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In Search of a Better Physical Model for the Atom

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Introduction

*The **physical model** for atomic structure is poorly defined, resulting in a proliferation of diagrams that send mixed messages regarding structure of atoms. **Nucleons** are usually represented as spherical structures although, according to the **Standard Model**, they have a triangular geometry consisting of strong-force bonded up and down quarks. An **atomic nucleus** is represented as having no particular structure, consisting of an apparently random conglomerate of spherical neutrons and protons, mysteriously held together by strong-force bonds or gluons that prevent the strong mutual repulsion of protons causing the nucleus to explode.*

*Then there are the electron orbitals. Although the **Quantum Mechanics** wave equations define multiple irregular '**spdf**' orbital patterns that are far from being spherical (except for 's' orbitals), the nucleus is usually shown encapsulated by high-speed spherical electrons moving within circular orbitals, with electron energy levels seemingly being the only orbit-related aspect of interest.*

*Unfortunately, neither Bohr-like spherical nor the 'spdf' orbital patterns are conducive to explaining the physical characteristics of atoms. Consequently, areas such as Applied Chemistry have had to adopt the dubious practice of **orbital hybridisation**, which involves the mixing atomic orbitals, to create the required tailored orbitals that approximate to the bonding patterns of molecules and compounds. Then there are the largely unexplained physical properties of the **allotropic forms** of certain elements; a prime example being the vastly different physical properties of graphite and diamond, the two carbon-12 allotropes.*

*Theoretical Physics research is unfortunately mainly focused upon the development and tweaking of theoretical mathematical models of the atom, with few resources or research effort being directed towards the development of a realistic **physical model** for the atom that reflects, and can reliably explain, the physical characteristics (such as strength and bonding patterns) of atoms and matter. This needs to change.*

This paper overviews six atomic models developed over the past 30 years which propose alternative or modified structures for atoms, and purport to better explain the observed bonding patterns and physical characteristics of atoms. The implications of some of these proposed models are far more profound and far-reaching than might first be expected, and should be factored into the building of a more functional physical model of the atom that could provide increased practical benefit to Physics, Chemistry and related technological areas.

The Need for a Physical Model of the Atom

Despite the impressive mathematics and research associated with the conventional **orbital nuclear atomic model** (ONAM), it has unfortunately become overly complicated and esoteric. Under the auspices of the ***Standard Model*** *(SM)* and ***Standard Model*** *(SM),* ONAM would seem to have become counter-intuitive and confined to a mathematical bubble. It certainly has not proven to be greatly helpful to practical Science areas such as Applied Chemistry and new emerging areas such as nano-technologies and DNA-research. Currently, it represents the antithesis of a useful **physical model** and, due to its shortcomings, has given rise to multiple alternative models over the past 30 years aimed at addressing its perceived short-comings.

A Structure for the Nucleus

Since the 1990's, several theories supporting the concept that the atomic nucleus might have a pattern or structure have been advanced. One of the earliest of these theories was proposed by Russian Scientist Ph. M. Kanarev in the early 1990's. Kanarev, now retired, strongly disagreed with the planet-like orbital electron concept, and has argued for over 30 years against the 'spdf' orbitals as defined by the wave equations of QM. Kanarev considers that neutrons are located centrally within the nucleus, with protons being outer-most where they can bond with electrons. He thus contends that there are no orbital electrons, which is contrary to the conventional view in the form of ONAM. Kanarev supports his theories with experimental data and related mathematical interpretations and, although some of his explanations suffer in translation from Russian, they are freely available at the Micro World web site. Kanarev models for Boron and Carbon are shown in figure 1.

More recently, around 2018, the **Structured Atom Model** (SAM) appeared. SAM is based upon the concept that a neutron is simply the combination of an electron and a proton. Its 3D representation of atomic nuclei is in terms of spherical nucleons that present as **platonic solids**: five basic geometric forms that are regular, convex polyhedra constructed by congruent regular polygonal faces (with the same number of faces) meeting at each vertex. The SAM 3D graphics for the atoms of the Periodic table (e.g. figure 1 right) are visually enticing, but not necessarily more detailed than the 2D ones of Kanarev. As well as having an interesting web site, SAM is backed up by the book 'The Nature of the Atom: An Introduction to the Structured Atom Model' by J. Kaal et al.

By replacing the neutron with a proton–electron pair, SAM claims that *'an electrostatic attractive force is reintroduced into the nucleus. The electrons acting as "glue" between the protons'*, and that the associated '*spherical dense packing gives the nucleus its fractal shape*'. It also claims that '*several known nuclear phenomena follow directly from the structural configuration of the nucleus, including nuclear instability, radioactivity/radioactive decay, the asymmetrical breakup of fission products, and the various nuclear decay schemes.*' Unfortunately SAM is associated with the Electric Universe (which has been widely debunked on the internet) and several mythology-related groups, which does not add to its credibility; however, this does not mean that it should be dismissed outright.

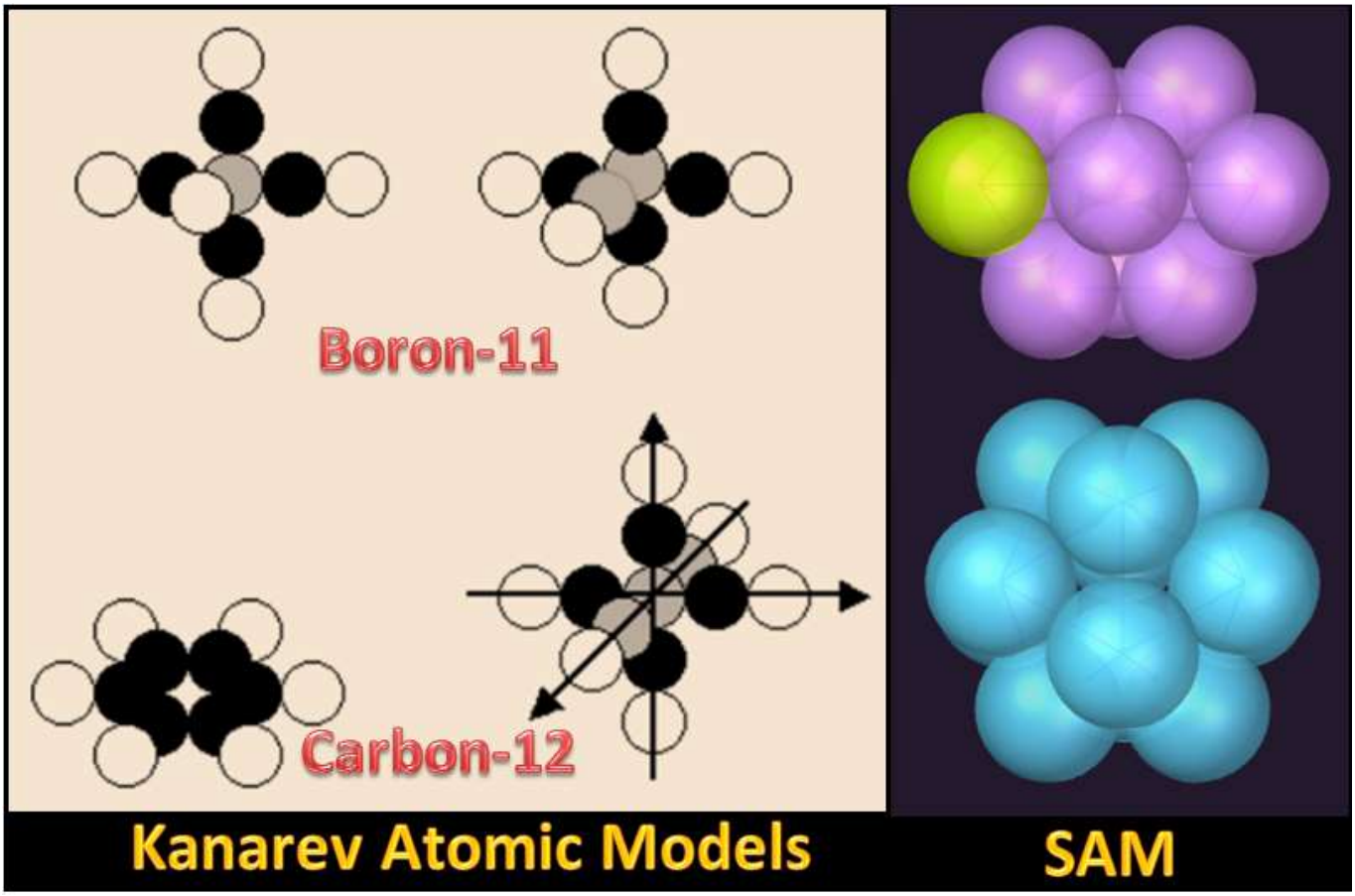


Figure 1: Kanarev and SAM Models for Boron and Carbon

A **third approach** to atomic structure is the **Spin Torus Energy Model** (STEM), as supported by the **STEM Development Group** (**SDG**). STEM started life in around 2016 as a research project looking into the structure and nature of the electron. **Toroidal-electron models** have existed since the 1990's, with claims that they provide a better fit for the electron than the equivalent abstract **point-form** mathematical construct used to satisfy the **QM wave equations**. With appropriate base (i.e. parameter) settings, the toroidal-electron also satisfies the wave equations; and, because it has a diameter and rest mass, it has **spin** and **angular momentum** that does not have to be considered **intrinsic** as for QM's point-form electron definition.

STEM is an **energy-centric approach** that is underpinned by the hypothesis that ***there is only one type of energy-generating material*** (dubbed **energen**). All **fundamental particles** and their associated **electromagnetic fields** are considered to consist of energen, but in different forms and concentration levels. It is evidence based **physical model** developed to provide feasible explanations for Science-based observations and experiments: it is thus a **pragmatic approach** as opposed to a dogma or mathematical driven approach. However, despite its rather simple underlying premise, the explanations and implications of STEM are quite extensive.

The STEM structure for nucleons is aligned to that of SM nucleons. Both approaches contend that they consist of three quarks each held together in a triangular geometry by strong force bonds, with **protons** consisting of two **up-quarks** and one **down-quark**; and **neutrons** of two down-quarks and one up-quark. This quark-based structure leads to a net positive charge of 1eV for protons and zero net charge for neutrons.

However, as can be seen in figure 2, there are slight differences between SM and STEM nucleons: SM considers that they have an equilateral triangle quark geometry involving three **strong-force bonds**, whereas STEM considers them to form a right-angled isosceles triangle involving just two strong-force bonds.

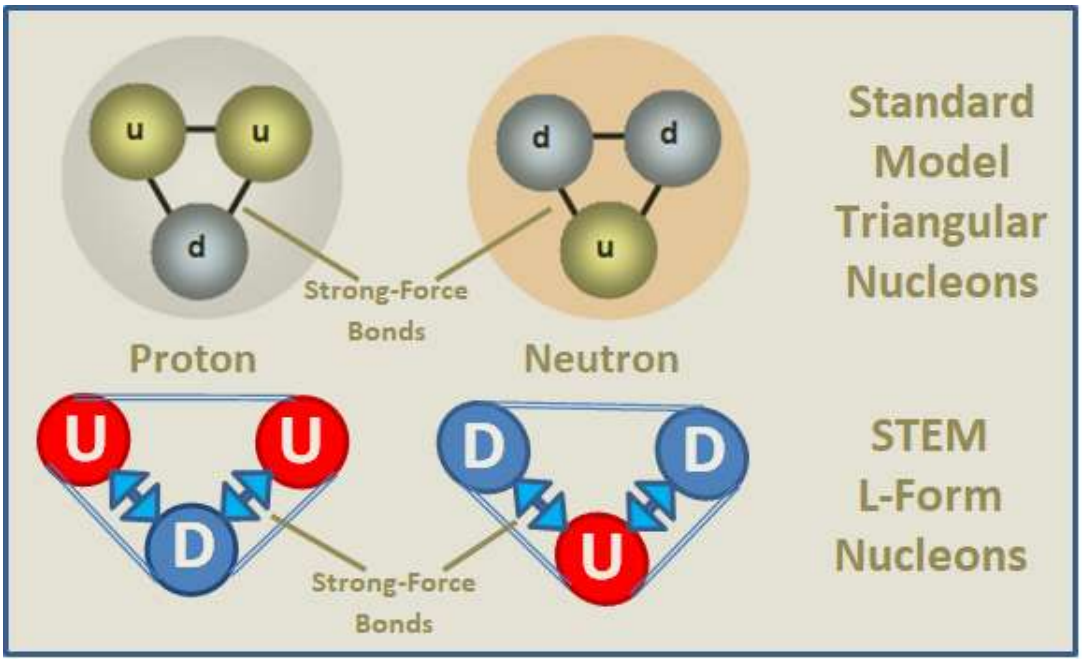


Figure 2: The Triangular Quark Structure of Nucleons

Due to their **right-angled isosceles triangular** structure, **STEM nucleons** have an 'L' shape and are called **L-form nucleons**. L-form nucleons have two **preferential bond directions** (shown by the **olive-green arrows** of figure 3): one parallel to one arm of the 'L', and the other perpendicular to the other arm.

Cosmological evidence suggests that elements with low atomic number (up to lithium) were mainly created by the **Big Bang**, whereas elements with a higher atomic number were created by the collapse and/or merging of **stars**. In such chaotic high-energy environments, STEM contends that the preferential bond directions of L-form nucleons results in the random fusion of nucleons to create **nucleon chains** (see the top part of figure 3).

Because the L-form nucleons are joined by the same type of strong-force bond (STEM actually provides an explanation of strong force bonds) that holds their quarks together, the nucleon chain structure presents as separate layers of linear **I-form** proton and neutron layers, such as shown in the bottom part of figure 3.

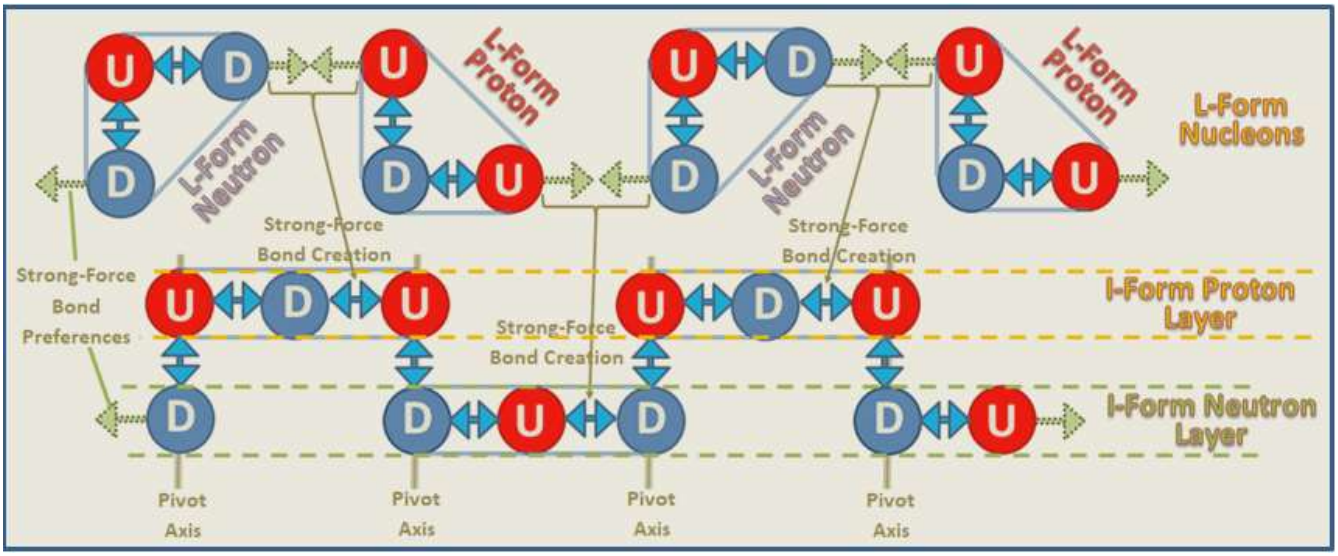


Figure 3: L-form Nucleon Conversion to I-form Nucleon Layers

Buffeting and violent flexing and flapping within the chaotic energised chain-formation environment would cause nucleon chains to partly break-up and re-form; and quite often (part)chains would combine to create **multi-layer chains** and partial layers. And should opposite ends of a chain meet, they can become strong-force bonded together to create a more resilient **polygonal structure**, and so become the **nucleus** of an atom, or part thereof. This is a simplified overview of the process and, as might be expected, the devil is in the detail: the first 15 pages of SDG's atomic structure paper goes somewhat towards providing that detail, albeit speculative.

According to STEM, with the exception of hydrogen, an atom's nucleus has a polygonal structure created by end-joined nucleon chains. Figure 4 shows a quark and a cylindrical model of the **helium-4** atom structure, highlighting L-form nucleon juxtaposition that creates the **I-form nucleon layers** within the polygonal forms

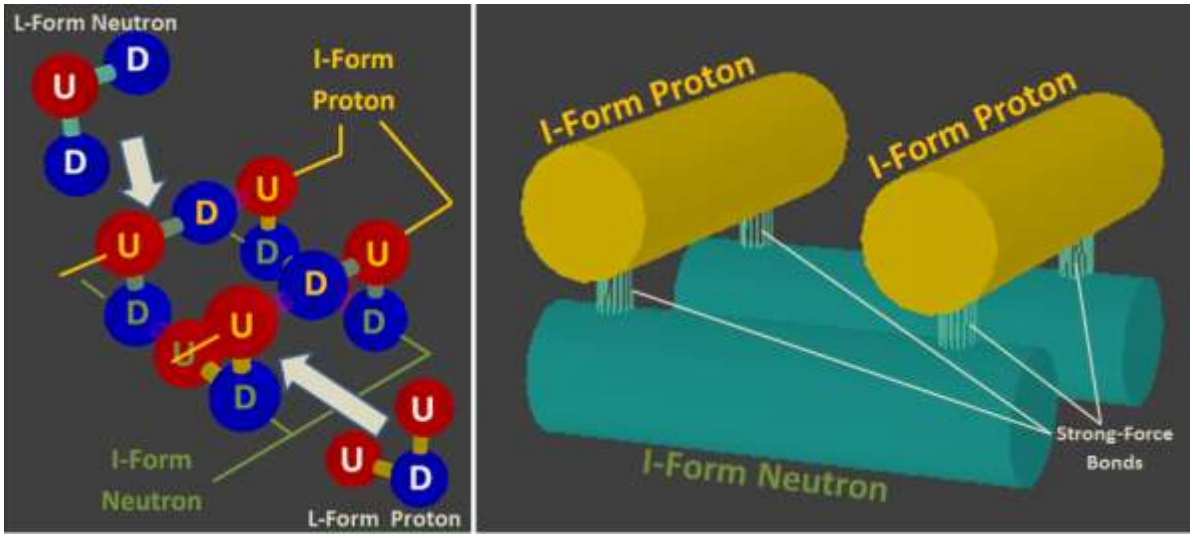


Figure 4: STEM Quark and Cylindrical Nucleon Models of Helium-4

In its simplest form, the STEM atomic nucleus consists of a combination of complete and partial polygonal (cubic, hexagonal, octagonal etc.) nucleon layers. SDG provides a PowerPoint presentation that overviews the STEM approach; this rather ambitious presentation is also available as a slide-based pdf document.

For elements of atomic number ≥ 9 (fluorine), smaller polygonal forms can become embedded within the larger ones. Helium-4 (see figure 4) is the most commonly **embedded** or **attached** polygonal form: it is a strong structure with high binding energy, and can readily be released as **alpha radiation** from the larger unstable elements such as the Uranium, Actinium, Thorium and Neptunium, as evident in the **radioactive decay series** (see the 'Fission, Fusion and the Creation of the Elements' chapter of SDG's atomic structure paper).

What the SAM, Kanarev and STEM approaches have in common is the claim that ***the structure of the atomic nucleus dictates the physical properties of atoms***, including their chemical and molecular bonding patterns. Kanarev and STEM represent the more controversial approaches because they both claim that ***orbital electrons***

are not required and are thus non-existent, which is a concept that is most difficult, if not impossible, for advocates of the conventional Science status quo to contemplate. However, this in itself does not invalidate these models, but it does make it much more difficult for them to get a fair hearing, and be properly peer-reviewed and evaluated by a Science community obsessed with an atomic orbital model and variations thereof.

As a pragmatic approach, STEM can be judged by how well its hypotheses and interpretations can explain Physics phenomena (i.e. Science-based observations and experimental results). So what can it explain? Apart from the feasible fusion-based description of the atom-creation process as summarised above, STEM provides a tentative structure for up/ down quarks; and a feasible possible mechanism for **nucleon-type conversion** (i.e. of neutron ↔ proton conversion) to explain **electron capture** and **beta decay**, and their related by-products.

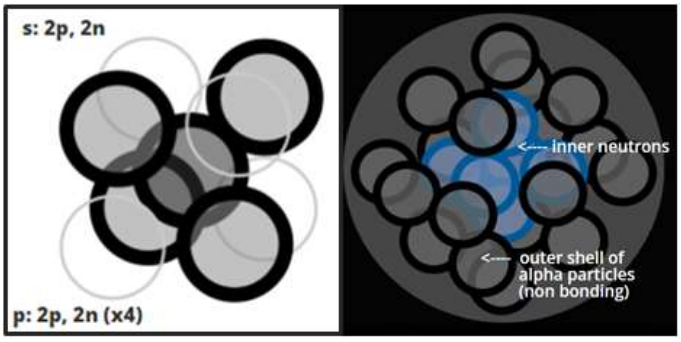
It also provides two alternative nucleus structures for **carbon-12** that explain the different physical characteristics of the allotropic forms of **graphite** (and graphene) and **diamond**; detailed true-to-scale models of important molecules of **hydrogen** (both para and ortho forms) and **water**, with feasible explanations the **bend** and **stretch** of steam molecules and for the hexagonal form of ice crystals; explains the different polygonal patterns apparent in **hydrocarbons**; explains the **Coulomb barrier** and **redox reactions** (including those appropriate to **galvanic** and **electrolytic cells**); and even suggests an interesting tentative explanation for **Gravity** that is conceptually simpler than Einstein's mathematical model involving the warping of **space-time**.

As developed in SDG's 2021 Duplicit Electron paper, the **electric fields** associated with electrons (and other fundamental particles) are considered to be formed by **field-energy** consisting of low-concentration energen with a circular vortex-like or twisted flow pattern: polarity (i.e. negative versus positive) is determined by the **chirality** of the field-energy. **Charge carriers** (CCs) have the same characteristics as electrons, with **negative** and **positive CCs** having different chirality. Normal matter is considered to contain an equal number of positive and negative CCs. A **metal conductor** contains a large number of CCs that can be induced to move as an **electric current**. **Semiconductor** current can also be explained without invoking the spurious concept of **positive holes**.

Unlike electric fields, the field-energy of a **magnetic field** has no twist to its flow pattern; it follows curved flow lines from an **energy source** (a **north pole**) to an **energy sink** (a **south pole**). **Electromagnetic fields** thus consist of the same type of field-energy, with an electric field able to generate a magnetic field (e.g. around an electric current carrying wire), and a magnetic field able to induce the movement of CCs as an electric current.

In SDG's 2021 paper about the physical nature of light, an explanation is provided for light's apparent **wave-particle duality**; for light's **polarisation** characteristics due to **refraction** and **reflection** when a medium of different refractive index is encountered (as evident in **Fresnel coefficient** graphs plotted by angle of incidence); and for the nature of plane polarised (**PPL**), circularly polarised (**CPL**) and optic vortex light (**OVL**).

A **fourth model**, the Subtle Atomics approach by Simon Brink, proposes a nucleus structure based on multi-nucleon and **alpha particle** composites. Although the author does not claim to understand the model's subtleties, it claims to '*clearly demonstrate a geometric link between chemistry and atomic nuclei structures*'. Shown right are the Subtle Atomics' structure for the Neon-20 and Krypton-78 nuclei.



Although highly speculative, and representing radical, and possibly controversial, approaches related to the structure for the atomic nucleus, the SAM, Kanarev, Subtle Atomics and STEM models would seem to be able to provide reasonably straight-forward explanations for a wide range of Physics-related phenomena. Kanarev applies a more theoretical and mathematical-oriented approach, as opposed to the pragmatic approach of STEM: the SAM and Subtle Atomics approaches would seem to fall in between these two. Each approach potentially represents a basis for a **physical model** that places more emphasis on **the structure of the atomic nucleus** to explain the physical characteristics of atoms: a topic that is rarely, if at all, countenanced by mainstream practitioners that continue to support a structure-less ONAM nucleus.

Orbital Model Variations

Perceived problems related to the 'spdf' orbital patterns (theoretically derived from the QM wave equations) and the orbital-fudging techniques associated with **orbital hybridisation** to explain chemical bonding geometries, have motivated in several Physicists, who essentially are supportive of the conventional orbital concept, to develop alternative orbital models. These models include the extensive treatises of the Grand United Theory (GUT) by Randell Mills and the MCAS electron orbital model by Joel Williams.

For the **GUT** approach (a **fifth model**), Mills derives two basic equations from Classical Physics' **Maxwell's Equations**, which are applied to elements and support bonds (solid, semiconductor, ionic and metallic) for molecules and organic chemicals. GUT also provides an explanation for the allotropic forms of carbon and, by applying Maxwell's Equations to electromagnetic and gravitational fields, Mills derives the Schwarzchild solution of Einstein's theory of general relativity to create a modified version of **General Relativity**.

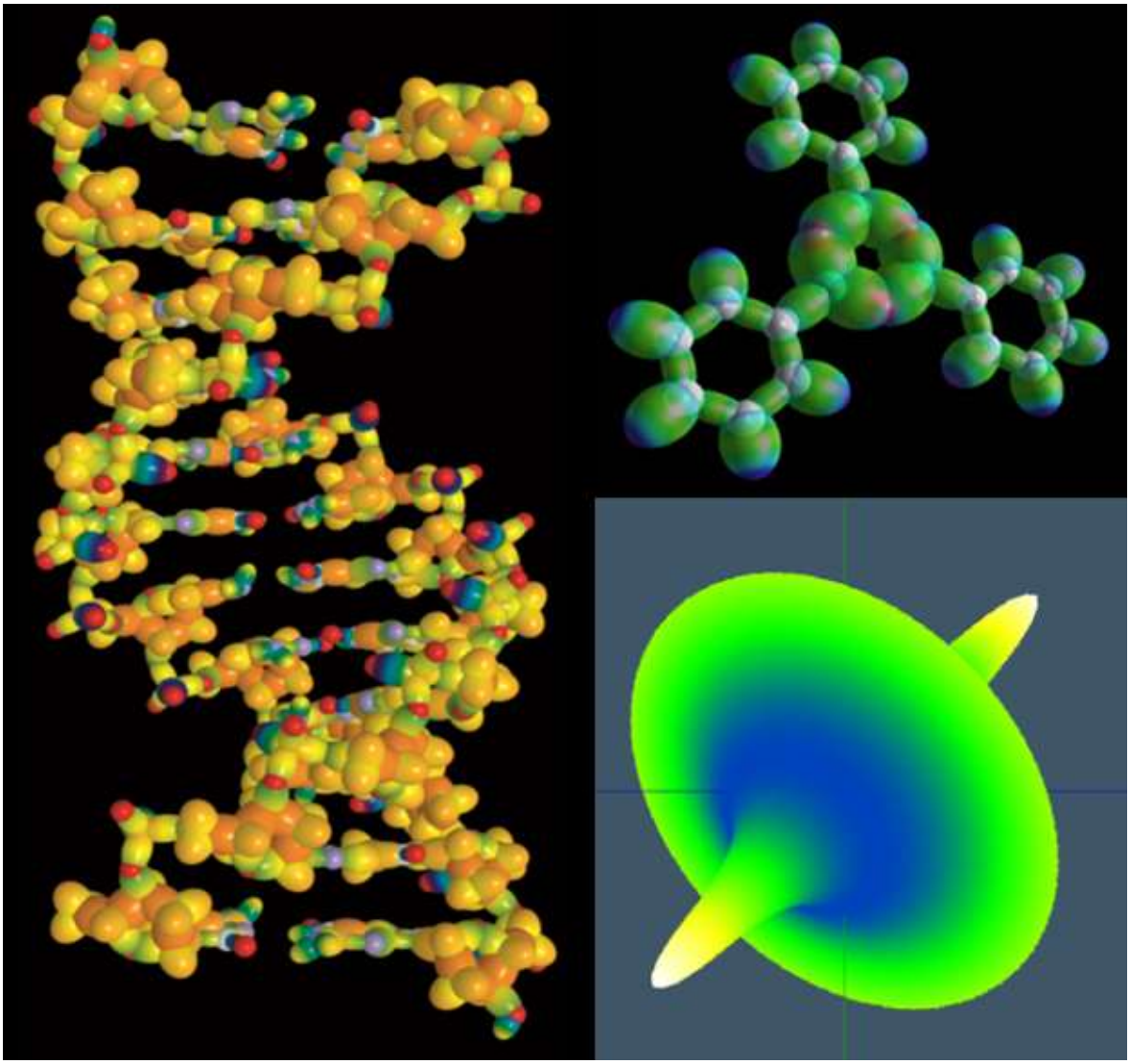


Figure 5: GUT Organic Molecules and a Current Density Plot

MCAS is an acronym representing the orbital patterns **M**ulti-lobe (tetrahedral), **C**ubic , **A**nti-cubic, and **S**quare-faced cubic. With MCAS (a **sixth model**), Williams explains the behavior of electrons with **Classical Physics**, and contends the they are particles whose electrostatic fields are additive. With MCAS, orbital hybridization is not needed to explain the bonding angles of elements as MCAS bond angles apparantly do the trick.

Mills, Kanarev and Williams are all well respected Physicists that have held research and/or academic teaching roles at a senior Professorial level. They have dedicated serious time, effort and resources towards the development and promotion of their alternative approaches. They are certainly not amateur crackpot Scientists, pseudo-Science promoters, conspiracy theorists or the like; and their models deserve serious consideration and evaluation, even if only to identify what aspects are worthy of further investigation and those that are not.

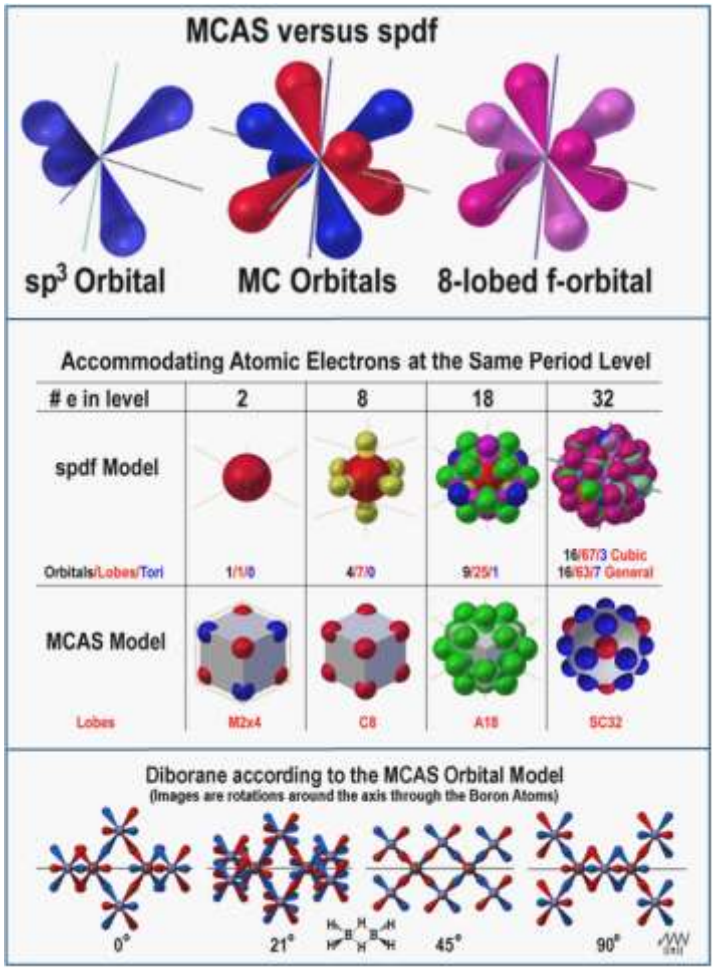


Figure 6: MCAS Orbitals and Diborane Molecule

Summary

The atomic models of Kanarev, SAM, Subtle Atomics and STEM each develop a **structure** for the **nucleus** that is absent from ONAM, conventional Science's orbital model. These four models all claim that their proposed structures for the nucleus help explain the physical characteristics of elements, including their bond-angle preferences within molecules and chemical structures. The GUT and MCAS models provide for modified electron orbital patterns that are different to, and are claimed to provide a better fit (in terms of the bond orientation within molecules and chemical compounds) than, the QM wave equation derived 'spdf' orbitals. Although these alternative models potentially provide new insight into atomic structure, and explain aspects poorly explained by ONAM, they have been mainly ignored or vilified by the mainstream Science community.

ONAM, as underpinned by SM and QM, has not proven to be of much practical assistance to applied areas of Science and technology: it has also resulted in complex and often conflicting concepts, and a proliferation of misleading diagrams involving structure-less nuclei and circular electron orbitals. What is needed is a more consistent and practical **physical model** that provides a better to interface to Classical and applied Physics areas. It also needs to be more robust and reliable and, possibly, be amenable to the building of predictive simulation models more supportive of Chemistry, nano-technologies and DNA-related research.

It would seem that, alone, none of the available atomic models (including ONAM) represents a suitable basis for a **new practical physical model**. It thus makes good common sense to objectively re-assess which aspects of each model have relevant merit and possibly inter-link. The evaluation process would be tedious, contentious and call into question many pre-existing concepts and beliefs. Although such a process might ultimately prove to be illuminating, and lead to some unexpected greatly beneficial break-throughs, there would seem to be little interest in looking into and testing alternative approaches, with ONAM research continuing to blunder and stumble into the future with blinkered vision, never able to produce a useful practical physical atomic model.

Disclosure: The author has been involved in the development of SDG's STEM approach