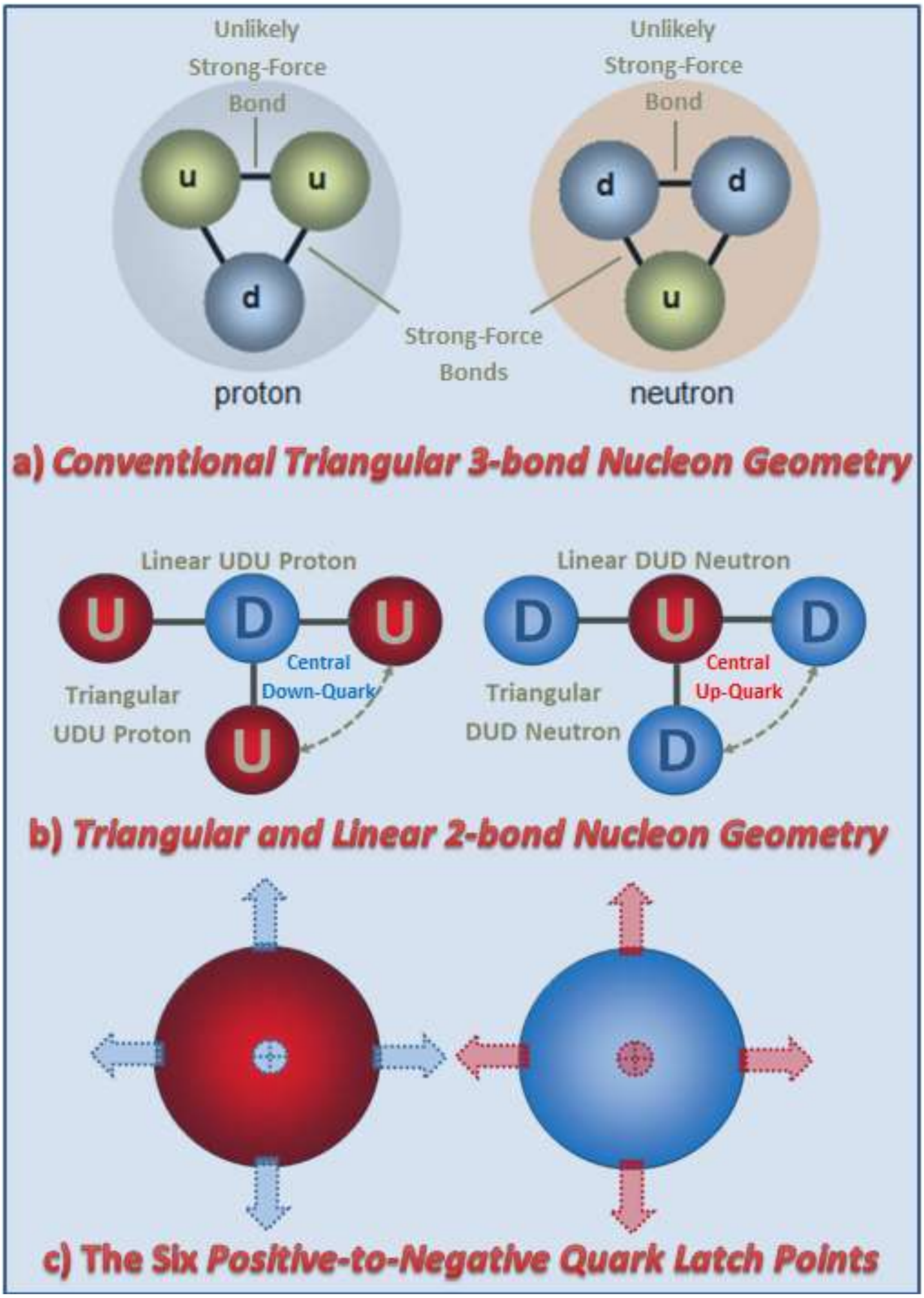

Figure 1: Quarks and Nucleon Structure

Should positive (up) and negative (down) quarks only be able to form strong-force bonds with each other via 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 isosceles triangle geometry, rather than connect at any angle in between. It would also mean that, simply on the basis of geometry, there would be an 80% probability of a nucleon being triangular, and a corresponding 20% of it being linear.

Should, as for the central quark within a nucleon, a quark can only support a maximum of **two strong-force bonds** with other opposite-charge quarks, the main resultant nucleon join patterns are shown in figure 2.

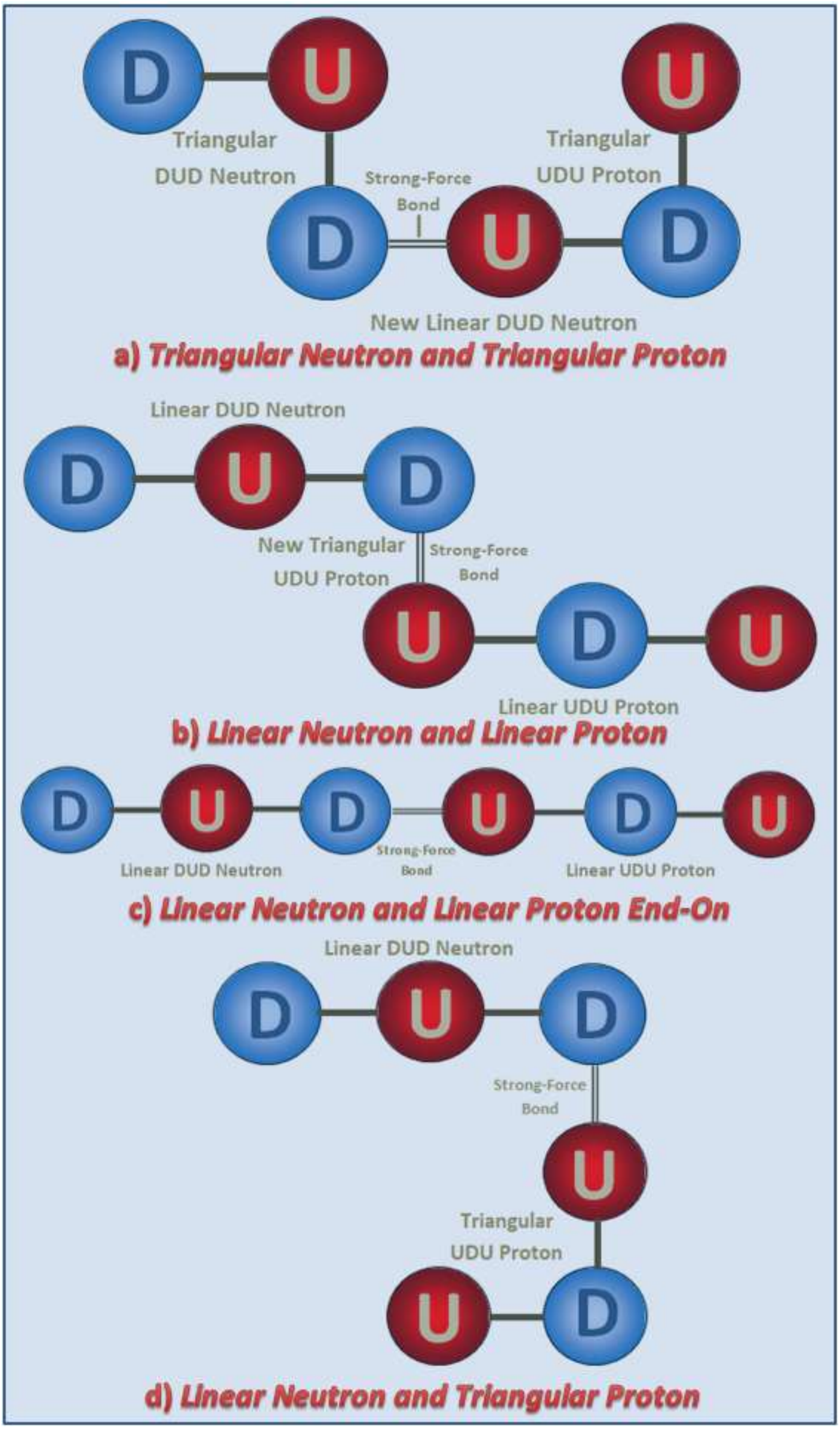

Figure 2: Nucleon Strong-Force Bond Patterns

Science's understanding of the creation of the elements 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 the environment that created and/or recycled elements might be, it would most certainly be 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 recycled. The arms of triangular nucleons present less of an impact target and they would tumble rather than break up, and be thus more robust, which would increase the percentage of available triangular nucleons from the 80% mark (due to geometry) to well above the 90% mark. On this basis, it is most likely that the bulk of the nucleus building blocks are triangular nucleons, and these have a propensity to join in patterns similar to that of figure 2a, with any linear segments so generated being the chain's weak points.

As nucleons join, the first significant structures to evolve are simple **nucleon chains** (figure 3a), to which other nucleons and minor quark groups can strong-force bond. These nucleon chains are 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 loose opposite ends may meet and become strong-force joined together to create a **polygonal structure** (e.g. figure 3b) that is relatively robust and forms the basic framework of an evolving atomic nucleus.

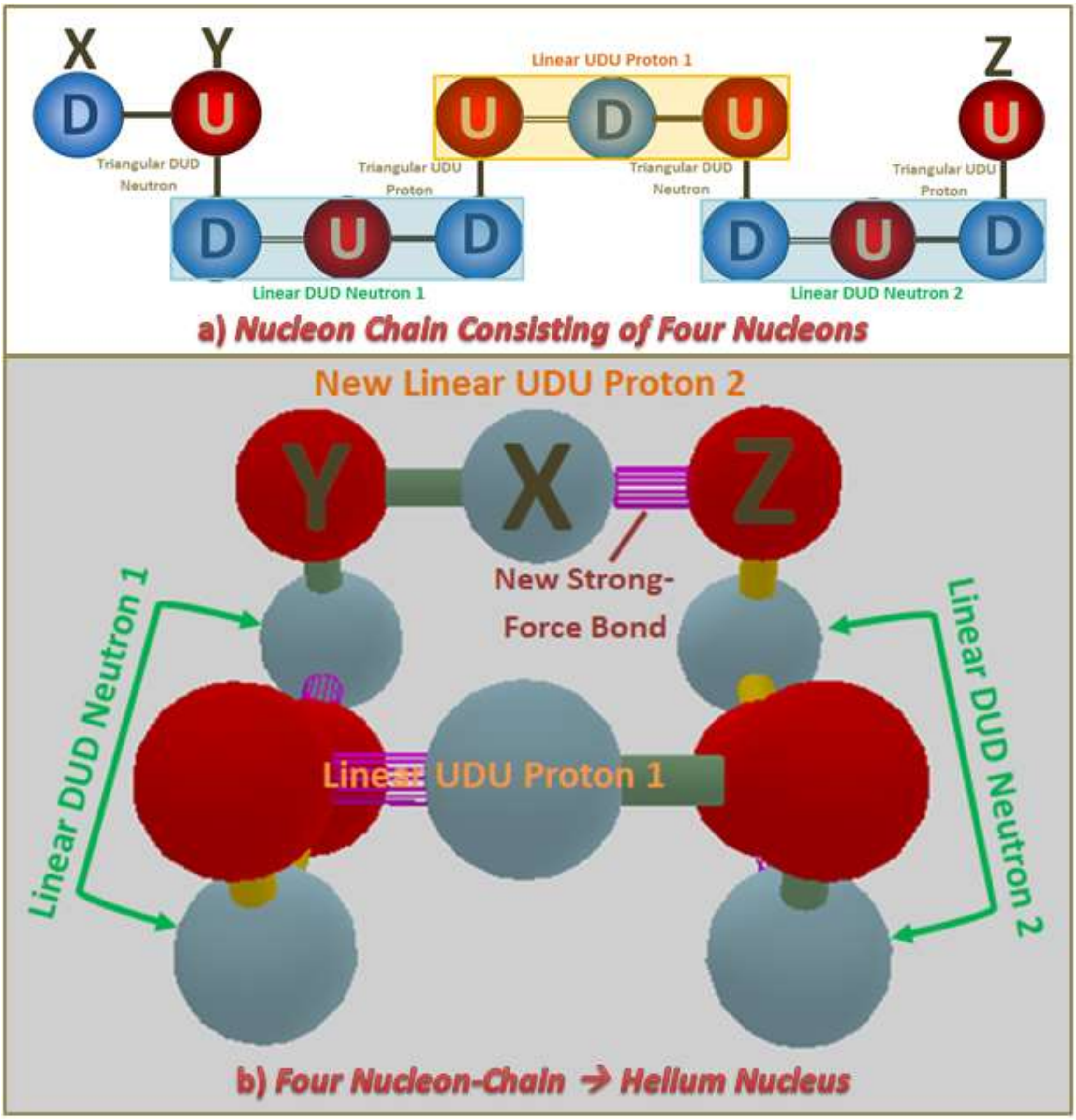

Figure 3: Helium Nucleus Creation from Four-Nucleon Chain

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 with what is known about fusion-based element creation environments.

The **nucleon-chain** building process, and ultimately the atomic nuclei building process, may simply be an extension of a **quark-chain** building process that does not need to build of nucleons first. The simplest quark-chain is a bonded pair of positive and negative quarks: it 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. Should this be the case, nucleons would simply represent the shortest quark chain that is stable.

The closed-off nucleon-chain helium nucleus of figure 3b is a paired Ո-U structure that is strong and very robust, with each quark being held in place by two strong-force bonds. Its 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**.

Conventional Science represents the helium nucleus as two spherical protons that, due to their positive charge, should mutually repel each other so as to cause the nucleus to explode (but it doesn't), 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 smooth and spherical in shape, being made up by an amorphous aggregation of spherical nucleons with no ascribed structure, which is quite unconvincing and most unlikely.

A hydrogen atom is simply a single proton but, with the nucleon-chain approach, it is far more likely to be triangular rather than linear or spherical (conventional Science view). The framework of the nucleus for all other elements is considered to consist 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 nucleon chain approach results in a lattice-like structure for atomic nuclei that influences their physical characteristics such as strength and their bonding affinity and patterns with other elements and compounds. It also opens up a range of other possibilities related to electron orbitals, energy transfer and distribution within matter, EMR emission (including that in the visible light frequency range) and electric current flow.

Some Unanswered Questions

The two assumptions that underpin the nucleon chain approach are that:

1. A nucleon has only two (rather than three) strong-force bonds that connect a central positive or negative quark to a pair of oppositely charged quarks.
2. A quark has only six orthogonal latch points, which causes a nucleon to present as a three-quark chain in a triangular or linear form.

A strong case for the first point has already been presented in this paper, which is difficult to argue against. However, the latch point concept warrants more exploration and explanation. Specifically, *why would there be six latch points and why would they be orthogonal*?

To answer this last question requires speculation regarding the possible composition of up and down quarks and the nature of strong-force quark-to-quark bonds. One Atomic theory that does just that is the **Spin Torus Energy Model** (**STEM)**. STEM is an **energy-centric approach** that 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 of the STEM approach is built around the claimed behavioural characteristics of concentrated energen.

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 thus must be composed of a quantised concentration of energen and/or a flow pattern that distinguishes it from other fundamental particles. **Composite particles** (e.g. nucleons and atoms) are considered to consist of multiple fundamental particles.

Opinion varies within the Science community as to whether up/down quarks are fundamental particles; or whether even smaller fundamental particles, traditionally called preons, combine to create up/down quarks. STEM adopts the latter view: that up/down 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', 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 electrons are considered to be fundamental particles that have the same structure, which consists of a central toroidal **energy-core** of concentrated energen, which flows or spins at close to the speed of light, and is enveloped by an **outer torus** of **less concentrated energen**, which presents as their **energy-field** and is responsible for their electromagnetic characteristics. As shown at close to true scale in figure 4, with an outer diameter of its energy-core being estimated at 5.6 pm (1 pm = 10^{-12} m), a CES is much larger than an electron that has an estimated energy-core diameter of 1.2 pm.

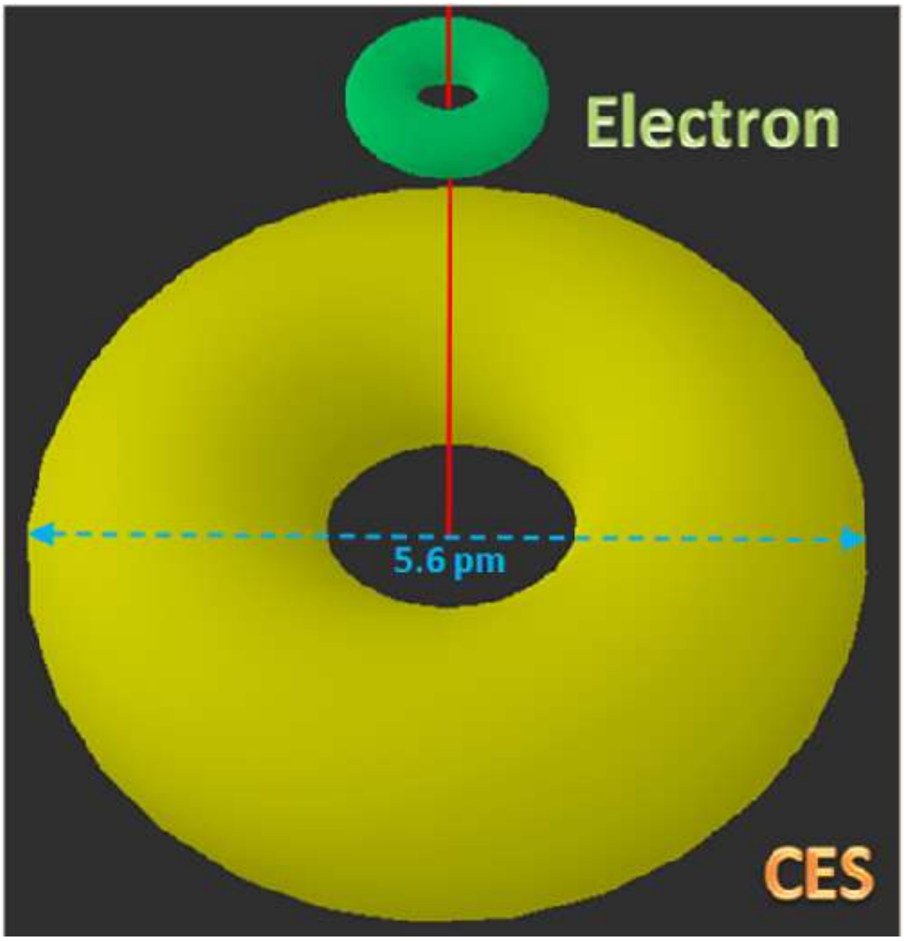

Figure 4: Energy-Core of A CES and an Electron (True to Scale)

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

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 so-called **anti-particle** of the electron. In keeping with the **e**-lectron/**p-**ositron names, a CES with left-handed chirality is an **e-CES**, and as represented by a **blue** coloured field-energy torus in figure 5a; and a CES with right-handed chirality is called 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.

Fundamental particles with the CES and electron structure interact with matter via their electromagnetic field-energy characteristics, 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.

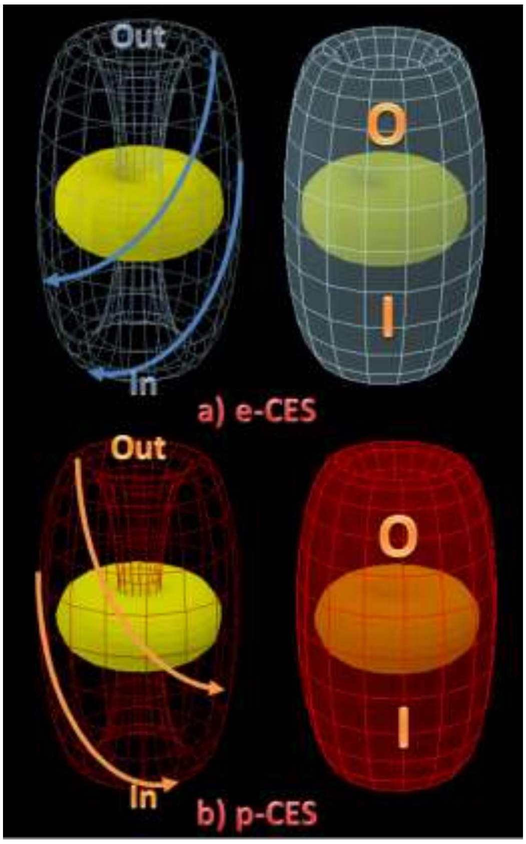

Figure 5: CES Energy-Field Flow Patterns

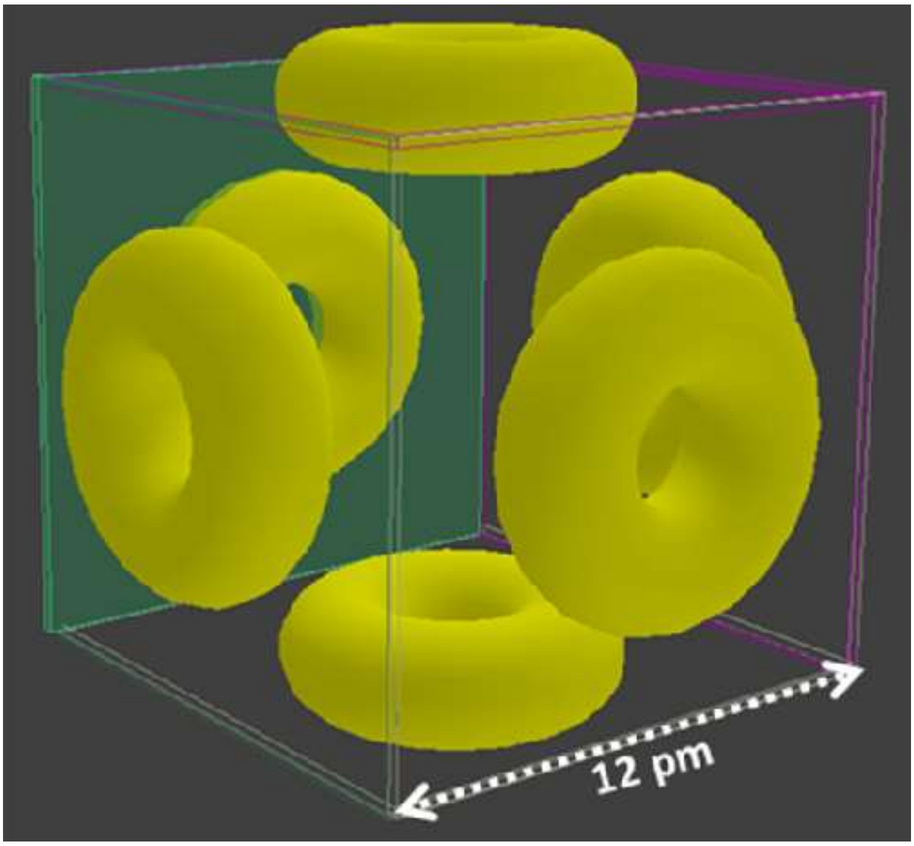

Figure 6: STEM CES-based Quark Structure

The up/down quark structure proposed by STEM consists of a three-dimensional octahedron array of six CESs, as shown in figure 6. The geometry of an up/down quark is that of a **face-centred cube**, the edge length of the unit cube (defined by the intersection of the equatorial planes of each component CES) being 12 pm. With there being six outward facing CES, the STEM quark model provides a means by which there could be six potential orthogonal latch points for inter-quark strong-bond formation.

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).

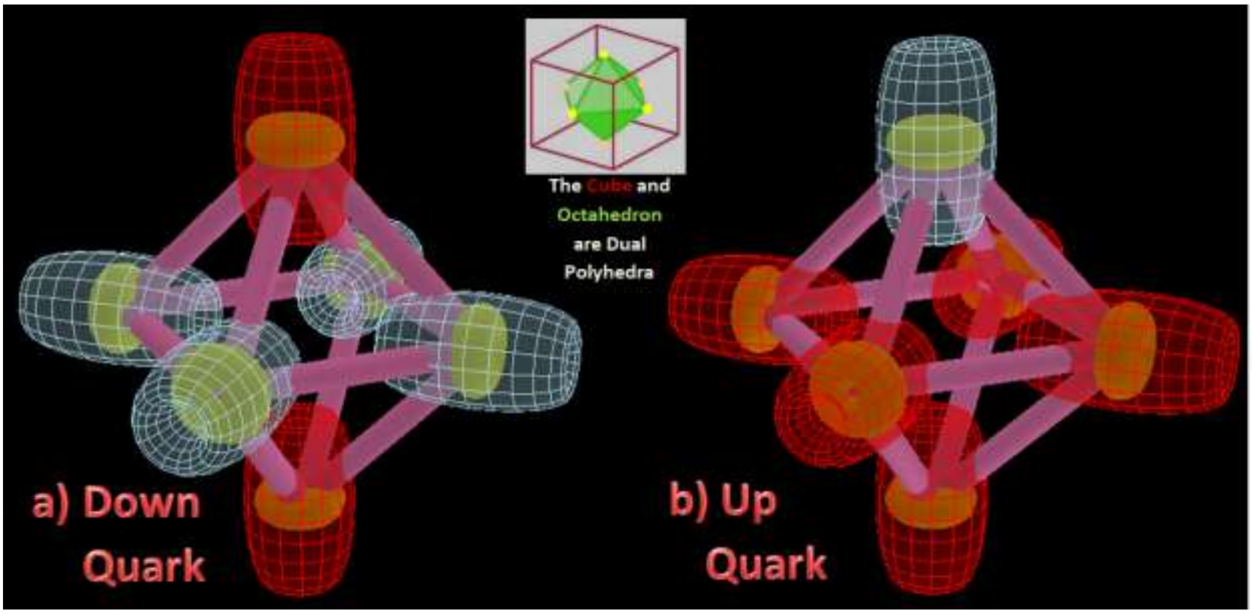

Figure 7: Up and Down Quark CES-based Models

STEM also provides a relatively simple explanation for strong-force bonds without having to resort to the use of the Standard Model's phantom exchange particle, the gluon. A strong-force bond can 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) to the inflow vortex (**I**) of another **same-type CES**. The strong-force nature of the bond is claimed to be due to the balanced two-way exchange and sharing of field-energy between the bonded CES pair as evident in figure 8.

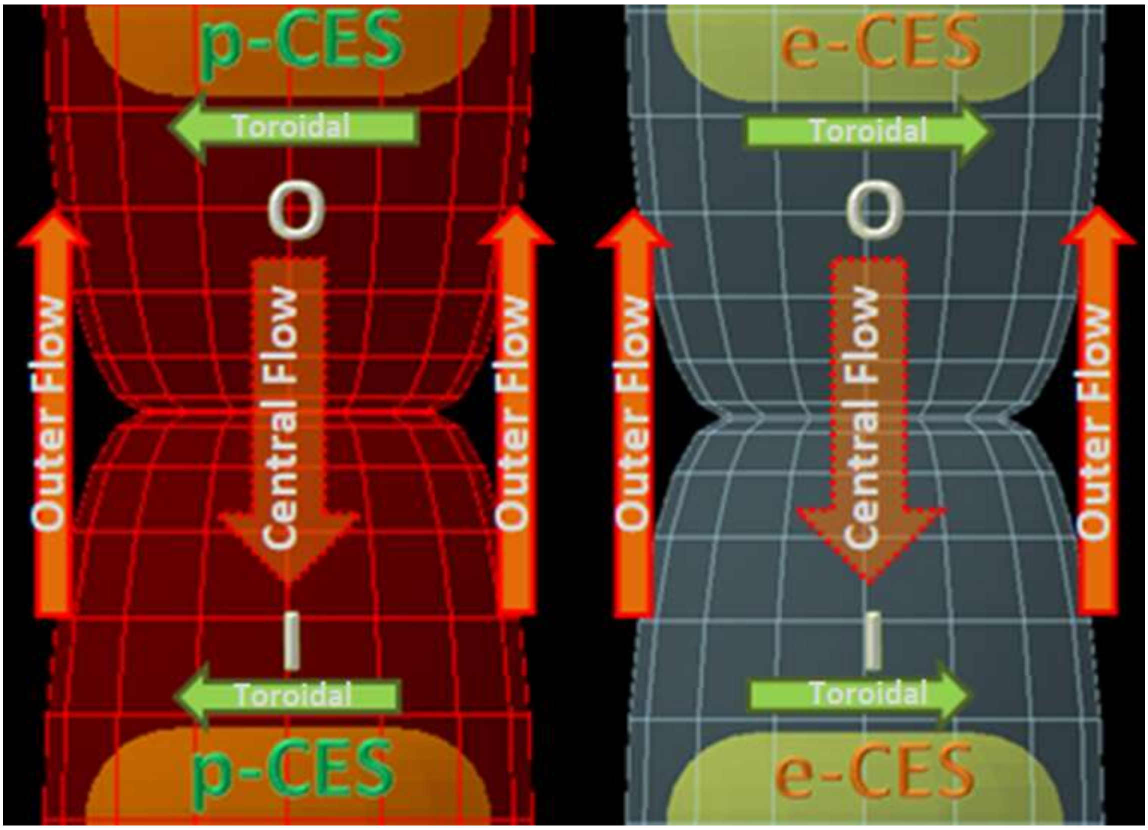

Figure 8: Strong-Force Bond Formation

STEM refers to triangular and linear nucleons as **L-form** and **I-form** nucleons respectively, and identifies two types of nucleons (type 1 and type 2) that differ only by the reversal of the direction of their energy-field energen. The subtle differences between type 1 and 2 nucleons are evident in figure 9, which corresponds to nucleon chains diagram of figure 3a. Figure 9 also highlights how L-form nucleon building blocks produce an I-form **nucleon layer** affect within a nucleon-chain and corresponding atomic nucleus should the chain close.

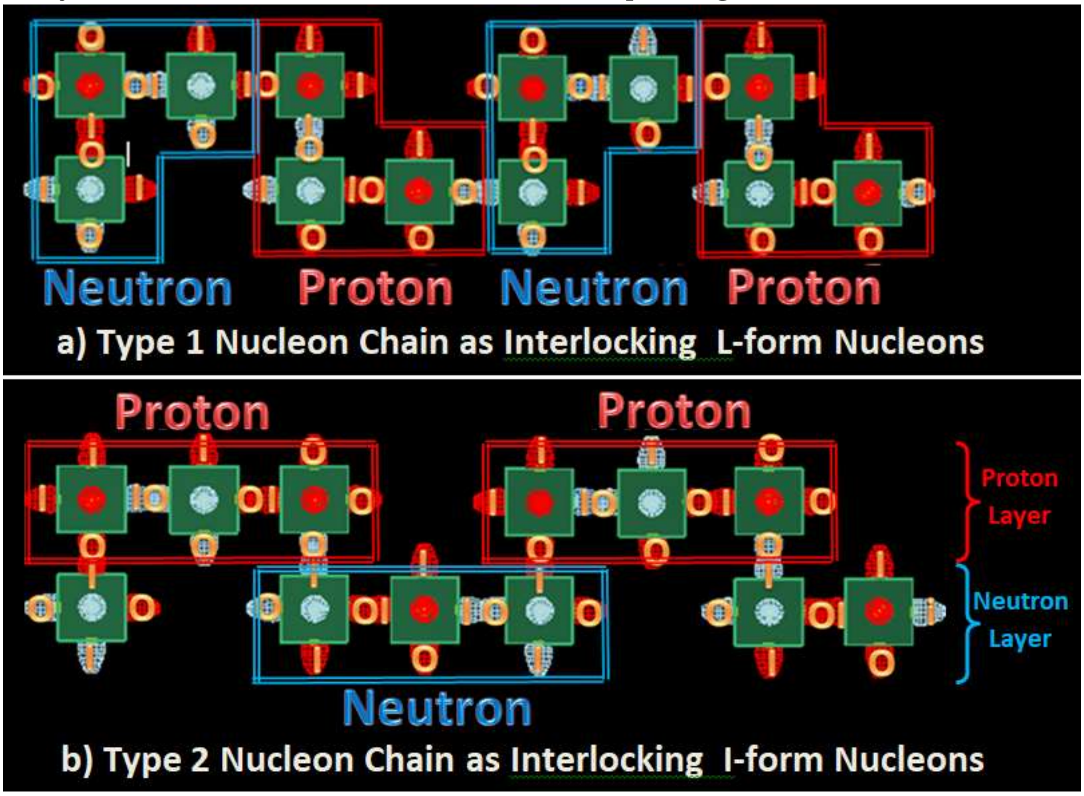

Figure 9: Type 1 and 2 Quark Chains

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

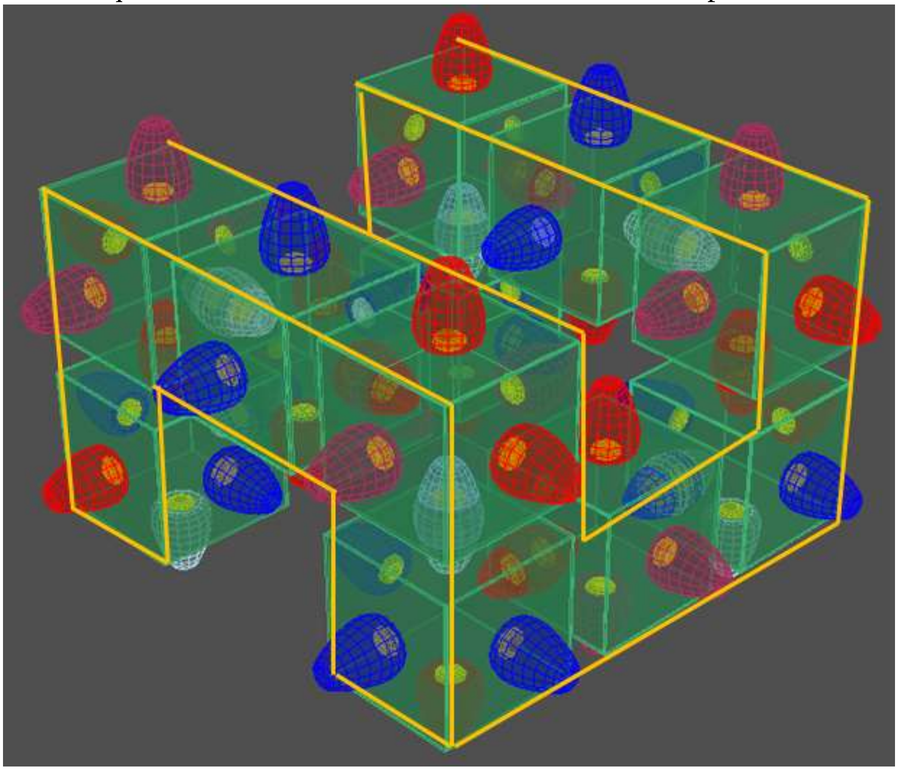

Figure 10: Quark-Model of a Helium Nucleus

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 to104.5^O and the O-H bonds correspond to the bond length of 95.8 pm as measured experimentally. This model also provides an explanation for how, due to inter-molecular buffeting within steam, the attached hydrogen atoms within the water molecule can 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 either of these two well documented phenomena.

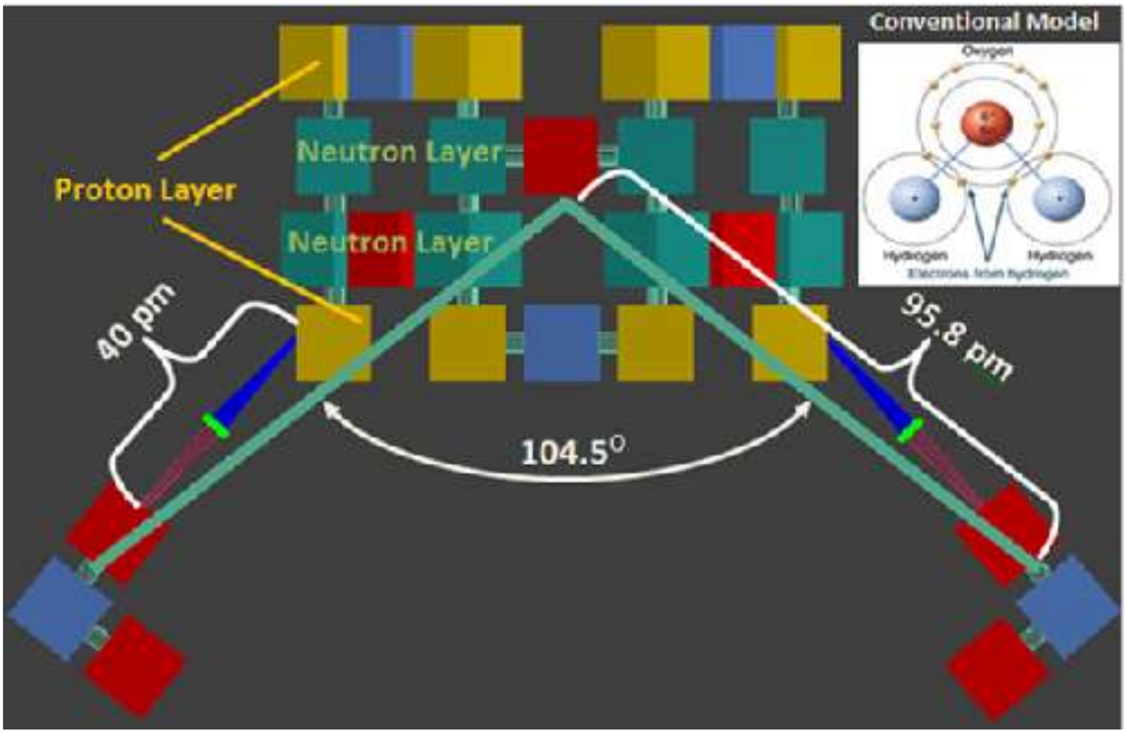

Figure 11: Quark-Model of a Water Molecule (True to Scale)

Another 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).

There are many facets to the STEM approach and even more implications relating to the nature of electric and magnetic fields, the origin of electrons and positrons, and the nature of EMR (including that in the visible light frequency range). The **STEM Development Group** (**SDG**) provides detailed 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.

STEM brings a consistency across many areas of Physics and Chemistry, and certainly supports the nucleon-chain nucleus building process put forward in this paper. Should you wish to check out the STEM approach further then 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)