

# Redefining the Electron (Part 2):

## The Implications for Atomic Structure

by

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# Abstract

The **Spin Torus Energy Model (STEM)** was introduced in [Part 1 of the 'Redefining the Electron'](#) series to define the structure of electrons and positrons so as to explain the nature of electric and magnetic fields, electric current generation from battery and induction sources, capacitor charge and discharge, and superconductivity. In Part 2, STEM is extended to define a structure Preons, quarks and nucleons and to explore the nuclear structure of atoms. The atomic model developed provides explanations for the physical characteristics and different allotropic forms of elements in the Periodic Table, their various bonding geometries, and for electron capture and beta decay.

The third and final paper provides a STEM explanation for the particle-wave nature of EMR, spectral line emission and absorption, the photo-electric effect, the Compton effect, electron pair generation and annihilation, and Gravity.

## Preons and Concentrated Energy Sources (CESs)

The primary fundamental particle in Physics is the **Preon**. In order to avoid conflict with the various definitions and connotations related to Preons, STEM uses the term **Concentrated Energy Source** (or **CES**). STEM contends that CES-styled Preons build into quarks; quarks into nucleons; and nucleons into atoms: thus CESs are considered to be the primary energy form that builds into ordinary matter.

As for electrons and positrons, a CES has a toroidal energy core and energy field, but unlike STEM electrons and positrons, the electric field of a CES is always polarised, and does not assume a neutral energy field pattern equivalent to that of a neutral bitron.

The energy field of a CES thus has either an electron-like AO/CI pattern or a positron-like CO/AI pattern, which are referred to as an **e-CES** and a **p-CES** respectively. Also, In keeping with the chiral convention used for electrons and positrons, the energy field of an e-CES is coloured **red** and that of a p-CES **blue** (see figure 1), but their core energy torus is **yellow** whereas those of electrons and positrons are **green**.

As discussed in Part 1, the conversion of an electron into a positron, and vice versa, which is an important aspect of the explanation of electrical capacitors and AC electricity, requires a change of chirality that can be achieved instantaneously and efficiently. Similarly, the conversion of an e-CES into a p-CES, and vice versa, is central to the STEM explanation of beta decay and electron capture.

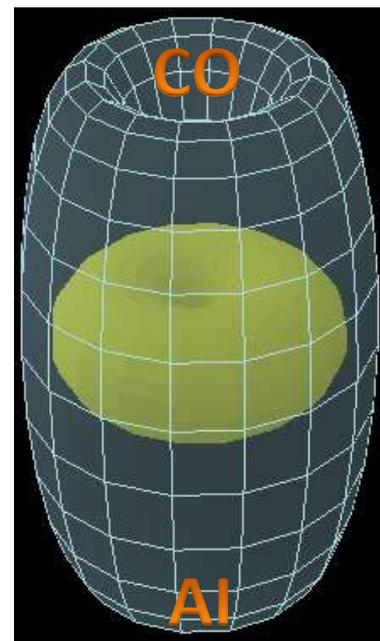


Figure 1: A p-CES

Only an energy field-flip can change the chirality of electrons, positrons or CESs: proof of this can be found in the table of figure 2. Should the first letter of the AO/CI & CO/AI notation for electrons, positrons and CESs be replaced by a '0' for a 'C' and a '1' for a 'A', and the second letter 'O' be replaced by a '0' and 'I' by a '1', the binary pattern of column 3 (and its decimal equivalent in column 4) is produced. A 180° rotation of torus and field is shown in column 5 (a binary 11<sub>2</sub> XOR of column 3) does not change chirality; but the torus-only flip of column 6 (a 10<sub>2</sub> XOR of column 3) and the energy field-only flip of column 7 (a 01<sub>2</sub> XOR of column 3) do. However, because energy field spin is dictated by torus energy flow, a torus-only flip is not possible, and thus an energy field-flip is the only valid way to change chirality.

1. CES Type	2. Dual Letter	3. Binary C and O = 0 A and I = 1	4. Decimal Equivalent	5. X Rotation (180° turn)	6. X Torus Flip (Reverse Helicity)	7. ✓ Field Flip (Reverse Helicity)	8. Flipped CES Type
Electron Compatible	CI	01 = 1	1	2	3	0	Positron Compatible
	AO	10 = 2	2	1	0	3	
Positron Compatible	CO	00 = 0	0	3	2	1	Electron Compatible
	AI	11 = 3	3	0	1	2	

Figure 2: Flip Transformations to Change Electron, Positron and CES Electric Field Chirality

An **energy field flip** is thus achieved by a reversal of the axial I/O flow direction of the energy field: for electrons and positron it is generically called **electron flipping**; for CESs it is called **CES flipping**, which turns an e-CES into a p-CES and vice versa.

Because nuclear models of atoms contain many CESs, the CES annotation is reduced to energy field colour indicating an **e-CES** or a **p-CES** and, should flow direction be important, an 'A' is added for **Anti-clockwise** or a 'C' for **Clockwise** for spin direction: from this annotation the AO/CI & CO/AI pole configurations can easily be determined. Also the digital encoding of figure 2 provides for an efficient single digit encoding CES chirality patterns plus a mathematical means to apply rotation and flip to CESs and polarised bitrons within computer models.

The rest mass of a CES is considered to be in the vicinity of  $52.5 \text{ MeV}/c^2$ . In energy terms, this means that a CES contains about 100 times more energy than an electron (or a positron), which has a rest mass of  $0.511 \text{ MeV}/c^2$ , and about half the mass of a **muon**, which has a rest mass of  $105.7 \text{ MeV}/c^2$  (speculatively, a muon can be considered to be a pair of strongly bonded CESs).

CESs have also been attributed with the ability of being able to capture, absorb and store extra electromagnetic energy from other electromagnetic sources, in order to increase their net energy, or to lose some energy to their environment. Both processes are ongoing and in parallel, providing CESs with dynamic, responsive energy transfer and balancing capabilities.

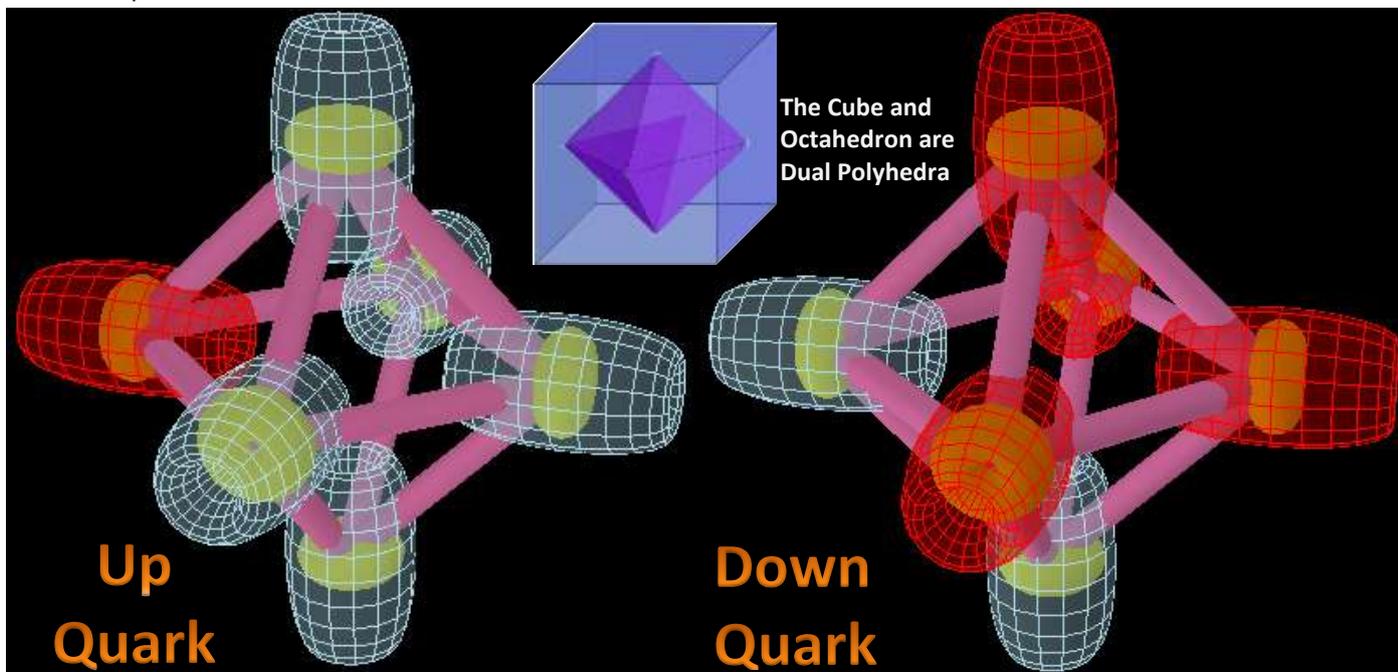
Unlike CESs, the electromagnetic energy level of electrons and photons remains relatively constant until it is absorbed (fully or partially) by another structure or field. STEM supports the hypothesis that electrons and positrons are secondary energy sources which have been created by or derived from CESs.

## Quarks

STEM postulates that each up and down quark consists of a three-dimensional array of 6 CESs, held in place by their respective electromagnetic fields in a **regular octahedron** form, as represented by the stick connectors in figure 3.

An **up quark** consists of 5 p-CESs and 1 e-CES. The electric charge of a quark is considered to be equivalent to a point charge of  $1/6 e$  (elementary charge) located at the centre of the quark, with a p-CES having a positive charge of  $+1/6 e$  for a positron CES and an e-CES having  $-1/6 e$ . Thus the net electric charge equivalence of an up quark is  $+2/3 e$  (calculated as  $+5/6 - 1/6$ ).

Similarly a **down quark**, consisting of 2 p-CESs and 4 e-CESs, results in a net electric charge of  $-1/3 e$ . The electric charge estimates for STEM thus correspond quite well to the experimentally determined electric charge equivalents of up and down quarks.



**Figure 3: Ball and Stick Model of Up and Down Quarks**

Because the cube and regular octahedron forms represent **Dual Polyhedra**, rather than using ball and stick models involving 12 sticks per quark to represent the internal bonding, up and down quarks are represented by their simpler cubic form, with the 1 CES energy core shown central to each face of the cube: the cube faces (green in figure 4) also represent the intersection geometry of the CES equatorial energy fields of quarks. The 'A' and 'C' notation of figure 4 shows the spin direction possibilities, with 'C' on one side of a cube matching with an 'A' on the other, and vice versa.

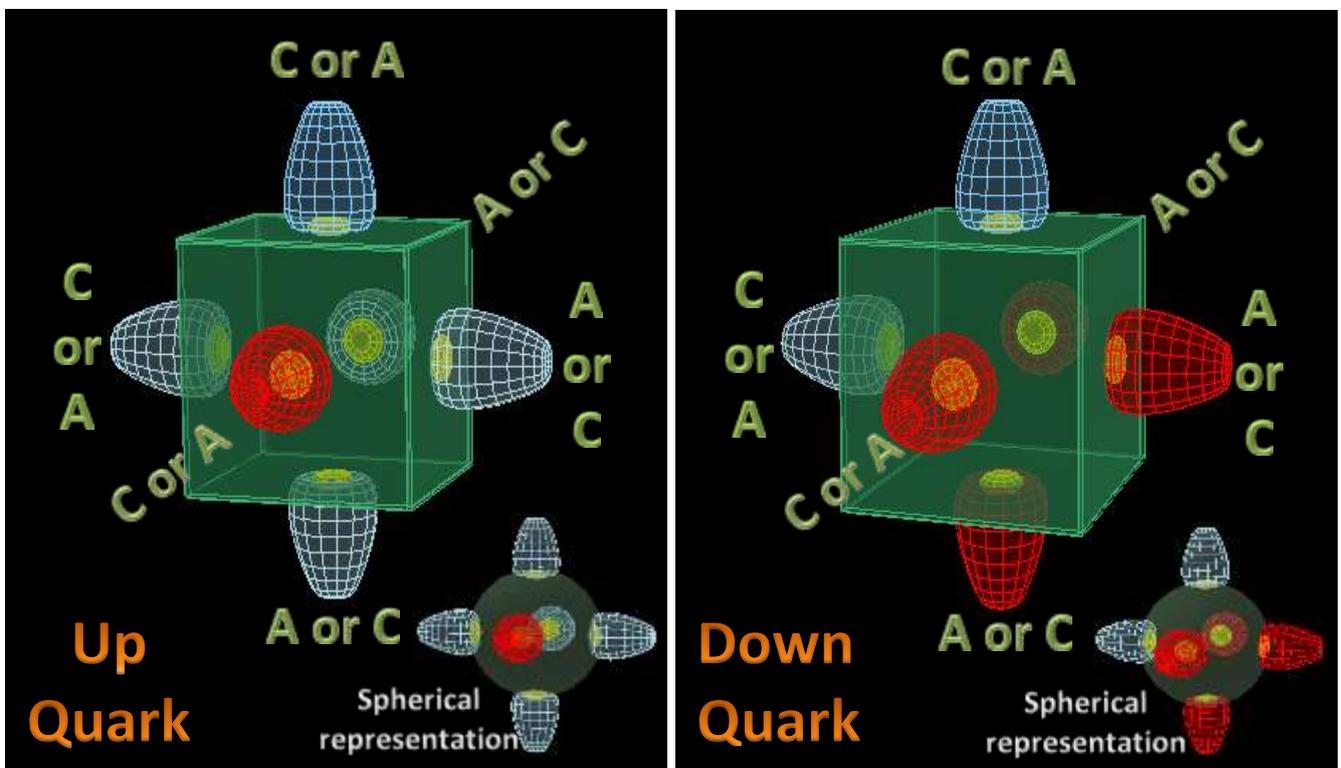


Figure 4: Cube Model of Up and Down Quarks

## Nucleons and Nucleon Bonding

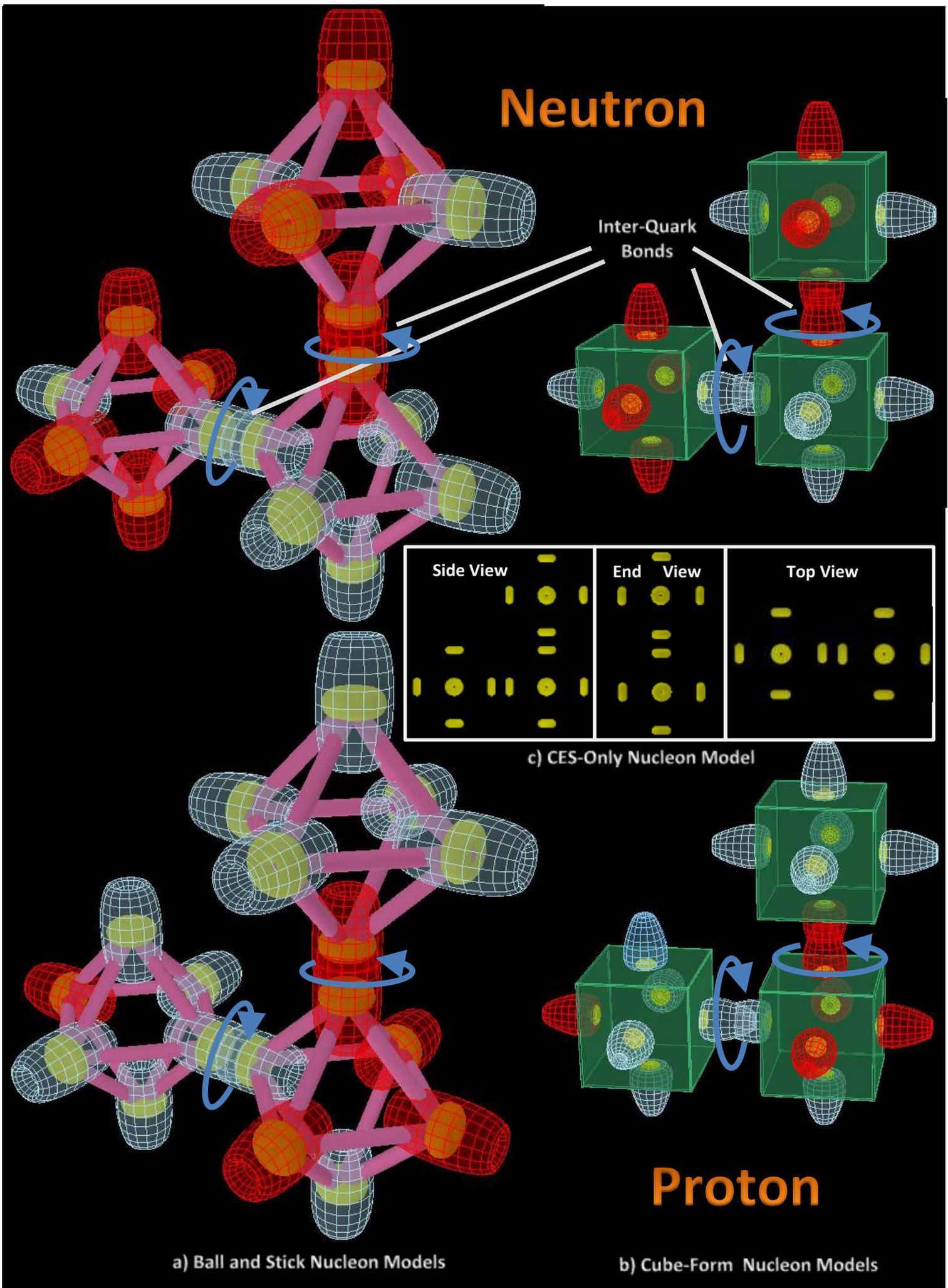
A **Proton** consists of 2 up quarks and 1 down quark, with a **Neutron** being 2 down quarks and 1 up quark. Both nucleons have an 'L' shaped form (**L-form**) as in figure 5; L-form and associated bar notations will be discussed shortly. In terms of net electric field strengths, protons consist of 2 up quarks of  $+2/3 e$  and 1 down quark of  $-1/3 e$ , resulting in a net electric charge of  $+1e$ ; neutrons consist of 2 down quarks and 1 up quark, and are thus electrically neutral.

The up and down quarks forming nucleons are joined by **strong force** joins, called **inter-quark bonds**, with the outer quarks (2 up quarks for the proton and 2 down quarks for the neutron) spinning rapidly around the join axis as shown in figure 5, unless they are restrained from doing so. The spin of the quark arms around the central quark plus the spin of each outer quark ensure a reasonably evenly distribution of electrical charge around nucleons, positive for protons and neutral for neutrons, which masks the angular L-form geometry of nucleons.

The strength of Inter-quark bonds is due to the alignment and merging of their inner and their outer energy field flow directions (figure 6a); this arrangement also provides an energy exchange and balancing function within nucleons. They can form whenever an e-CES (or a p-CES) within one nucleon is brought in close contact with an e-CES (or correspondingly, a p-CES) in another nucleon, allowing an inter-quark bond to form between them, so bonding the nucleons together. The net effect of such inter-nucleon bonding is the creation of **nucleon chains** (see figure 8). A nucleon chain can loop and close, joining up with itself so as to create a **polygonal form**. Polygonal nucleon chains with an even number of sides (4, 6, 8, 10, 14, 16...) form the structural backbone of most atoms defining their physical and chemical characteristics.

A **bitron bond** can be created when an e-CES and a p-CES are held facing each other as in figure 6b. For an AO e-CES pole facing and a CO p-CES pole the outflow of their energy fields has the same spin direction, but the linear outflow component of their central energy fields oppose each other, concentrating as a spinning torus of concentrated energy called a **bitron** (bitrons were defined in STEM Part 1, and their role in bonding atoms together to form molecules and chemical compounds will be addressed shortly). Bitron bonds apply a push-force that increases significantly as the bond length shortens, are strong in compression and correspondingly weak in tension, and they keep nucleons apart.

**Offset bonds** are inter-quark bonds that generate a pull-force (i.e. attraction) that offsets the relatively gentle push-force of bitron bonds. Offset bonds are far weaker than the inter-quark strong-force bond holding nucleon quarks together due to the increased separation distance between the participating CESs. Offset bonds exist between nucleon layers (the gold and green rods in figure 8), holding the layers together, whereas the bitron bonds keep them apart. Bitron and offset bond combinations are also responsible for ionic bonded molecules and chemical compounds.



**Figure 5: Proton and Neutron Structure**

Figure 7 shows how Inter-quark bonds can bind L-form nucleons together to create nucleon chains. The L-form nucleons interlock and so as to create nucleon layers that appear to be made up of overlapping 'l' form (l-form) protons and neutrons. Such subtle visual duality is quite fortunate because it allows nucleon chains, and thus nucleon polygonal forms, to be represented as layers of overlapping l-form nucleons, which is simpler to process and far less confusing.

The intricacies of nucleon chains and polygonal forms can be further simplified by use of **bar models** which show l-form nucleons as coloured bars that overlap to form adjacent layers. l-form protons are shown as **gold bars** and l-form neutrons as **light green bars**, as shown in figure 8b and the bottom part of figure 7.

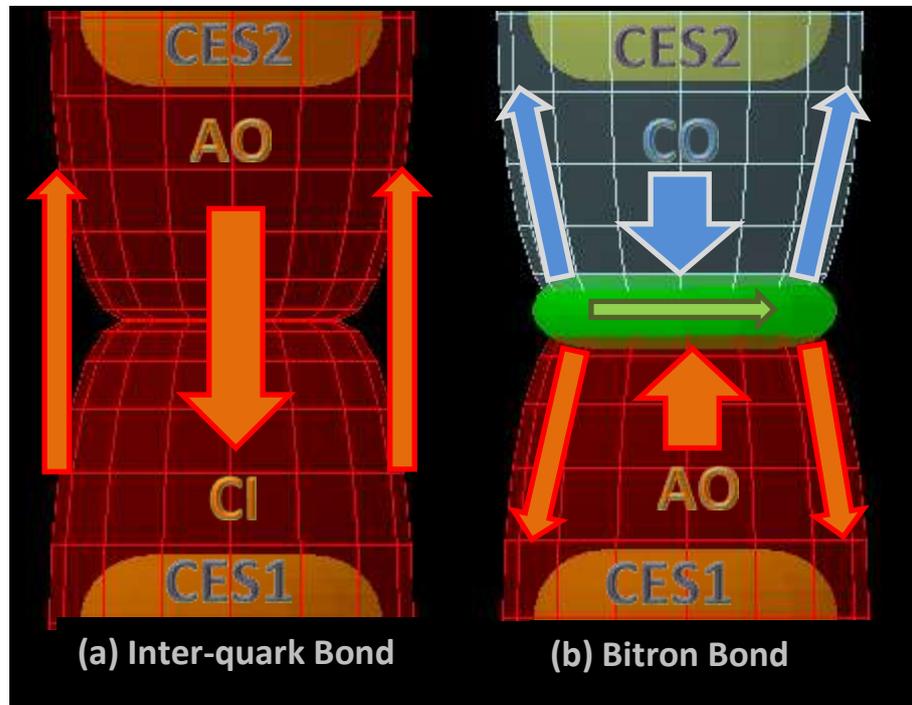


Figure 6: Inter-Quark and Bitron Bonding

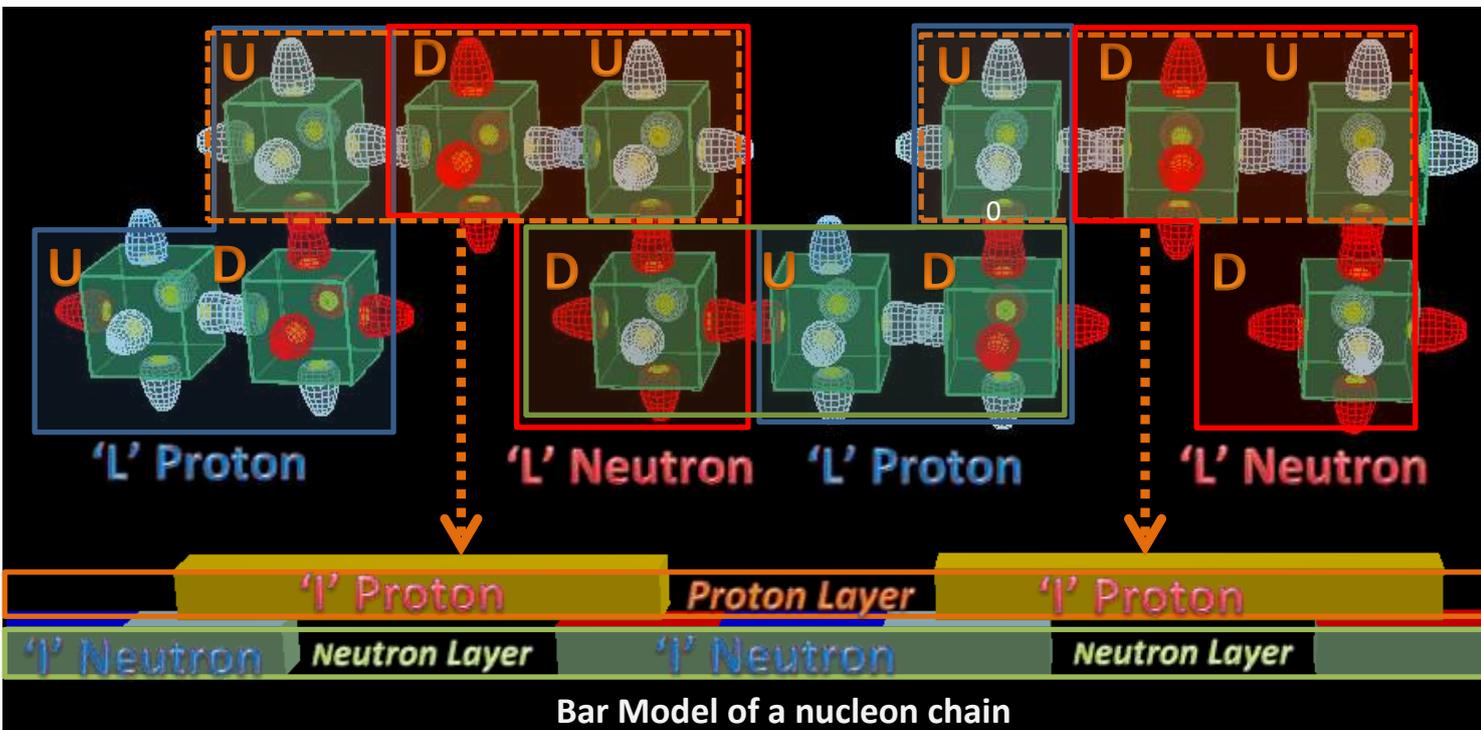


Figure 7: Nucleon Chains of L-form Nucleons interlocking to form l-form Nucleon Layers

Polygonal nucleon layers are a key component of the structure of atoms (apart from Hydrogen or Deuterium), and will be discussed in detail in the next section. However, before we can tackle the structure of atoms, the layering and bonding patterns within nucleon chains needs to be addressed.

Figure 8 shows common layering and bonding patterns within nucleon chains at both the quark and nucleon level, with layers numbered  $\pm 1$  to  $\pm 4$  building out from a central bitron layer (0). Full nucleon layers come in pairs (as for layers -1 and -2 or +1 and +2), being formed by the inter-locking of L-form nucleons as explained above. A common layer combination is the **nucleon sandwich** consisting of 2 outer proton layers (e.g. -2 and +2) being the 2 slices of bread; 2 neutron layers (e.g. -1 and +1) being the butter; and a central bitron layer (0) the sandwich filling that holds it all together.

As the outer layers of the nucleon sandwich are proton layers, more proton/neutron layer pairs (e.g. layers -3 and -4) can be built and attached via inter-quark bonds. Layer +3 represents a part or incomplete layer pair on the other side of the nucleon sandwich (now a triple-decker Dagwood sandwich): such incomplete layers warrant more attention.

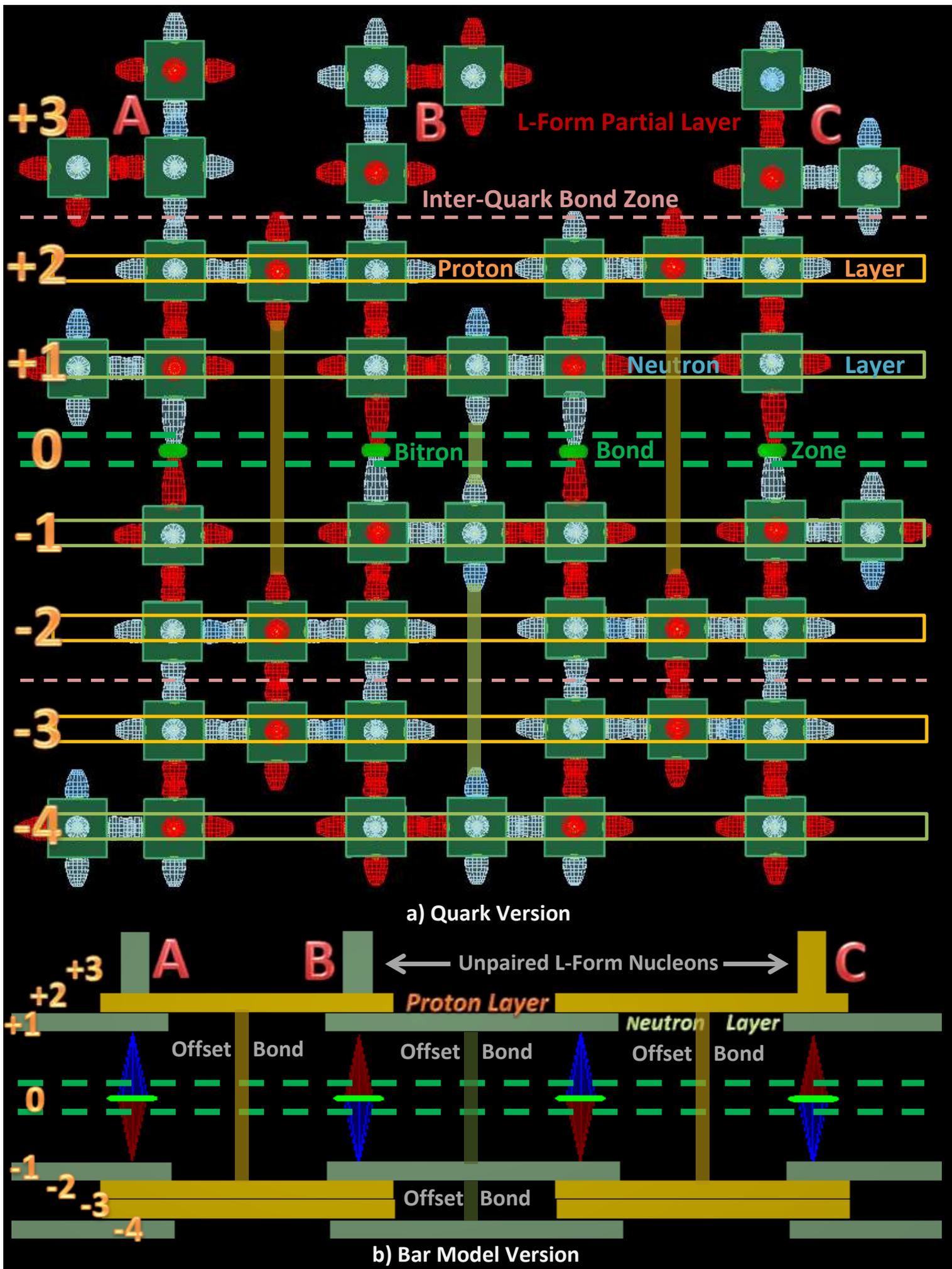


Figure 8: Nucleon Chain Layer and Bonding Patterns

L-form nucleons can attach to an outer proton surface of a nucleon sandwich via an inter-quark bond to create incomplete (or partial) layers, as for layer +3 in figure 8. Nucleons so attached can assume a **foot-out** orientation as for nucleon B or a **foot-in** orientation as for nucleons A and C. However, the spatial geometry of the attachment points on the surface of the nucleon sandwich's outer proton layer forces L-form nucleons to attach in alternating foot-in and foot-out sequences, or to leave a gap. The result is a fairly random mixture of L-form nucleons attached in groups with an alternating foot-out and foot-in pattern, plus the possibility of a few gaps in between groups. The manner in which alternating foot-in/out nucleons pattern facilitates the building of the outer I-form nucleon layers is quite intriguing.

At the centre of the intrigue is the ability of a proton to be converted into a neutron, and vice versa, as evidenced by beta decay and electron capture spread of figure 10. Putting aside the [detail of beta decay and electron capture](#) until later, when those CESs marked with an hourglass symbol in figure 9a are flipped, the proton transforms into the neutron of figure 9b, and vice versa. It can thus be argued that, just as a positron is the anti-particle of an electron, a neutron can be considered to be the anti-particle of a proton, with field flipping able to convert one to the other.

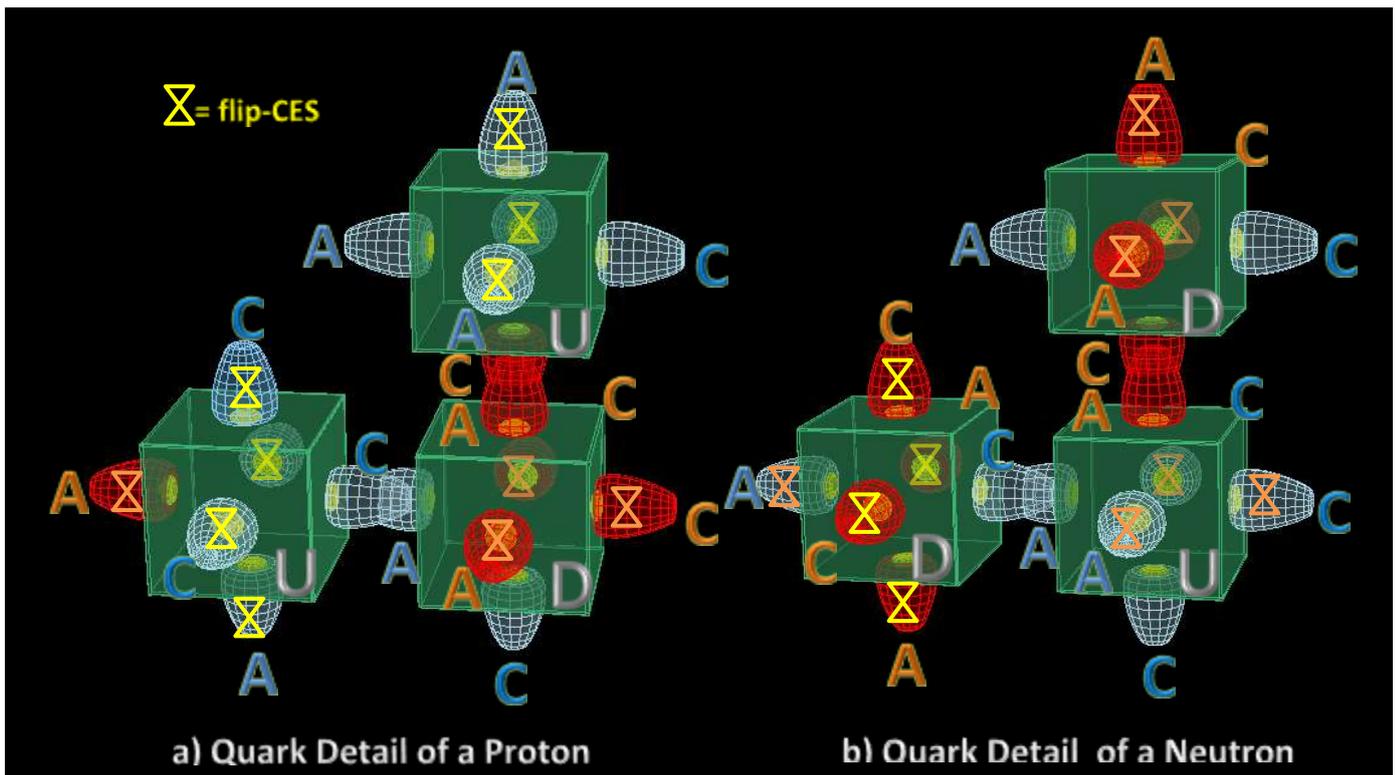
The **yellow hourglasses** indicate the CESs that can **trigger** the flipping: when any one of these is forcedly flipped, because all the CESs within a nucleon are inter-connected and inter-dependent, the internal dynamics of nucleons cause all other flip-CESs (the other 10 marked with an **orange** or **yellow** hourglass) to flip simultaneously, resulting in an instantaneous nucleon-type conversion.

To add to the intrigue, certain CESs are never flipped by the neutron-type conversion process. CESs involved in Inter-quark bonds are exempt from being flipped, as are the 3 p-CESs that are without hourglass symbols in figure 9.

Another aspect of intrigue is that, for the nucleon-type conversion process, none of those CESs marked with an hourglass can be restrained so as to prevent them from flipping. When any one the flip CESs is restrained none can be flipped: it is an all or nothing situation. However, for foot-out orientated nucleons, one of their flip CESs is involved in the inter-quark bond that attaches the nucleon to the proton layer, causing it to be restrained: thus no foot-out nucleon can be nucleon-type converted. This means that only foot-in orientated nucleons (e.g. neutron A and proton C) can become nucleon-type converted, with foot-out nucleons (such as neutron B) unable to be type-converted.

Foot-in nucleons can continue type-converting, alternating between the neutron and proton forms indefinitely. However should they become bond-restrained either by becoming inter-quark bonded to an adjacent foot-out nucleon, so forming neutron-and-proton interlock pair; or by forming an external bitron bond with another atom. Once bond-restrained any further participation in a type-conversion process is prevented.

Thus nucleon-type conversions or the possibility thereof, can continue indefinitely for atoms that have foot-in nucleons that remain un-restrained. The ongoing decay instability associated with unrestrained foot-in nucleons is extensive throughout the Periodic Table and well documented (e.g. the graph of figure 10) but little understood.



**Figure 9: Nucleon Conversion - CES Flip Patterns**

Should neutrons become attached to all latch points on the outer proton layer of a nucleon sandwich, over time the foot-in nucleons would randomly be type-converted into protons and inter-quark bond with an adjacent foot-out neutron. At some stage all the foot-in nucleons will convert to protons, so forming a complete pair of proton and neutron layers similar to layers -3 and -4. Such atoms would fall into the Group 18 (noble gas) column of the Periodic Table, which, according to the orbital model, have a complete outer electron shell.

For other elements falling within other Groups of the periodic Table, gaps and mismatched groups result in incomplete or partial outer layers, with the total number of protons and neutrons only becoming stable when all the foot-in nucleons have been restrained by bonding.

Another aspect of the sub-atomic landscape is the ability of **swivel quarks** (up quarks within I-form neutrons and down quarks within I-form protons) within nucleon chains to swivel  $360^\circ$  as shown in figure 11. Swivel quarks within protons contain 4 e-CESs within their spin planes, and those within neutrons have 4 p-CESs. Bitron bonds are invariably formed by pairs of opposite chirality swivel quarks.

As well as providing columnar support keeping nucleon layers apart, bitron bonds provide support struts keeping embedded polygonal forms in place and away from the enclosing polygonal form. The push-force of all bitron bonds is always countered directly or indirectly by offset bonds.

STEM quark and bar diagrams may suggest a rigid cube-based geometric framework that would lack sufficient flexibility to accommodate the range of bond angles and structural geometry observed in molecules, chemical compounds and cellular structures. However, this far from the case: the polygonal nuclear geometries combined with the swivel quark flexibility provide adequate degrees of freedom to explain the patterns observed.

So far STEM has provided an explanation for:

- nucleon layering within an atom,
- the types of bonding involved,
- nucleon-type conversion and its relationship to beta and electron capture related decay, and
- why nuclear decay stabilises and stops in some atoms but continues indefinitely within others.

Now that the nature of nucleons, nucleon bonding and nucleon chains and polygons has been established, we are able to move on to explore the nuclear structure of atoms.

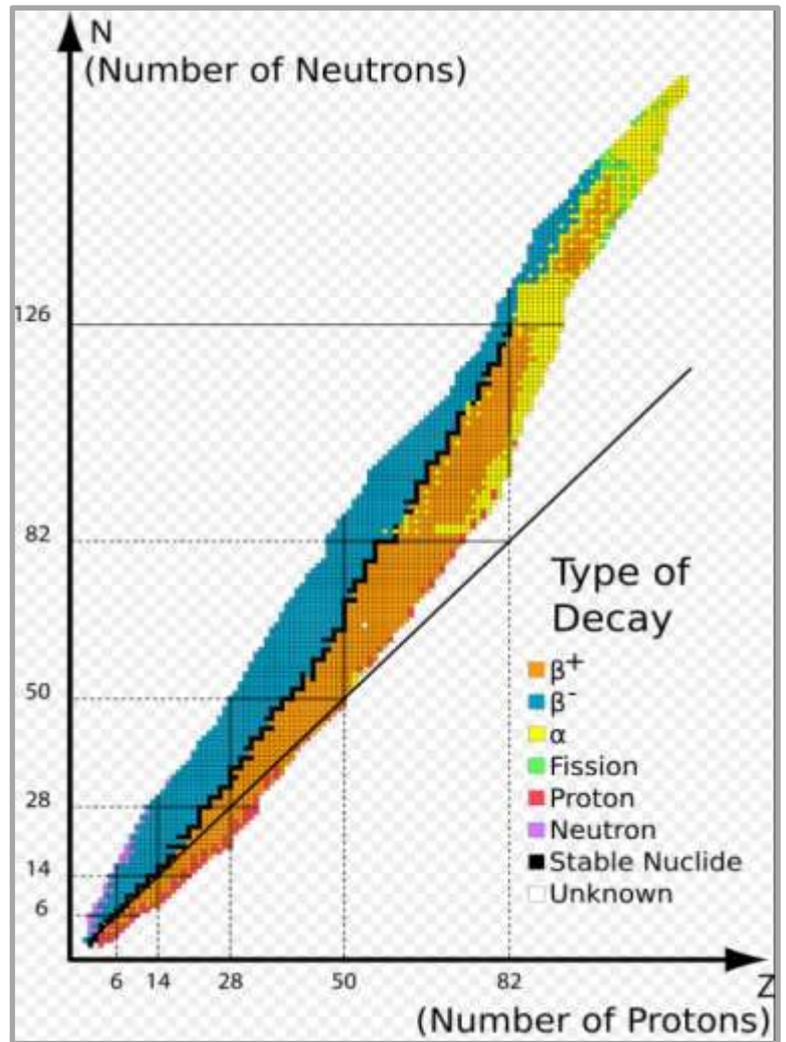


Figure 10: Plot of Nucleus Related Decay by Atomic

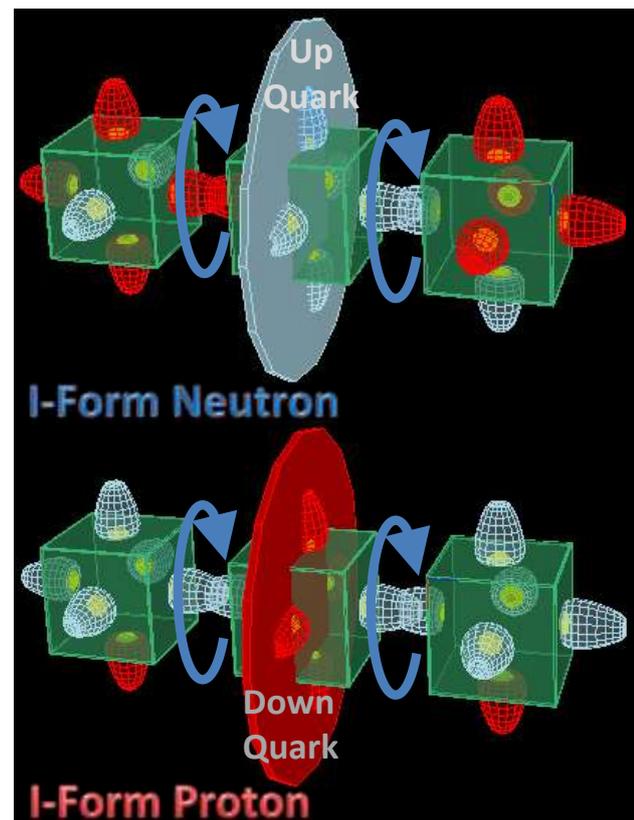
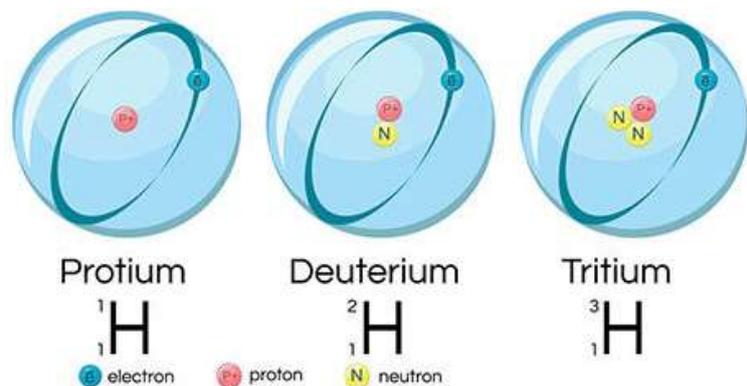


Figure 11: Swivel Quark  $360^\circ$  of Freedom

# Atomic Structure of the Elements of the Periodic Table

**Hydrogen**, the **first element** in the Periodic Table, has 3 naturally occurring isotopes, often denoted  $^1\text{H}$ ,  $^2\text{H}$  and  $^3\text{H}$ . The first 2, Protium and Deuterium, are stable, while Tritium beta decays. The conventional orbital nuclear model for the trio is shown in the diagram right, and in diatomic molecular form they are considered to covalently share 2 electrons.

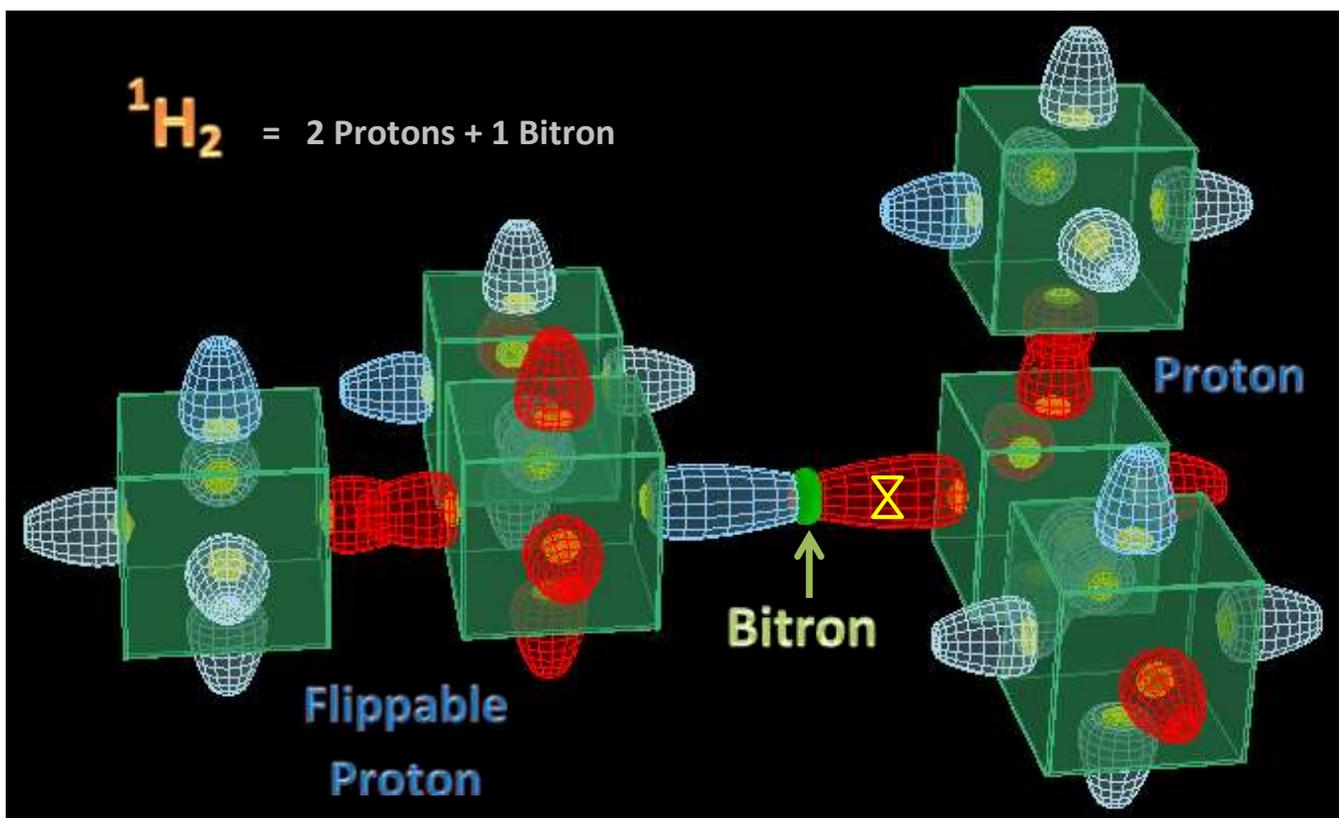


According to STEM, the  $\text{H}_2$  (or  $^1\text{H}_2$ ) **molecule** consists of two protons that are bonded internally by a single bitron bond (see figure 12). The 4 up quarks spin rapidly generating a uniform outer electric field.

There are two aspects of the STEM version of the  $\text{H}_2$  molecule. Firstly, an electron or a bitron does not covalently orbit around the proton pair: instead a bitron bond (internal to the molecular structure) keeps the proton pair apart and it is the attraction force between the up quarks spinning in unison that form the offset bonds that binds them together. And secondly, 1 of the proton pair has 1 of its flip quarks (indicated by an hourglass symbol in figure 12) restrained by the bitron bond, whereas no flip quarks in the other proton are restrained, thus allowing it to potentially be converted into a neutron, and still have the ability to convert back into a proton.

Should one of the protons of  $\text{H}_2$  be converted into a neutron, a **Deuterium atom** (see figure 13a) is created, but it has very little chance of long-term survival as it lacks a mechanism to keep the proton and newly formed neutron attached: it either splits or it attaches to another neutron to form **tritium**. Cosmologically, as stellar fusion is considered to destroy deuterium, most deuterium is attributed to the Big Bang nucleosynthesis process. This might explain why, although deuterium can be created chemically,  $\text{H}_2$  does not auto-decay into deuterium under conditions that can be simulated experimentally: we have a mechanism but not the conditions that trigger the transformation.

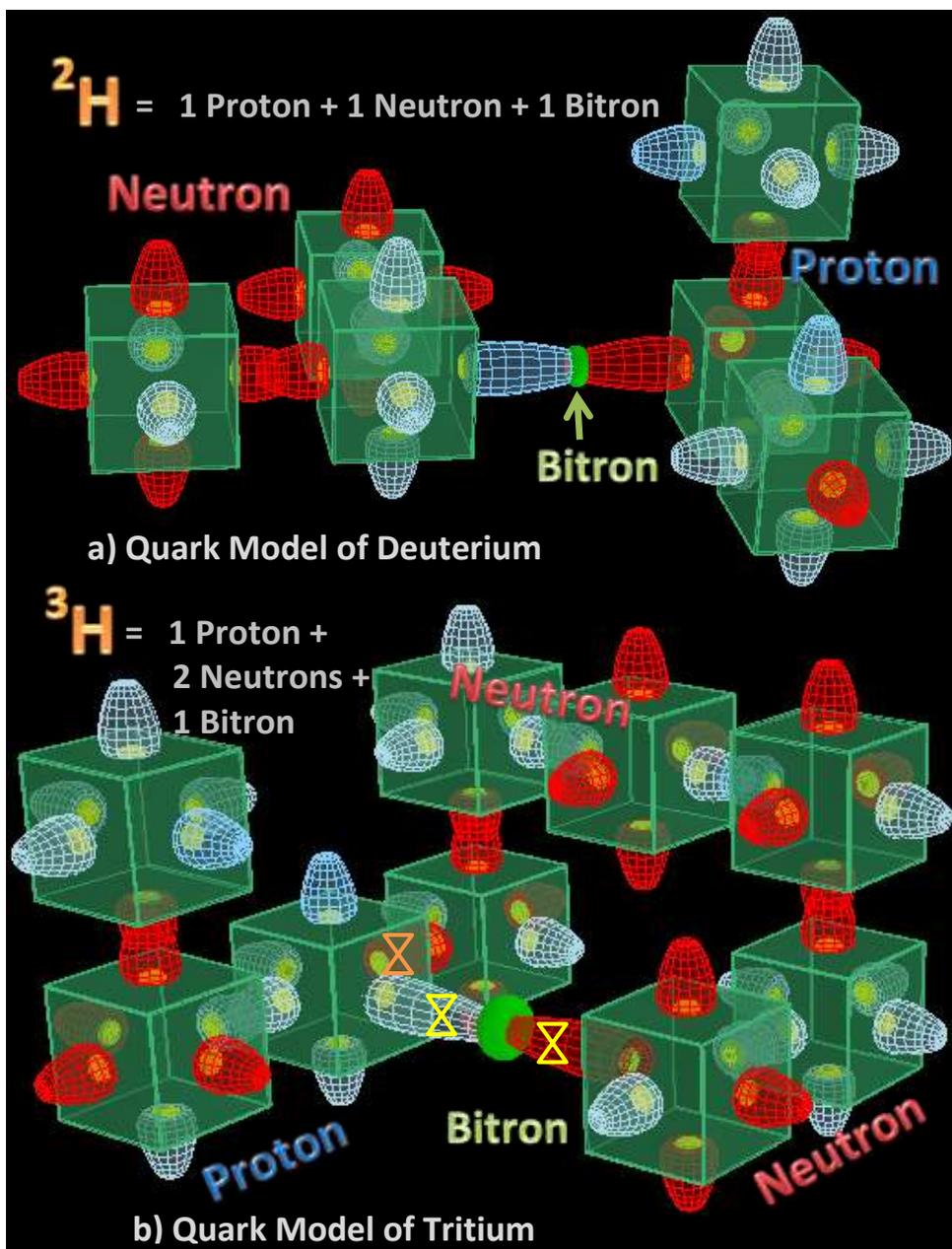
Tritium consists of 2 neutrons and 1 proton with a bitron bond forming between an up and a down quark as shown in figure 13b. Being subjected to torque from the spin of L-form nucleon arms and spin-quarks, the Tritium structure is not overly stable, with the bitron bond regularly breaking and re-forming. When the bitron bond is in place, a pair of flip quarks becomes restricted: when the bond is broken, the 1 of the flip quarks the proton (orange hourglass) is restrained, but 1 neutron (the rightmost one in figure 13b) is unrestrained and can be converted into a proton, so converting  $^3\text{H}$  into Lithium-3 (figure 14) by beta-minus decay. The half-life of tritium is about 12 years.



**Figure 12: Quark Model of a Diatomic Hydrogen Molecule**

Even though the Hydrogen atom has a simple structure (just 1 proton), its molecular structure is quite complex and there are 2 other natural isotopes and 4 synthetic ones. As the atomic number of atoms increases, so does the structural complexity and variation possible. Although not suited to Hydrogen, the bar-model technique comes into its own from He-4 onwards by simplifying the modelling process, and making the 3-D geometries of models easier to visualise and more manageable.

The down-side is that the bar-models are visually clunky and angular compared to the more aesthetic ball-and-stick models. It is hoped that in the near future software will allow instant conversion between bar and ball-and-stick modes, and to switch between the I-form and L-form views with full rotate and zoom support. It is also hoped to link the models to the physical and chemical properties of atoms, molecules and chemical compounds, as do many Chemistry-based modelling packages such as ArgusLab, Avogadro, ChemSketch and ChimeraX (listed in alphabetic rather than preference order).



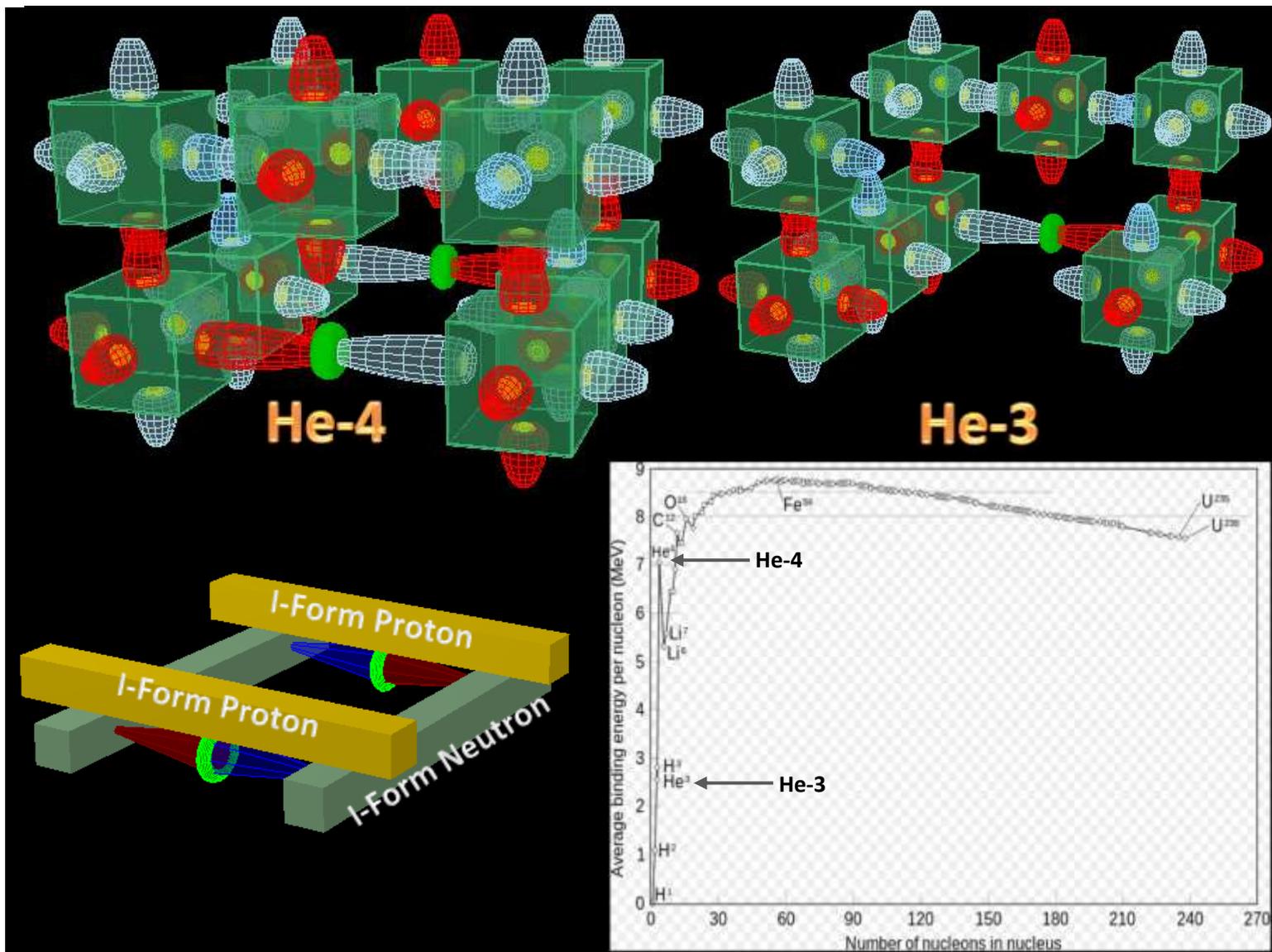
**Figure 13: Quark Model of Deuterium and Tritium**

STEM contends that it is bitrons rather than electrons (as defined and used by orbital models) that are an integral part of the structure of all atoms in the Periodic Table. Internally bound bitrons form an integral part of the nucleus's structure, whereas external bitrons can be generated, lost and/or exchanged dynamically, as reflected in the valency options and bonding patterns of atoms. Bitrons are not electrons, but upon release from an atom, molecule or chemical compound, as a free entity, they can become an electron, or, with equal probability, a positron. Bitrons are a secondary form of concentrated energy that can be re-generated within a bitron bond should they be removed from the bond. All free electrons and positrons are considered to have, at some stage, come from bitron bonds.

**The second element** in the Periodic Table is **Helium**, which is the first in the **noble gas** group in the Periodic Table. He-4 consists of two L-form proton and neutron pairs inter-locking to form a 2 proton I-form and a 2 neutron I-form layer, and further strengthened by 2 bitron bonds as shown in figure 14 (note that inter-layer bonds are not shown in bar models to reduce diagram complexity). STEM contends that He-4 contains 2 bitrons internal to the nucleus rather than 2 electrons in the external  $1s^2$  orbital as claimed by the orbital model.

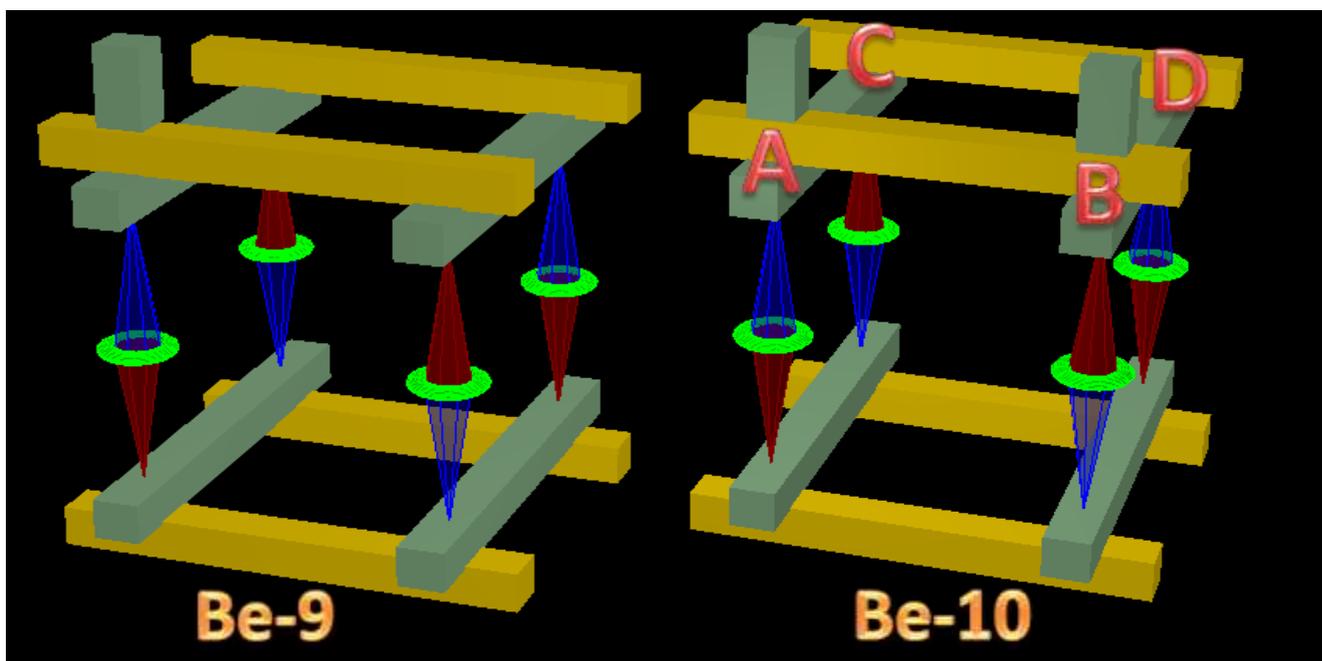
The compact geometry of helium-4 results in a high binding energy (see the graph of figure 14) compared with He-3, which consists of 2 L-form protons, 1 L-form neutron and only 1 bitron bond). As **alpha radiation**, the nucleus of He-4 can be quite damaging to other matter over short distances. Although it has a strong backbone consisting of and an I-form neutron and a bitron bond, the He-3 atom is somewhat unbalanced and far weaker and unstable than He-4.

**The fourth element** in the Periodic Table is **Beryllium**, which is a divalent element only occurring naturally in combination with other elements within minerals. As a free element it is a steel-grey, strong, lightweight and brittle alkaline earth metal.



**Figure 14: Bar Models of He-4 and He-3**

Beryllium predominantly consists of only 1 stable isotope, Be-9, and thus can be considered monoisotopic. Be-9 has one neutron attached to one of its outer proton layers and Be-10 has two: thus Be-9 is stable, whereas Be-10 has the potential to decay depending upon the location of the attached neutrons. There is about a 30% probability that the neutron pair of Be-10 attach to favourable positions (A-B, A-C, C-D or D-B in figure 15), with one having a foot-in and the other foot-out orientation, so facilitating interlock when the foot-in neutron beta converts into a proton.



**Figure 15: Bar Model of Beryllium-9 and Beryllium-10**

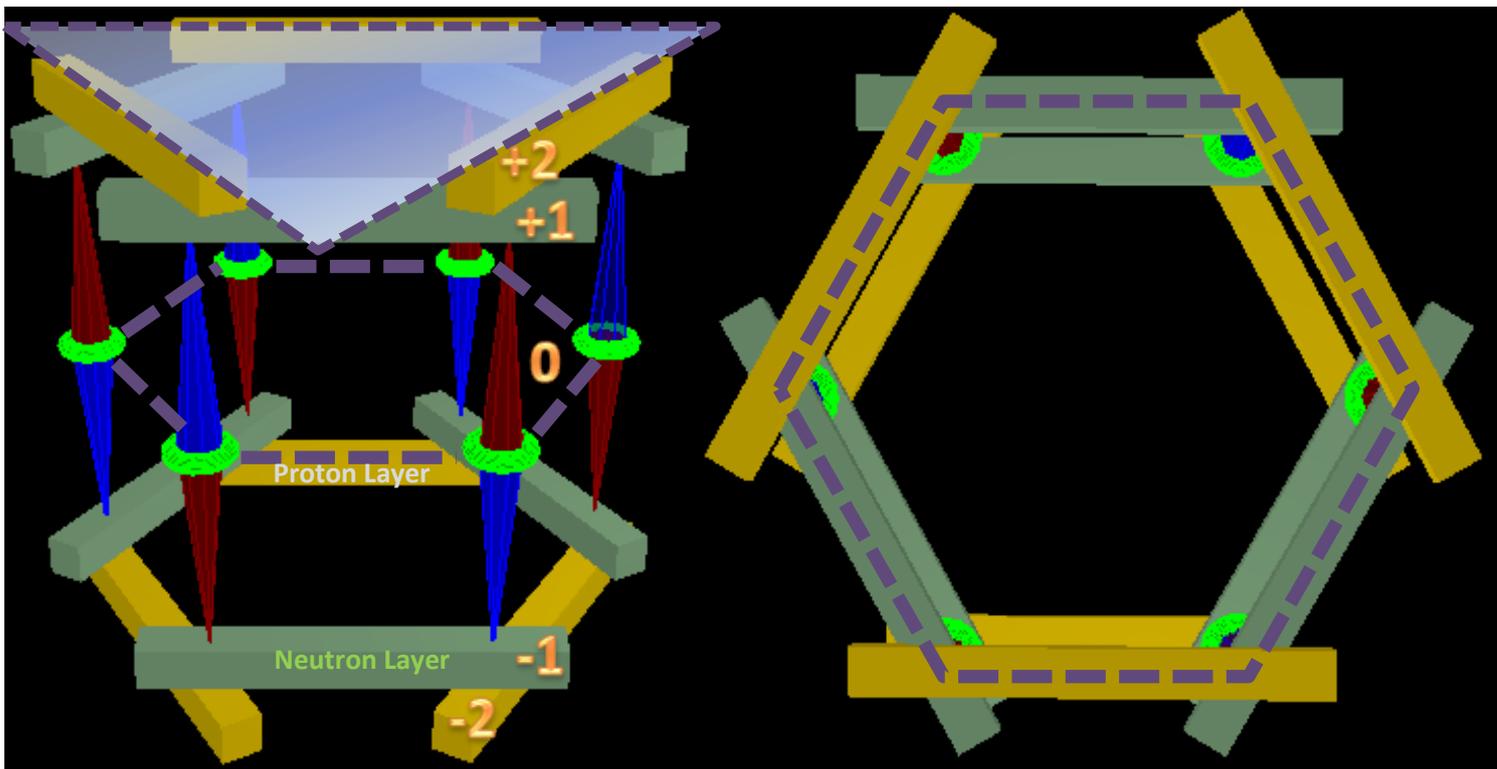
Some Be-10 atoms thus beta decay to form Boron-10, with some atoms engaging in beta decay but reverting back into Be-10 because they are unable to interlock due to the attach location of the extra neutrons (possibly on opposite sides of the atoms or diagonally opposite as for A-D, B-C combinations), and some Be-10 atoms display no beta decay because both neutrons have foot-out orientation. Some however undergo once-off beta decay and interlock to produce decay-stable B-10. This mix of configurations of attached neutrons results in a long half-life of 1.36 million years for Be-10, with its radioactivity gradually diminishing as some atoms (less than 30%) are permanently converted into stable B-10 atoms.

For larger atoms further up the Periodic Table the number of sides of the polygonal layers increases, but, particularly in the lower Periods of the Periodic Table, not consistently so. As the Atomic number of elements increases, so does the size and number of polygonal nucleon layer shapes possible and thus the number of forms an element can take: Carbon 12 is a good example of such **allotropy**.

**Carbon** is the **sixth element** in the Periodic Table. Carbon-12 has two allotropic forms: one hexagonal presenting as **Graphite** (figures 16 and 17), and the other tetragonal form presenting as **Diamond** (figures 18 and 19).

Graphite's nucleus consists of two hexagonal polygonal layers each made from 6 overlapping I-form nucleons consisting of 3 neutrons and 3 protons: the triangular nature of each I-form layer and overall hexagonal shape is highlighted by the purple dashed shapes in figure 16. Layer 0 contains 6 bitron bonds and the nucleon layers nucleon layers -2 to +2 (using the figure 8 notation) are all complete with no unpaired L-form nucleons attached.

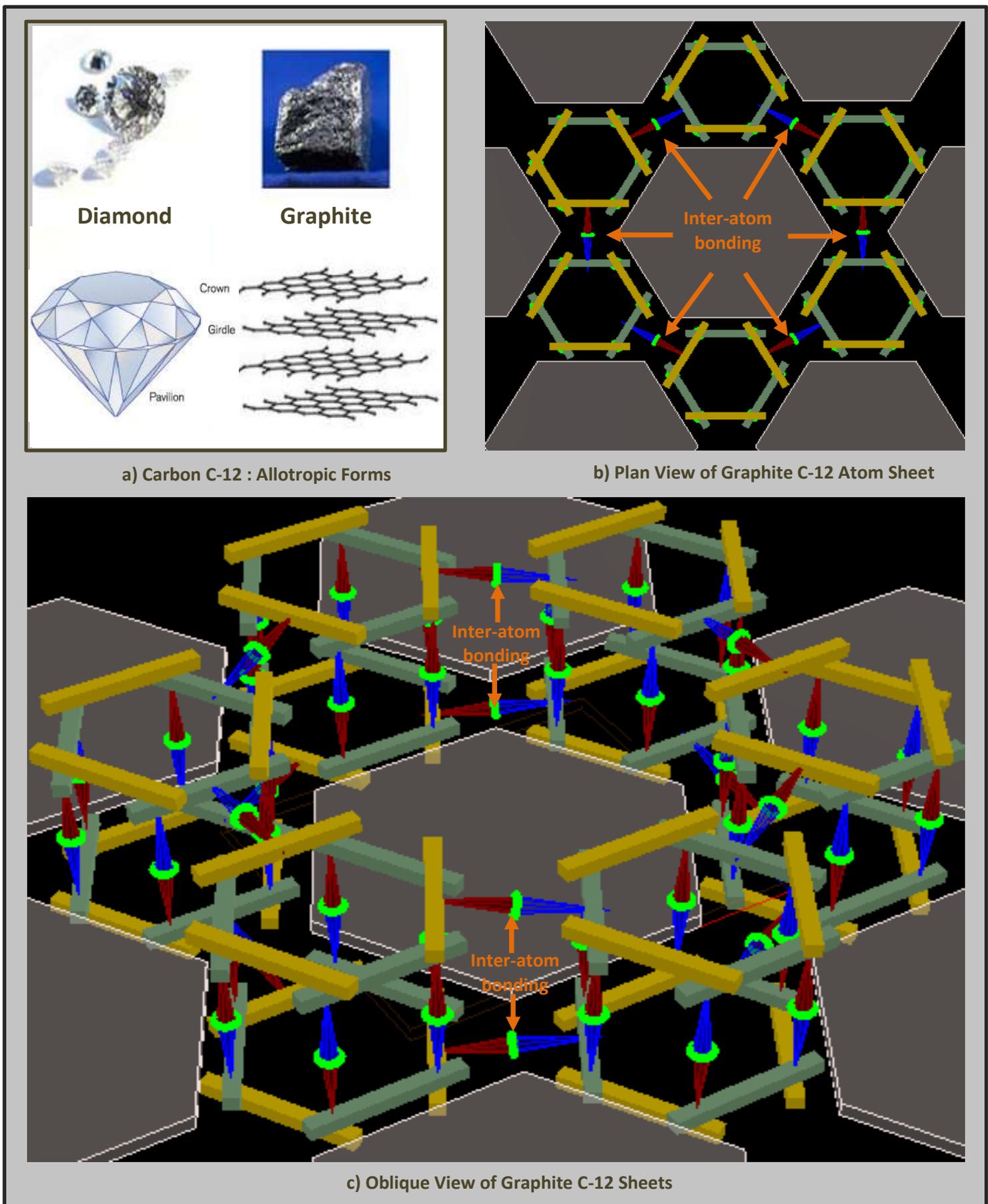
Graphite commonly occurs in sheets, as shown in figure 17, with the swivel quarks deployed as inter-atom bitron bond struts connecting adjacent C-12 atoms, creating a larger-scale hexagonal pattern, and providing graphite with its soft layered structure. C-12 graphite sheet atoms each have 6 column-like internal bitron support bonds.



**Figure 16: Bar Model of C-12 Graphite: Side and Plan Orthographic Views**

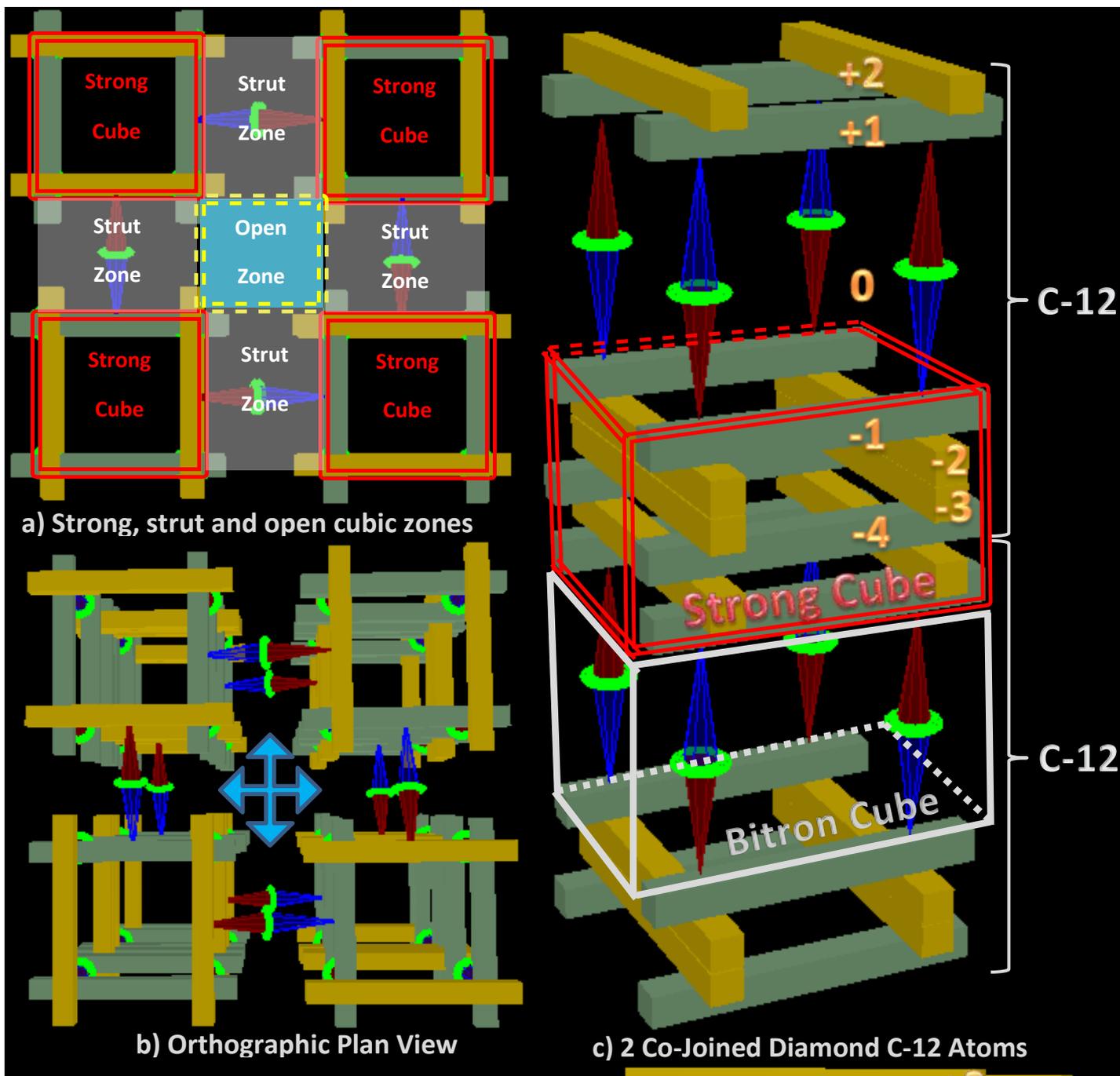
The **diamond** nucleus, on the other hand, consists of a **tetragonal** structure as shown in figure 18d, containing 7 layers (including a bitron layer of 4 bitrons) corresponding to layers -4 to +2.

Diamond atoms strongly bond together end-on-end so as to form atomic stacks as shown in figure 18c, with proton layer +2 of the lower atom inter-quark bonding to neutron layer -4 of the other. The join boundaries between adjacent co-joined atoms become obscured as layers -1 to -4 in the upper atom combine with layers +2 and +1 of the lower atom combine to create a cubic form referred to as a **strong cube** because all its nucleons are bound by strong-force inter-quark bonds. Separating the strong cubes within the diamond atom stacks are structurally weaker bitron bonds that are referred to as **weak cubes**. Thus stacks of co-joined tetragonal diamond C-12 atoms form a columnar structure consisting of a series of connected **strong** (inter-quark bonded) and **weak** (bitron bonded) cubes, and thus present as having a **cubic** form.



**Figure 17: C-12 Allotropic Forms and Bar Models of Graphite Sheets**

Adjacent columnar stacks of diamond C-12 atoms are separated from each other by bitron bonds struts that form between proton layer +2 and neutron layer +1 (or -4) in the other stack, as can be seen in the orthogonal XY plan view of figure 18b. Note that adjacent stacks are rotated by  $90^\circ$  (around the vertical Z axis) to each other to facilitate inter-strut formation. Also, central to any 4 adjacent stacks is an 'open zone' that is free from obstruction, thus allowing the free passage of light and contributing to the transparency and clarity of diamonds.

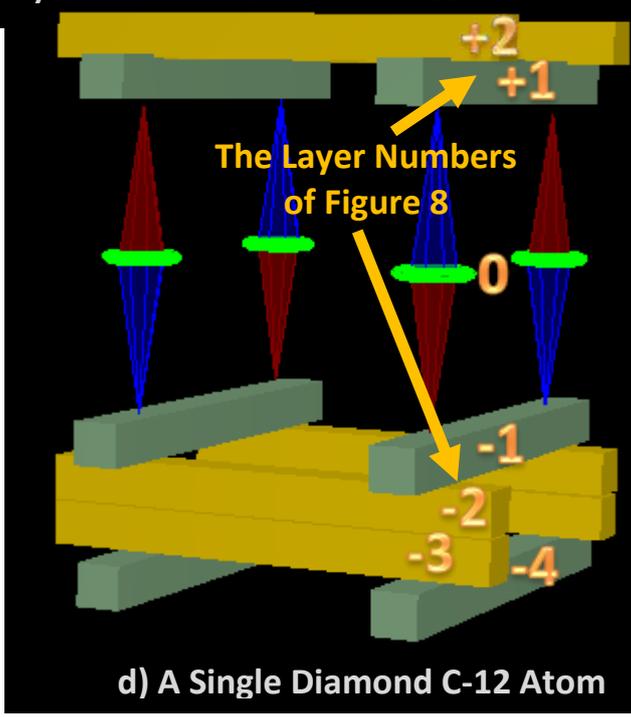


The 'strong cubes' are held together by strong force inter-quark bonds and thus one of the strongest structures to be found in any element, as reflected by the hardness of diamonds.

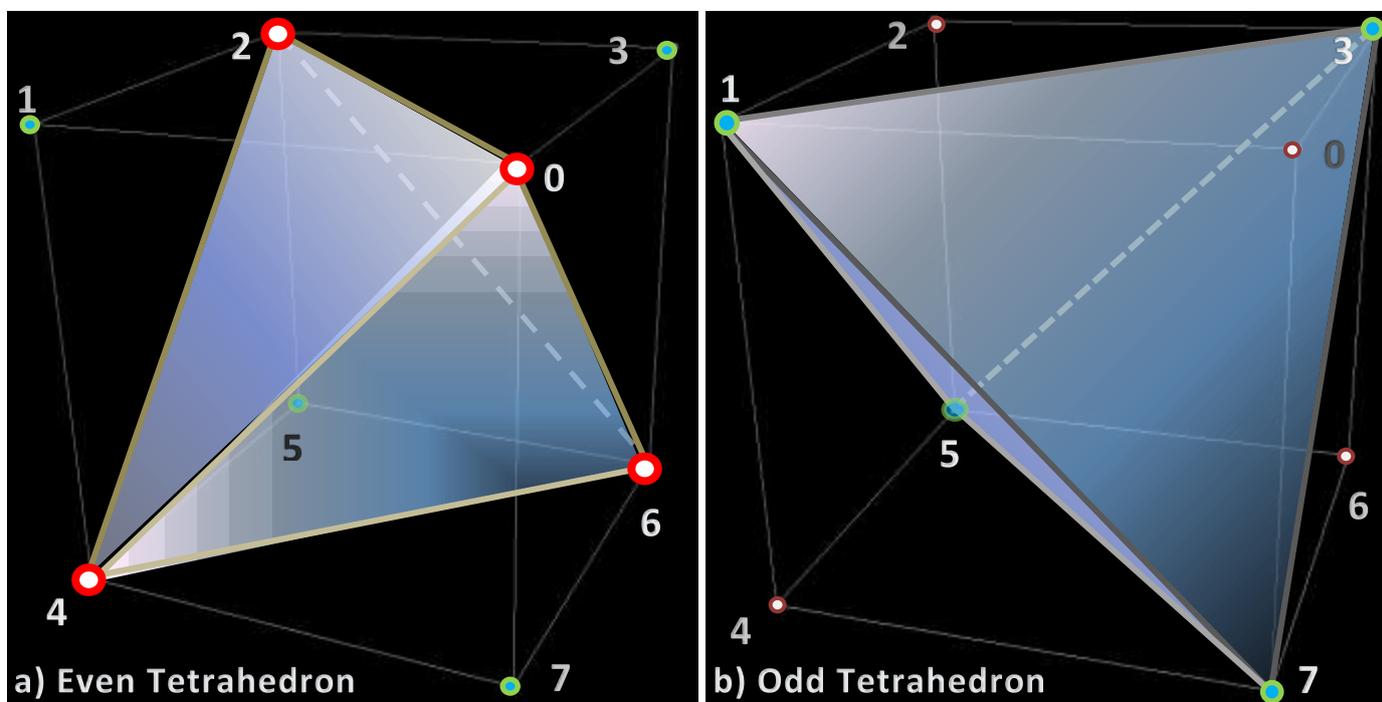
'Weak cubes', consisting of the 'strut zones' between atom stacks and the 'bitron cubes' between the 'strong cubes', act as separators to produce a regular 3-D lattice-like array of strong cubes that is responsible for the tetrahedral crystal structure of diamonds.

Figure 19c emphasises the regular 3-D lattice geometry of the strong cubes suspended within and separated by the weak zones. The alternating colours represent the 90° rotation between adjacent columnar stacks of hard cubes.

The weak and open zones allow light photons to pass through diamond crystals largely unobstructed, apart from minor absorption, dispersion and refraction.

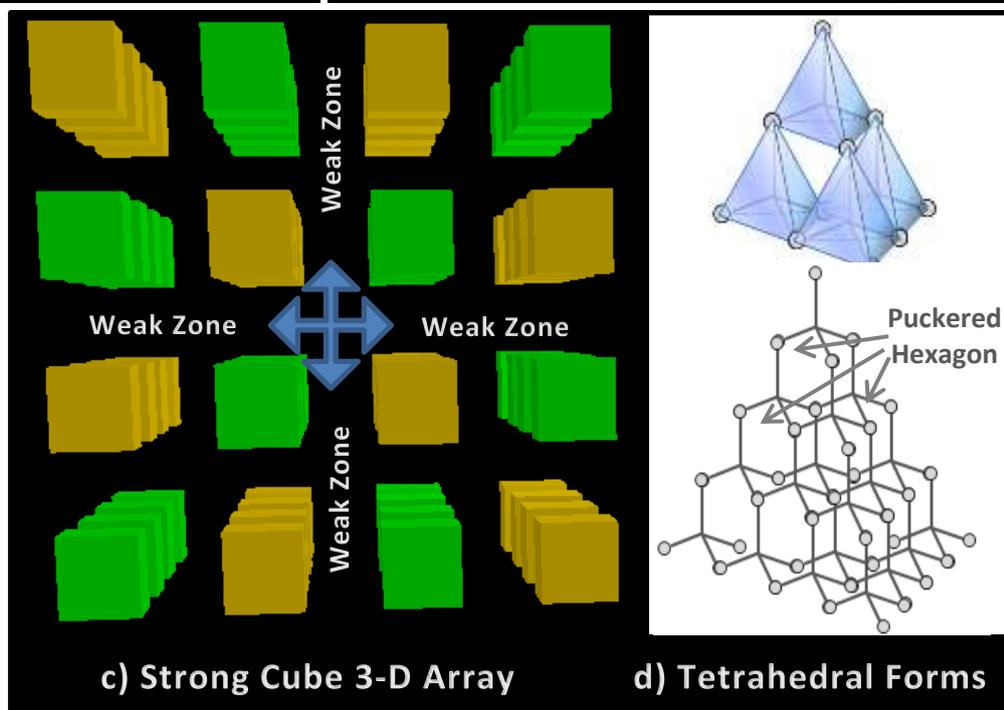


**Figure 18: Bar Models of C-12 Diamond**



Any cube defined by 8 vertices (numbered 0 to 7 in figure 19a-b) contains 2 embedded tetrahedral forms, each defined by 4 vertices: 1 formed from even numbered vertices (**red circled dots** of 19a-b) the other by the odd numbered vertices (**green dots**).

The hard cubes form a regular 3-D cubic array within diamonds. Any cube-shaped grouping of  $n^3$  hard cubes (including overlapping cube groups) for  $n \geq 2$  defines 2 tetrahedral forms, each with hard-tipped vertices that influence the formation and shape of diamond crystals. The strut and open zones represent areas of relative weakness that line up to create micro shear surfaces that form diamond's multi-faceted faces.



**Figure 19: Diamond C-12 Tetrahedral Forms**

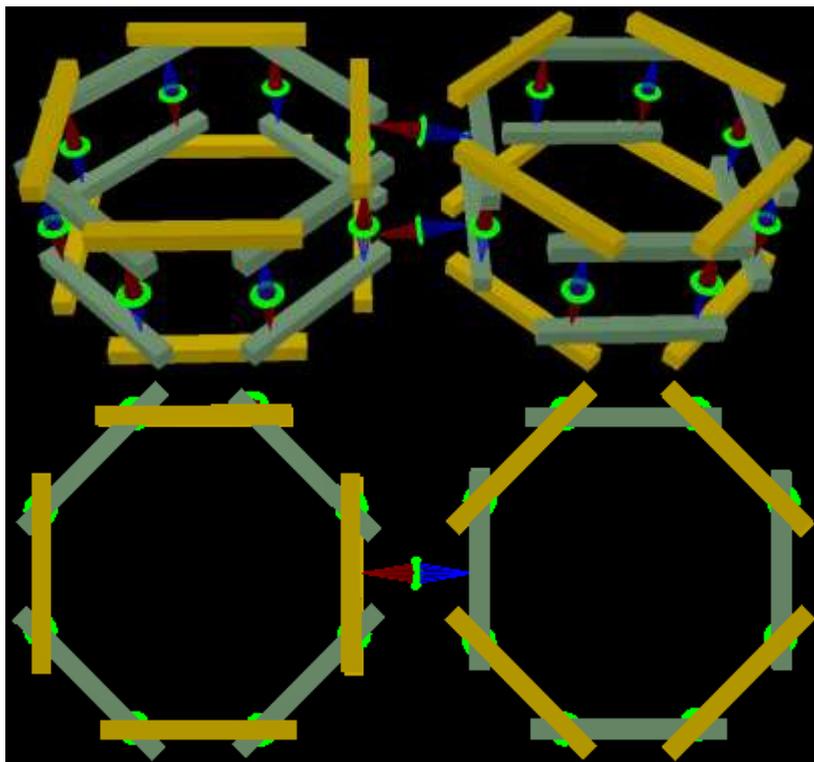
It is thus the regular 3-D grid of strong cube nodes produces the tetrahedral aspect of a diamond's crystal structure, with the repeat strong (or hard) cube vertex pattern producing one of the hardest elements in the Periodic Table. Although contaminants produce imperfections that weaken and distort the crystal lattice, the angular external faces so formed create internal reflection and refraction that creates the diamond's sparkle, with the valley-like weak and open zones providing its brilliance and transparency.

When the embedded tetrahedron forms are represented in ball-and-stick form, as in figure 15d (note that there is no central cubic node connected), **puckered hexagon** rings become apparent in the crystal structure.

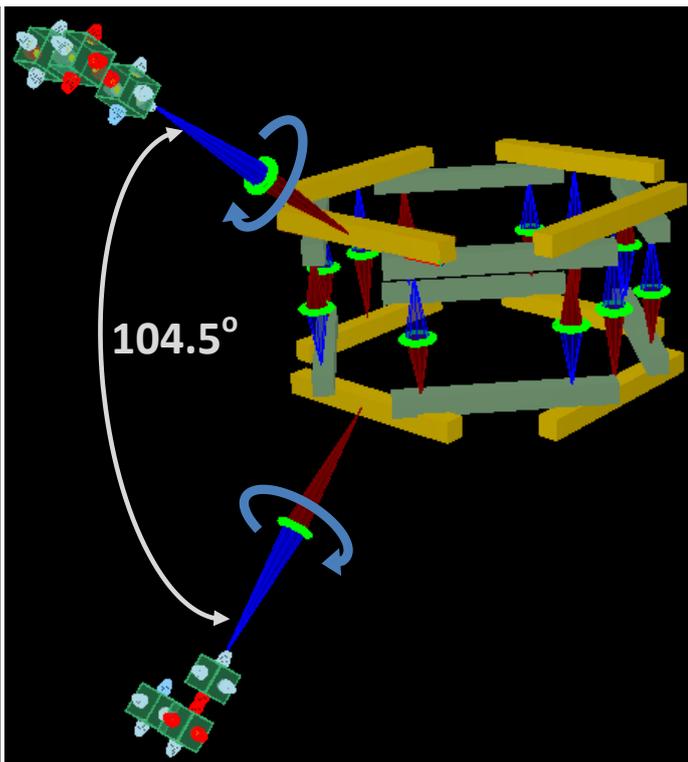
The uniqueness of the diamond structure is defined by its multi-faceted forms: tetragonal, cubic, tetrahedral and (puckered) hexagonal. The contrast between the physical characteristics of the 2 allotropic forms of C-12, which although having the same nucleon count, is extreme: Graphite is a layered, grey material that is soft enough to be used for pencil 'lead', whereas Diamond is clear, semi-transparent and sparkly, and hard enough to cut glass.

As explained by the STEM approach, the vastly different physical properties of the diamond and graphite allotropic forms are directly attributable to their different nucleus structures, underlining the importance that nucleus structure and geometry have in determining the physical and chemical characteristics of all of elements in the Periodic Table.

The **eighth element** of the Periodic Table is **Oxygen**, which is a highly reactive non-metal and oxidizing agent that, by mass, is the third-most abundant element in the universe after hydrogen and helium. The **Oxygen** atom has, 8 protons, 8 neutrons and 8 bitrons bonds. **Dioxygen** ( $O_2$ ) consists of 2 oxygen atoms joined and 2 external bitron bonds formed between swivel quarks in the +1 & +2 layers, and mirrored in the -1 & -2 layers, as shown in figure 20.



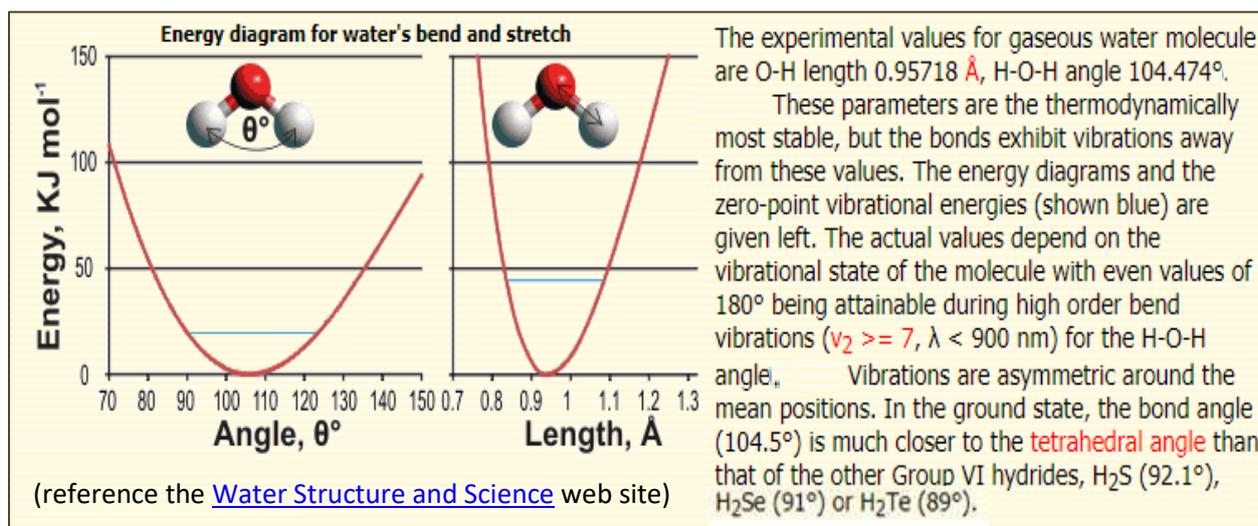
**Figure 20: Bar Model of Dioxygen ( $O_2$ )**



**Figure 21: Composite Model for Water**

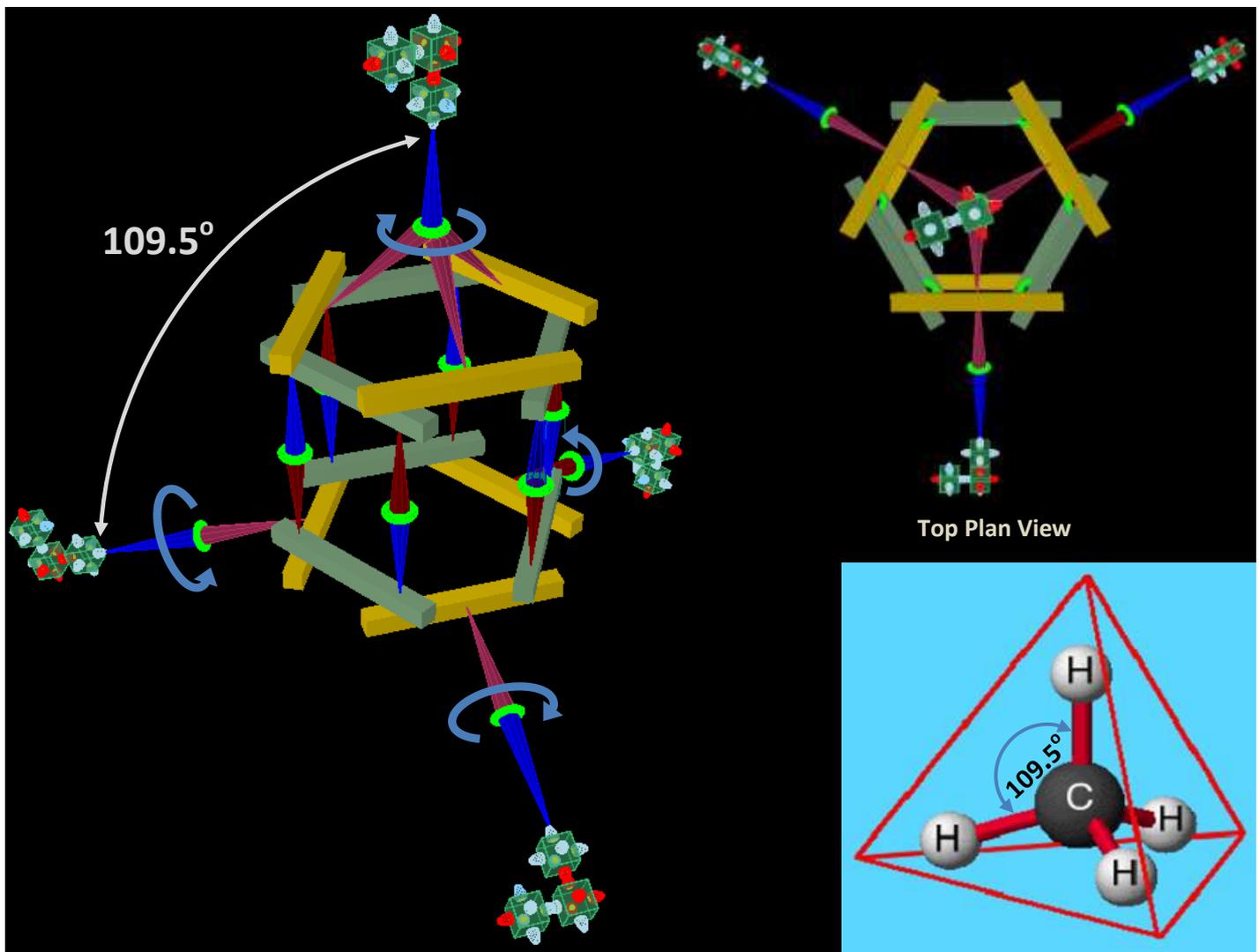
Whereas nucleon layers for Carbon-12 can have a tetragonal/cubic or hexagonal form, those for the Oxygen atom have an octagonal form. As atomic number increases, the maximum number of sides of the polygonal nucleon layers can also increase, and do so in even side number increments as they are formed by inter-linked L-form nucleon pairs.

Bitron bonds external to an atom create chemical bonds with other atoms, molecules or compounds. For water ( $H_2O$ ) the 2 hydrogen atoms (protons) are bitron bonded to a pair of swivel quarks within the top (+2) and bottom (-2) proton layers of an oxygen atom, as shown in figure 21. The  $360^\circ$  rotational ability of swivel-quarks means that in the gaseous state the angle between them and the length of the bonds can vary, or more accurately, vibrate around the mean angle of  $104.45^\circ$  and  $0.9584\text{\AA}$  (see graphs and notes of figure 22).



**Figure 22: Bond Variation of Gaseous Water (steam)**

Another example of external bitron bonding is Methane ( $CH_4$ ), a tetrahedral molecule created by the bitron bonding of 4 hydrogen atoms to a hexagonal C-12 atom. The 3 swivel quarks in the lower proton nucleon layer (-2) each bitron bond to hydrogen atoms, and the energy fields of the corresponding 3 swivel quarks in the +2 proton layer merge to form a single bitron bond with a 1 single hydrogen atom. The nett result is the tetrahedral structure of a methane gas molecule as shown in figure 23.



**Figure 23: Composite Model for Methane (CH<sub>4</sub>)**

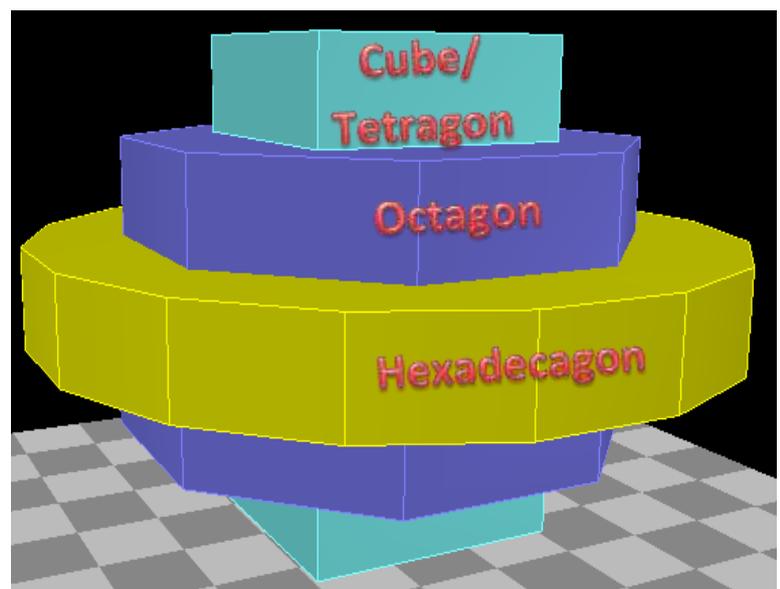
As atomic number increases, the maximum number of sides that a polygonal nucleon layers can have increases, but the polygonal forms for nucleus layers can only be in even side number increments, as they are formed by pairs of inter-quark bonded I-form nucleons resulting from the inter-locking of L-form nucleons. Polygons with an odd number of sides can only appear as a subset of a larger polygon with an even number of sides (e.g. pentagon geometries can only be a subset of a decagon geometry).

As atomic number increases to elements of the second Period in the Periodic Table, well as the development of larger polygonal forms, the embedding of one polygonal form within another occurs, as shown in the diagram to the right.

The embedding of one atomic structure within another could be considered to start with an embedding of Helium-4 within Be-9 (figure 15), but becomes much more pronounced and structurally significant from Period 3 onwards.

A good example of embedding is Silicon-28, the fourteenth element in the Periodic Table and the fourth in Period 3. Its structure is shown in figure 24, where the embedded cubic tetragonal form is embedded within an octagonal form.

The embedded form is supported by a combination of strut-like bitron and offset bonds which, rather than off-setting each other, providing outward push for 1 pair of sides and inward pull to the other. Thus the bitron and offset bonds can be considered to be interacting indirectly. Silicon atoms form a lattice with each pair joined together by a pair of bitron bonds to form a square or cubic grid (not dissimilar C-12 Graphite sheets), often referred to as a **silicon wafer**.



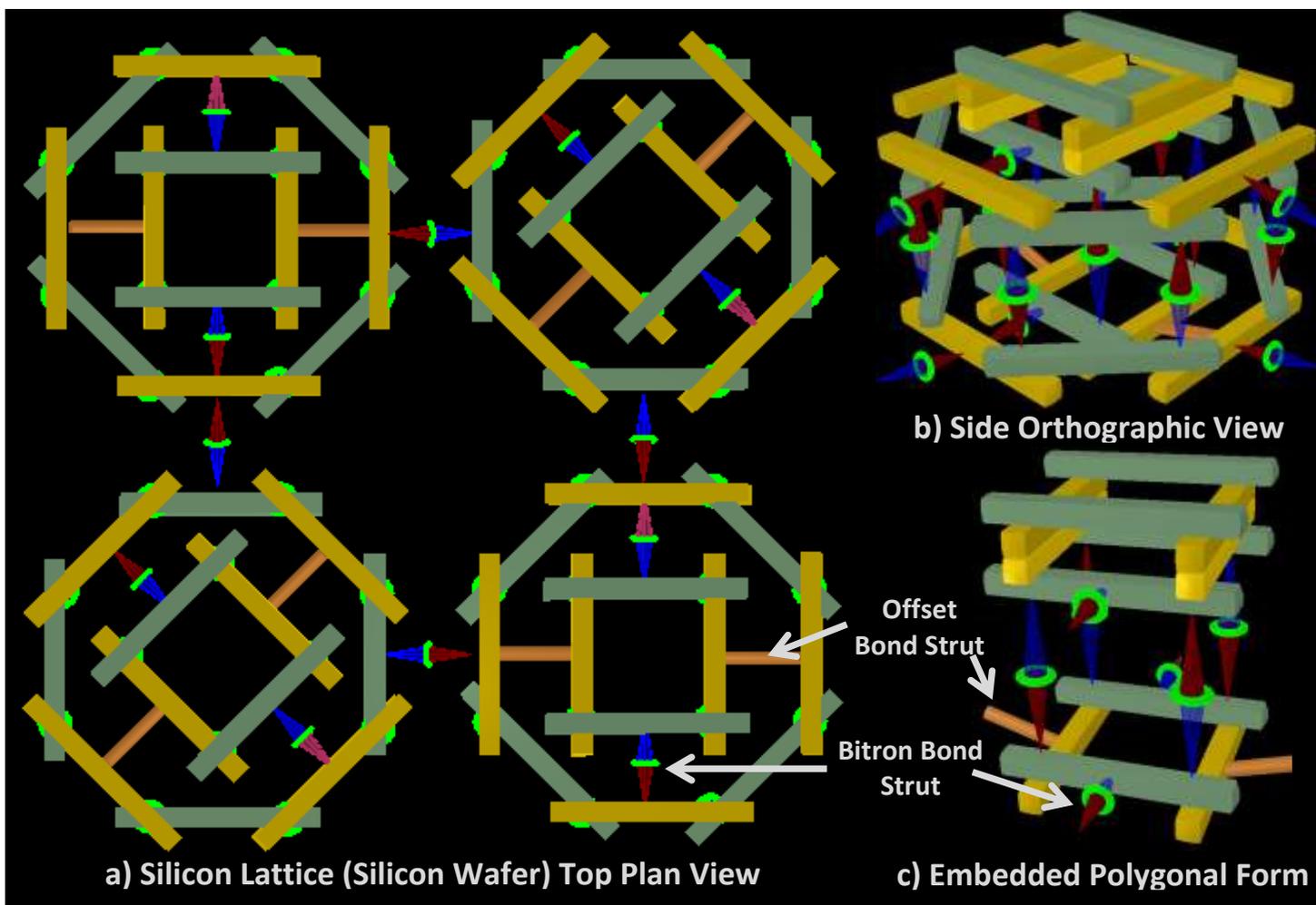


Figure 24: Silicon Atom and Wafer Structure

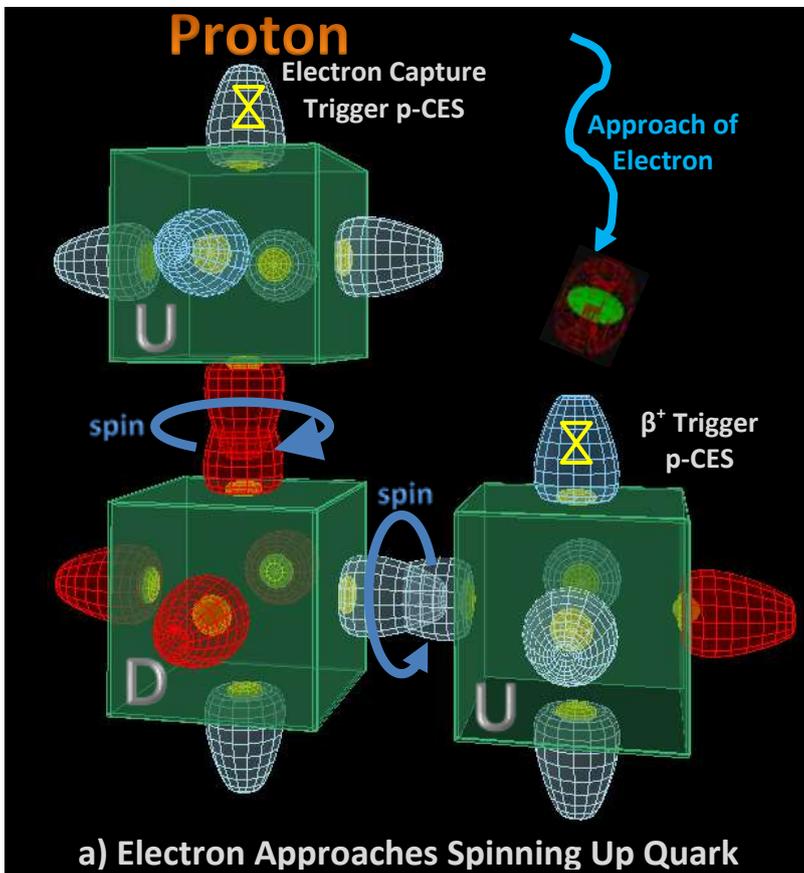
## Beta Decay and Electron Capture

**Beta decay** ( $\beta$  decay) is a type of 'weak reaction' radioactive decay in which a **beta ray** (a fast energetic electron or positron) and a neutrino are emitted from an atomic nucleus. It is quite prevalent across many elements of the Periodic Table as can be seen in figure 10.

**Beta minus** (or  $\beta^-$ ) decay is when an L-form neutron that is foot-in attached to the top or bottom layer of an atom, and is not restrained by forming an internal or external electron bond, converts into a proton, increasing the atomic number of the atom concerned by 1; and **beta plus** (or  $\beta^+$ ) decay is when an L-form proton foot-in attached to the top or bottom layer of an atom converts into a neutron, decreasing the atomic number by 1.

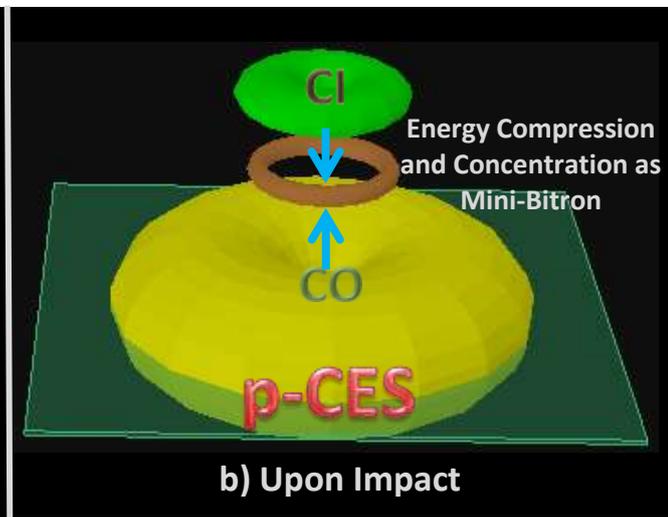
A detailed description of  $\beta^+$  decay is provided in figures 25a to 25c: it is triggered when a free electron accelerating towards an outer proton layer of an atom that has a foot-in L-form proton attached, colliding directly with a p-CES in 1 of the proton's 2 rapidly spinning up quarks. Should the p-CES be a flip CES (a 75% probability), then a high energy collision occurs resulting in the conversion of the proton into a neutron. The bi-products of the collision are an energised **positron beta ray** and a **neutrino** with the same energy field pattern of the e-CES in 25c but a rest mass of only about  $0.12 \times 10^{-6} \text{ MeV}/c^2$ . The STEM  $\beta^+$  decay equation is:  $\text{P} + \text{e}^- \rightarrow \text{N} + \text{e}^+ + \nu_e$

**Electron capture** is a low impact version of  $\beta^+$  decay that is caused by an accelerating free electron colliding with a spinning but stationary flip-trigger p-CES (the uppermost yellow hourglass of figure 25a). The collision causes the proton to be field-flipped into a neutron, the electron into a positron, and a mini-bitron neutrino to be generated by energy the impact. However, because of the low impact nature of the collision compared to that causing to  $\beta^+$  decay, the positron has insufficient kinetic energy to escape from the combined positive charge of the atoms of the host medium: it thus remains entrapped as a free positron within the host medium. Note that this explanation is not dissimilar to the reason why electron guns cannot be reversed to generate free positrons (see Part 1) and why positons cannot escape the host medium when positons are generated by the Photoelectric Effect (see Part 3).

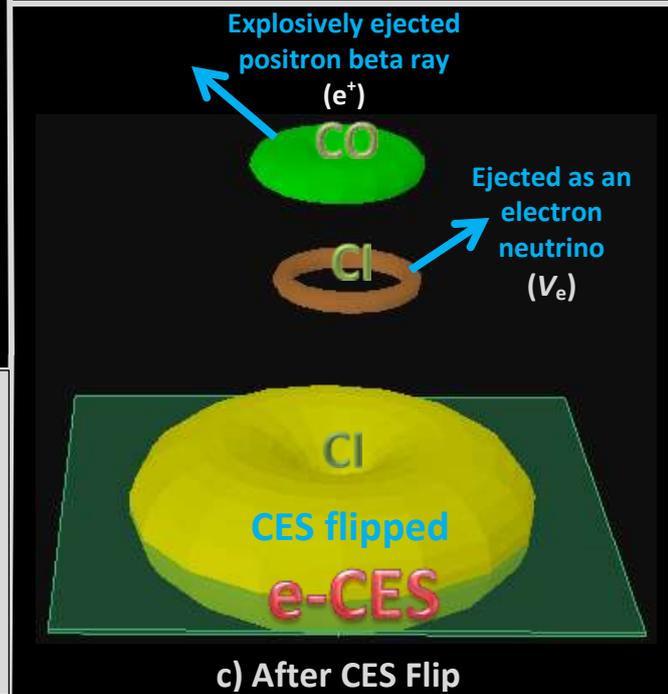


**a) Electron Approaches Spinning Up Quark**

An accelerating free electron collides directly with a p-CES in 1 of the proton's 2 rapidly spinning up quarks. Should the p-CES be a flip CES, then the impact of the collision causes the compression of the out-flow energy fields of the electron and CES, which generates a mini-bitron (brown torus in 24b and 24c) of concentrated energy and flips the energy fields of both the electron (transforming it into a positron) and the p-CES (transforming it into an e-CES) which in turn triggers the proton's 10 other flip-CESs to flip in unison, so converting the proton into a neutron. The newly formed positron is then explosively ejected at high speed with sufficient momentum to escape the host medium as a **positron beta ray**; and the mini-bitron, taking on the same energy field pattern of the newly created e-CES, is ejected as a **neutrino**.



**b) Upon Impact**



**c) After CES Flip**

**Figure 25: Explanation of Beta-Plus Decay**

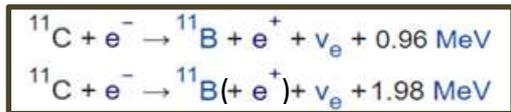
The STEM electron capture equation is identical to that for  $\beta^+$  decay, except that newly generated positron is bracketed ( $+ e^+$ ) to indicate that it does not leave the host. However, the conventional Science notation is:

$P + e^- \rightarrow N + \nu_e$  and  $P \rightarrow N + e^+ + \nu_e$  for  $\beta^+$  decay.

It is worth noting that synthetic C-11 (half-life 20 minutes) mainly  $\beta^+$  decays to Boron (B-11), but 0.2% electron capture decays to B-11. The STEM

equations, complete with residual energy, are shown right. The energised

$\beta^+$  decay positron acquires most of the collision impact energy (at least 1.2 MeV/c<sup>2</sup>, but more commonly in the range 2 to 3 MeV/c<sup>2</sup>) and exits the host material as a highly energised positive beta ray, leaving behind residual energy measured as 0.96 MeV/c<sup>2</sup>. Assuming that the  $\beta^+$  0.96 MeV/c<sup>2</sup> is the residual energy associated with this decay process, then for electron capture the positron is energised only to about 1.02 MeV/c<sup>2</sup>, which is well short of the minimum 1.2 MeV/c<sup>2</sup> required for it to escape the host: the bracketed ( $+ e^+$ ) in the STEM equation indicates the proton retention.



$\beta^-$  decay is essentially the reverse of  $\beta^+$  decay, being triggered when a fast moving free positron accelerates into the path of a rapidly spinning down quark within a neutron. The impact of the collision causes one of the trigger flip e-CESs to flip, turning the neutron into a proton with the release of an **electron beta ray** and an **anti-neutrino**. **Positron capture** (the reverse of electron capture) cannot take place because the corresponding e-CES is not a flip trigger.

STEM Decay Equation Examples	Isotope	Decay Type	Half-Life	STEM Decay Equation
	${}^{14}_6\text{C}$	$\beta^-$	5,700 years	${}^{14}_6\text{C} + e^+ \rightarrow {}^{14}_7\text{N} + e^- + \bar{\nu}_e$
	${}^3_1\text{H}$ (Tritium)	$\beta^-$	12 days	${}^3_1\text{H} + e^+ \rightarrow {}^3_2\text{He} + e^- + \bar{\nu}_e$
	${}^{23}_{12}\text{Mg}$	$\beta^+$	11 seconds	${}^{23}_{12}\text{Mg} + e^- \rightarrow {}^{23}_{11}\text{Na} + e^+ + \nu_e$
	${}^7_4\text{Be}$	Electron Capture	53 days	${}^7_4\text{Be} + e^- \rightarrow {}^7_3\text{Li}(+ e^+) + \nu_e$

## Ionisation and Chemical Compounds

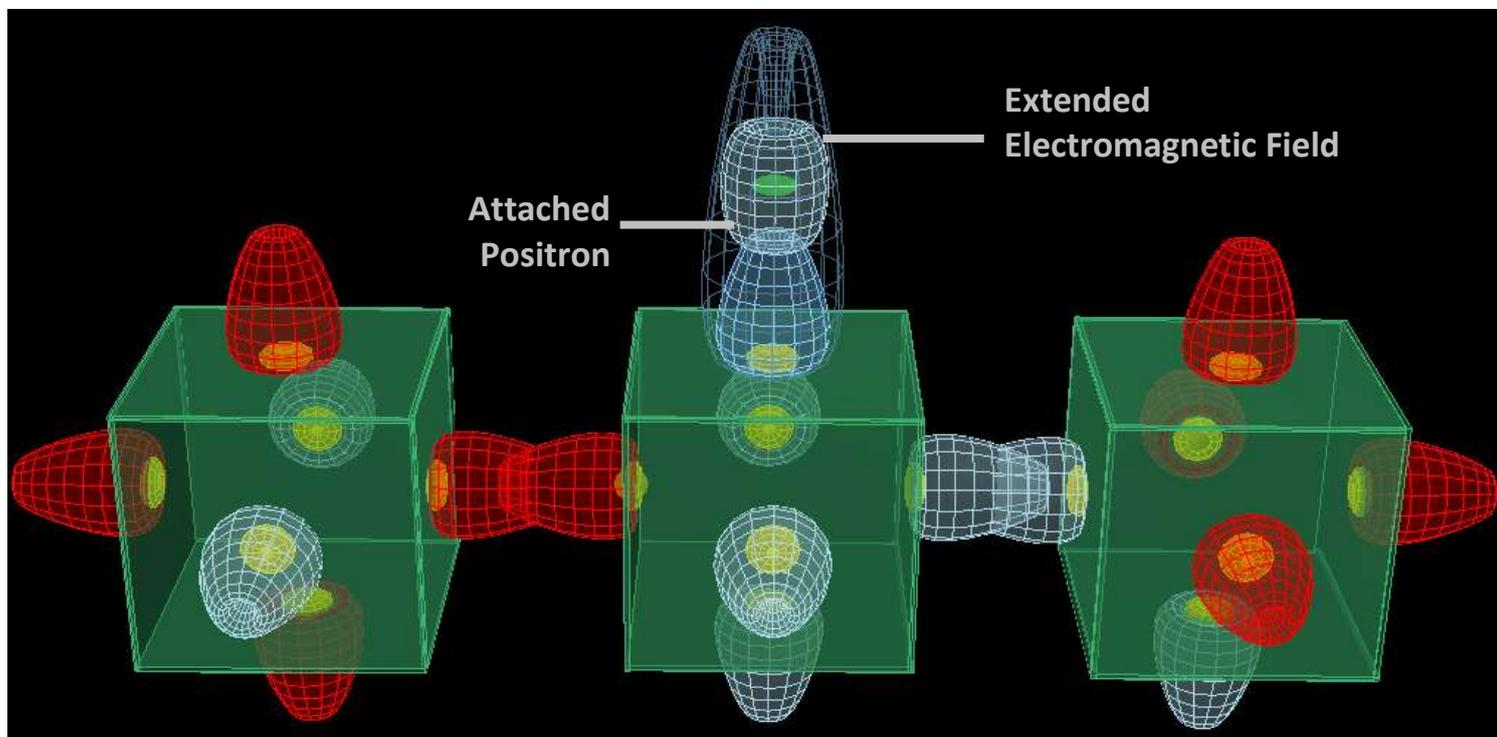
A central hypothesis of STEM is that there is only one fundamental source of electromagnetic energy from which normal matter is formed, and that source is the CES. All other energy manifestations, including electrons, positrons, neutrinos, anti-neutrinos, quarks, nucleons and photons, are thus derived directly or indirectly from CES energy.

Bitrons are a secondary form of concentrated energy that form bitron bonds between a pair of opposite chirality CESs held in close proximity within or between atomic structures. Within molecules and compounds, bitron bonds keep atoms apart and offset bonds hold them together. Bond equilibrium may be violently disrupted by the process of **ionisation** which creates **cations** and **anions**, with the release of bitrons, often in electron and/or positron form.

Ionisation can be caused in a variety of ways. One common way is ionisation by dissociation within an aqueous solution. Because of the structure of the water molecule, a range of acids and salts can dissolve easily in water. A water molecule has a bitron bond between each of the 2 L-form protons (i.e. hydrogen atoms) and its oxygen atom, such as shown in figure 21. The feet of the L-form protons spin rapidly around their bitron bond so forming an offset bond effect: however the spinning feet also act like an electric whisk that can beat and dislodge bitrons from the external bitron bonds within compounds that it encounters.

Using common salt, sodium chloride (NaCl), as an example, due to the extremely small size of the hydrogen atom and the 'V' shape of the water molecule, one of a water molecule's spinning L-form protons can quite easily work its way between a bonded sodium and chlorine atom, and wack the bitron, so releasing it from the bond. The breaking of the the bond causes separation of the atoms involved, creating a  $\text{Na}^+$  cation, a  $\text{Cl}^-$  anion, and a free bitron. Quite often, in keeping with the proverb that *those who live by the sword die by the sword*, the water molecule's destructive proton can be a casualty too, breaking away from its oxygen atom to create a hydride  $\text{H}^+$  cation and a hydroxide  $\text{OH}^-$  anion plus another free bitron.

Within a bitron bond the 4 CESs of the swivel quarks are restrained and thus unable to swivel. When the bond is broken the swivel quark can once again spin rapidly, quadrupling the effective energy field emanating from the swivel quark, which in turn pushes the atoms apart and creating a cation (e.g.  $\text{Na}^+$ ) for the atom with the 4 p-CES swivel and an anion (e.g.  $\text{Cl}^-$ ) for the one with the 4 e-CES swivel. The newly formed ions then proceed to jostle and tussle with other ions, molecules and compounds within the aqueous mix.



**Figure 26: Free Positron Enhancement of a Swivel p-CES**

The ions so created can become more active by attracting and attaching some of those newly released bitrons to their newly activated swivel quarks as shown in figure 26. Such loosely attached bitrons, called **CES enhancers**, further extend the strength and reach of the CES's electromagnetic field (see figure 26), which represents another way in which an ion can manage to extend its energy level.

Ionisation can also take place when solid ionic compounds are melted or when molecules from a gaseous state. As the crystal form of a solid phase melts, the increase in mobility and energy within the mix cause atoms and molecules to batter each other to the extent that their inter-atomic bitron bonds break and they become ionised causing the release of bitrons as electrons and positrons. In gaseous phases ionization is also by collision, and can occur at low pressures when an electric current is passed through them; without such electrical assistance ionisation tends to occur at high temperatures.

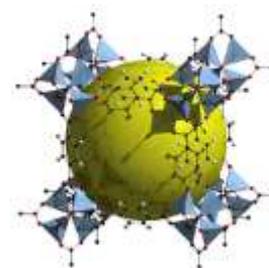
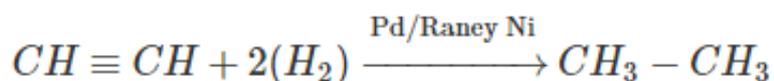
Ionisation also occurs whenever sufficiently energetic charged particles or radiant energy travel through gases, liquids, or solids. Energised charged particles, such as cosmic rays (see the 'Plasma and Cosmic Radiation' section of Part 3), alpha particles, positrons and electrons from radioactive materials, and EMR (see 'The Photoelectric Effect' section of Part 3) can cause extensive ionization along their paths by directly bump-releasing a bitron from its bond or indirectly by the collision impact with another part of the molecule or chemical compound.

The life-cycle of newly released bitrons largely depends upon the degree to which they have been energised by the collision impact. For bitrons newly released from solid material as free electrons and positrons with sufficient kinetic energy can escape the host medium. However, fast moving free positrons, which travel with their CO-pole leading, are held back by the net pull-force of the outer proton layer of host material that is analogous to the pull of an offset bond: for electrons the effect is the reverse and they receive an extra push away from the host material. Thus positrons require more than double the kinetic energy to escape the host material than that required for electrons. Thus for medium to low energy processes (e.g. electron guns and the Photoelectric and Compton Effects) emissions consist predominantly of electrons, with only a few positrons emissions at levels well below detection levels (i.e. at a frequency that cannot be distinguished from experimental error).

Free electrons and positrons that have insufficient kinetic energy to escape the host medium move around bumping and buffeting each other within the host material, and unless in an excited environment, gradually lose their recently acquired extra energy until they eventually revert to the neutral bitron state. Should the host material be a good electrical conductor, they form into bitron strand groupings that can, via induction, become re-polarised and start moving as an electric current as described in part 1 of this series. Otherwise they form less well aligned groups that are more influenced and orientated by the electromagnetic fields within the structure of the host material.

For **catalysis**, a pre-cursor for many chemical reactions, **enablers** (which promote the start of the main chemical reaction) can generate free electrons and positrons that become direct CES enhancers; or can create a reversible starter chemical reaction; or more indirectly via the creation of intermediate/transitional compounds.

Most molecules and chemical compounds are composed of multiple atoms held together by bitron bonds. Within some chemicals (and carbohydrates in particular), can form offset bonds without the presence of an off-setting bitron bond. This type of bonding is called **chemical adsorption** (or **chemisorption**), and may be homogeneous or heterogeneous, with collision impact being a factor in the latter. An example of chemical adsorption is the hydrogenation of alkenes and alkynes by H<sub>2</sub> molecules of Pd or Ni:



Water molecules also readily adsorb onto gold Nano-particles, and adsorption is also used in chromatography processes for the refining of metals and in the creation of Metal-Organic Frameworks (MOFs), as represented by the graphic shown right.

STEM contends that atomic bonding predominantly involves a balance between bitron and offset bonds, and that the bond characteristics and geometry within the nucleus define the physical and chemical characteristics of atoms.

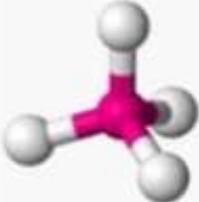
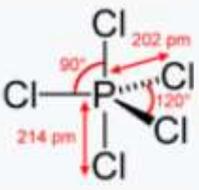
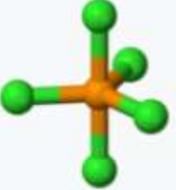
Apart from their structural function separating the nucleon layers, bitron bonds have many functions: they provide another form of structural connectivity and strength to the nucleus; upon release from the bond, a bitron can become transformed into a free electron or a positron; when a bitron is released, a new bitron can be re-generated; and as part of a chemical reaction bitron bonds can be broken, releasing bitrons and forming new external bitron bonds (i.e. **chemical bonds**) with other atoms, molecules or compounds.

A comparison between the conventional Science and STEM descriptions for the various types of chemical compound formation is tabulated in figure 27, which also contains hyperlinks to Wikipedia explanations of each compound type.

Compound Type	Conventional Description	STEM Description
<a href="#">Molecules</a>	An electrically neutral group of two or more atoms held together by chemical bonds (electron transfer or sharing).	An electrically neutral group of two or more atoms held together by bitron bonds.
<a href="#">Ionic Compounds</a>	An electrically neutral chemical compound composed of ions held together by electrostatic forces between positively charged ions (cations) and negatively charged ions (anions).	An electrically neutral group of two or more atoms held together by bitron bonds. As separate ions (e.g. in solution) cations have un-bonded p-CES swivel quarks (can be positron enhanced); anions have e-CES swivel quarks (can be electron enhanced).
<a href="#">Intermetallic Compounds</a>	Composed of definite proportions of two or more elemental metals wherein electrons form what may be termed an "electron sea" in which valence electrons are free to move from one atom to another to create a bonding effect.	Composed of definite proportions of two or more elemental metals, which pack due to the size and geometry compatibility of their nuclei that allows their atoms to inter-lock, possibly with pseudo bonding between nuclei.
<a href="#">Coordination Complexes</a>	Consists of a central atom or ion (often a metal) called the coordination centre, and a surrounding group of ligands (bound molecules or ions).	Consists of a central atom or ion (often a metal) called the coordination centre, and a surrounding group of ligands (bound molecules or ions) held by bitron bonds and/or pseudo bonds.

**Figure 27: Comparative Descriptions of Different Compound Types**

Conventional Science considers that the **valency** (or **oxidation state**) of an element is associated with the number of outer shell (valence) electrons, and, for polyatomic ions (such as  $\text{SO}_4^{2-}$ ), is the charge associated with the ion. For STEM valency relates to the availability of swivel quarks for bitron bonding. Atoms may display multiple valencies dependent upon the availability and electron/positron enhancement status of swivel CESs.

Shape	Geometry	Examples
Linear		$\text{BeCl}_2$ , $\text{HgCl}_2$ , $\text{CO}_2$
Trigonal planar		$\text{BF}_3$ , $\text{CO}_3^{2-}$ , $\text{NO}_3^-$ , $\text{SO}_3$
Tetrahedral		$\text{CH}_4$ , $\text{PO}_4^{3-}$ , $\text{SO}_4^{2-}$ , $\text{ClO}_4^-$ , $\text{TiCl}_4$ , $\text{XeO}_4$
Trigonal bipyramidal		$\text{PCl}_5$  
Octahedral		$\text{SF}_6$ , $\text{WCl}_6$ 

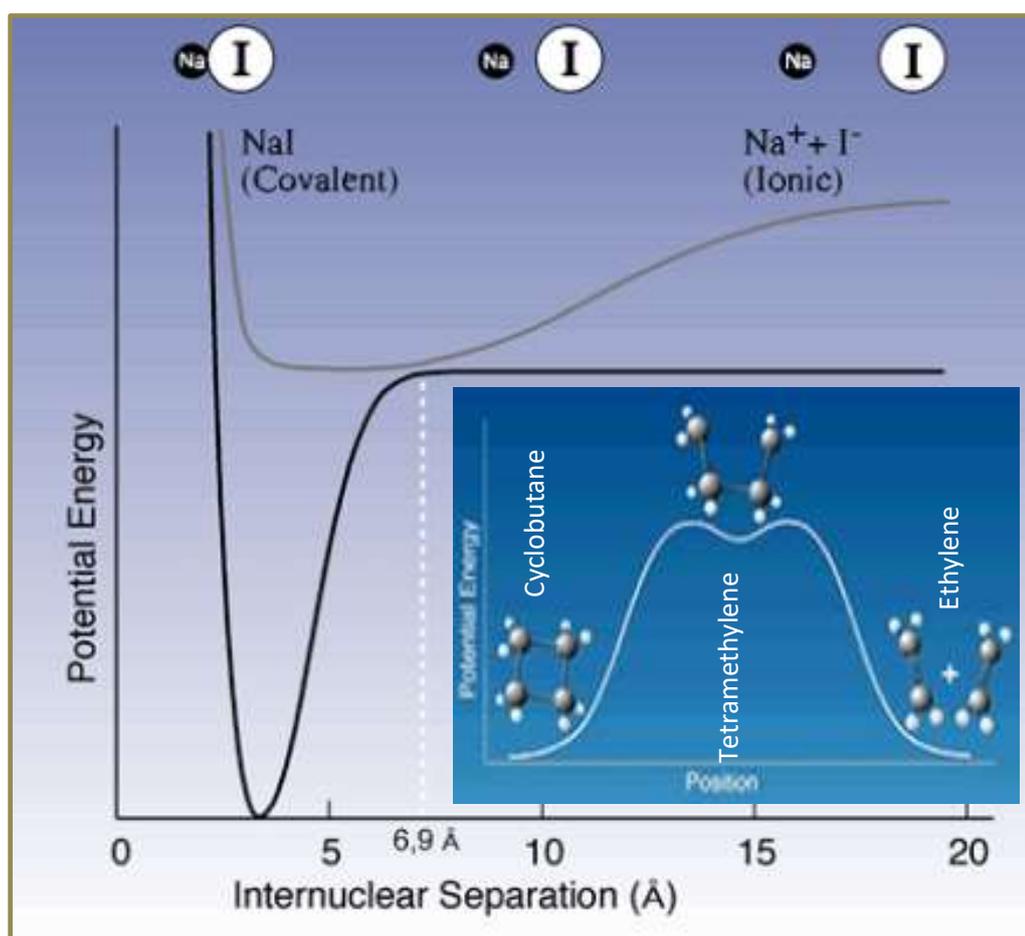
**Figure 28: Common Bonding Geometries**

The bonding patterns within compounds are related to the polygonal shape of nucleon layers within the elements involved. The lateral bitron bond angles are dictated by the polygonal nucleon layer shape, whereas the top and bottom nucleon layer landscapes dictate most vertical bitron bonding. All bonded groupings adjust their 3-D position in space in according to the net electromagnetic field generated by all attached atoms.

When two molecules collide, they just bounce apart, exchanging kinetic energy. But when extra energy is available that can be absorbed by the nucleon layers, as detected by an increase in temperature, then even mild collisions between atoms and molecules (e.g. the bumping of vibrating energised particles), they can react with each other and form new molecules or ions. It would seem that an increase of absorbed energy is a pre-requisite for many chemical reactions.

Most information about chemical reactions is empirical data derived from bulk chemical reactions, with little information relating to the mechanics involved at the atomic level. However this is changing with the development of femtochemistry spectroscopy and Nano-technologies.

Femtochemistry came into prominence in 1999 when Professor Ahmed H. Zewail received the Nobel Prize in Chemistry for studies of atoms and molecules in during a reaction. Using a super-fast camera that uses femtosecond ( $1 \text{ fs} = 10^{-15}$  seconds) laser flashes, he produced measurements backed up by "slow motion" visuals of chemical bond breaks and formation.



**Figure 29: Femtochemistry and Bonding**

One of the studies involved the dissociation of sodium iodide:  $\text{NaI} \rightarrow \text{Na}^+ + \text{I}^-$ . Bursts of energy from the laser pulse camera were used to excite the molecule, causing it to vibrate. When the vibration oscillations caused a nuclei separation gap of  $6.9 \text{ \AA}$  (see main figure 29 graph), there was approximately equal probability of it remaining molecular or for the inter-molecular bond to break and create an  $\text{Na}^+$  and  $\text{I}^-$  ion pair; when the separation reaches the  $10$  to  $15 \text{ \AA}$  range the bond is invariably broken and ions formed. Thus it would seem that a bitron bond between a sodium and an Iodine atom may break when stretched beyond  $7 \text{ \AA}$ , and always will break for distances beyond  $15 \text{ \AA}$ .

Professor Zewail's femtochemistry also confirmed that the breaking of 2 bonds within the ring molecule for Cyclobutane to yield 2 Ethylene molecules to be a 2-stage mechanism (insert figure 29), with the first bond break creating an intermediate Tetramethylene molecule about  $700 \text{ fs}$  before the second bond is broken to form 2 Ethylene molecules. As can be seen in the insert graph of figure 29, the activation barrier to each bond breakage was essentially the same, with a slight energy input required before the second barrier could be breached.

## Summary and Conclusions

By applying the STEM electron and positron model to preons (i.e. CESs), a new model for up and down quarks has been developed and used to define an L-form structure for nucleons. When formed into nucleon chains, L-form nucleons can interlock to create I-form proton and nucleon layers that, in closed form, become polygonal structures that provide the structural framework for all isotopic forms of atoms having an atomic number greater than 1 (Hydrogen being the exception). STEM contends that the physical and chemical properties of all elements and compounds are derived from their nuclear structure.

Bitron bonds form between a pair of opposite chirality CESs. STEM contends that it is bitrons within bitron bonds rather than orbital electrons (or the wave-form equivalent of orbital electrons) that form an integral part of an atom's composition and structure. Bitrons are pre-electron, only becoming electrons or positrons upon release from their bitron bond.

Internal bitron bonds form an integral part of the structure of the nucleus, keeping nucleon layers apart and adding to its strength, whereas external bitron bonds form between atoms, molecules, ions and a wide range of chemical compounds via chemical reactions. External bitrons can be gained, lost and/or exchanged dynamically, so dictating valency options and bonding patterns for chemical reactions. Bitron formation and release, combined with EMR emission and adsorption, represent a complex and dynamic energy management system within and between atoms.

The STEM approach provides an explanation for allotropes, such as those of Carbon-12, and of how a proton can transform into a neutron and vice versa via the CES field-flip mechanism. As well as explaining what is involved in beta and electron capture decay, STEM provides an explanation of why some levels of beta radiation can continue indefinitely, as implicit in the definition of decay half-life; why electron capture decay is a version of  $\beta^+$ ; and why positron capture (the  $\beta^-$  version of electron capture) cannot and does not take place.

The pragmatic approach of STEM provides an excellent framework for future detailed mathematical modelling, simulation and testing, with the potential to bring the mathematics of Atomic Physics more in line with Newtonian Physics. It potentially opens the door to realistic simulation, working from a micro to a macro model, which should lead to better predictive tools than current practices geared to the retrospective parameterisation and surface fitting of wave and associated equations to experimental observations. It also provides an excellent opportunity to extend and improve existing Chemical modelling software packages.

STEM expects that Femtochemistry, Nano-technologies and DNA-related biological research, and newer related spin-off technologies, will lead to more detailed pictures of nuclear structure and geometry in the near future. They have a practical emphasis related to Applied Chemistry, and most likely will become the technologies of the future, with the brute-force methodologies of Quantum Mechanics and the Standard Model, which have produced many overly complicated, esoteric, conflicted, incomplete and possibly flawed explanations, will become less relevant.

In order to contain the length of this paper, only a few key examples of atomic structure have been presented. To date models have been developed for about a third of the Periodic Table up to and including Gold. Also a discussion of **helical atomic bonding** patterns related to DNA formation has been omitted from the 'Redefining the Electron' series. Improved tailored modelling software and increased research resources are pre-requisites to extend STEM beyond Gold and to further explore embedded structures of the heavy elements, particularly those involved in atomic fission and fusion processes.

Part 3 of 'Redefining the Electron', the final paper of this series, presents possibly the most challenging aspects of the STEM approach. It addresses wave-particle duality, the photo-electric effect, and spectral line emission and absorption, electron-positron annihilation, plasma ionization, and Gravity. Part 3 sectional headings are:

- Photons, Energy Transfer and Spectral Lines
- Light Refraction
- Constructive and Destructive Interference
- The Photoelectric Effect
- Electron-Positron Annihilation
- Semiconductors, P-N Junctions and Holes
- Plasma and Cosmic Radiation
- Spin and the Orbital Nuclear Model
- The Pull of Gravity
- Appendix: Micro and Radio Waves