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# Universal Quantum Computing; 3rd Gen Prototyping Utilizing Relativistic 'Trivector' R-Qubit Modeling Surmounting Uncertainty

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We postulate bulk universal quantum computing (QC) cannot be achieved without surmounting the quantum uncertainty principle, an inherent barrier by empirical definition in the regime described by the Copenhagen interpretation of quantum theory - the last remaining hurdle to bulk QC. To surmount uncertainty with probability 1, we redefine the basis for the qubit utilizing a unique form of M-Theoretic Calabi-Yau mirror symmetry cast in an LSXD Dirac covariant polarized vacuum with an inherent 'Feynman synchronization backbone'. This also incorporates a relativistic qubit (r-qubit) providing additional degrees of freedom beyond the traditional Block 2-sphere qubit bringing the r-qubit into correspondence with our version of Relativistic Topological Quantum Field Theory (RTQFT). We present a 3rd generation prototype design for simplifying bulk QC implementation.

*Keywords*: Bloch sphere, Differential geometry, Graphene, M-Theory, Quantum computing, Qubit, Quantum Hall effect, Trivector

## 1. Introduction

Quantum Computing (QC) has remained elusive beyond a few qubits, enough only to operate a logic gate. Feynman's recommended use of a "synchronization backbone" [1] for achieving bulk implementation has generally been abandoned as intractable; a conundrum we believe arises from limitations imposed by the standard models of Quantum Theory (QT) and Cosmology. It is proposed that Feynman's model can be utilized to implement Universal Quantum Computing (UQC) with valid operationally completed extensions of QT and cosmology [2]. Requisite additional degrees of freedom are introduced by defining a relativistic basis for the qubit (r-qubit) in a higher dimensional (HD) conformal scale-invariant context and defining a new anticipatory based cosmology (cosmology itself cast as a hierarchical form of complex self-organized system) making correspondence to unique 12D Calab-Yau mirror symmetries of M-Theory. The causal structure of these conditions reveal an inherent new Unified Field, $U_F$ "action principle" (force of coherence) driving self-organization and providing a basis for applying Feynman's synchronization backbone principle. Operationally a new set of transformations (beyond the standard Galilean / Lorentz-Poincaré) *ontologically* surmounts the quantum condition (producing decoherence during both initialization and measurement) by an acausal energyless (ontological) topological interaction [2]. Utilizing the inherent structural-phenomenology of the HD regime requires new commutation rules and corresponding I/O techniques based on a coherent control process with applicable rf-pulsed incursive harmonic modes of HD spacetime manifolds such as those described by the a spin-exchange continuous-state spacetime resonance hierarchy. See US Patent [3].

In this work we review the 3rd generation prototype design for our model of bulk universal QC, an evolutionary scenario that has occurred as we have awaited funding over the last five years. Each generation of prototype design has reduced the perceived prototyping costs by an order of magnitude.

- The 1st generation was to utilize an IC chip that held an array of 1,000 ring lasers; the central cavity of which would hold the QC molecule. We arbitrarily chose a class II mesoionic xanthine crystal because it is stable at room temperature for ~ 100 years and has 10 relatively even separable quantum states in its ground state configuration. This xanthine was to be acted upon by rf-pulsed Sagnac Effect resonance [2]. This version would have cost over 10 million US$ to prototype because of a required partnership with the IC ring laser patent holder.
- The 2nd generation was operationally similar to the 1st generation, but utilizing much less expensive quantum dot ring laser arrays instead of an IC array. Quantum dots may be manufactured with internal mirrors to create quantum dot ring lasers. The quantum dots would be arrayed on a suitable substrate rather than an IC. Prototyping costs here were anticipated at about 5 million US$.
- The 3rd generation at a cost of 1.5 to 3 million US$ may possibly utilize a class II mesoionic xanthine doped multilayer graphene molecule array (currently under study) where it may be possible to operate a QC by forms of Quantum Hall effects, bilayer graphene alone, or a stand-alone mesoionic xanthine configuration since several mesoionic xanthine molecules have pertinent polar properties.

Graphene differs from most materials; electrons and holes near the six molecular corners behave like relativistic spin ½ particles that can be described by the Dirac equation causing graphene to be thought of as an ideal material for spintronics, also because it displays the anomalous quantum Hall effect at room temperature. The anomalous behavior is a result of emergent massless Dirac electrons. In a magnetic field the spectrum has a Landau level with energy precisely at the Dirac point. Bilayer graphene also shows the quantum Hall effect with a tunable band gap.

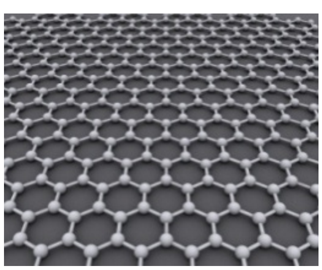

**Figure 1**. Graphene is a flat monolayer of carbon atoms tightly packed into a 2D honeycomb lattice, and is a basic building block for graphitic materials of all other dimensionalities. It can be wrapped up into 0D fullerenes, rolled into 1D nanotubes or stacked into 3D graphite composed of pure carbon atoms arranged in a regular hexagonal pattern similar to graphite. Figure courtesy [4].

Bilayer graphene typically can be found either in twisted configurations where the two layers are rotated relative to each other or in a stacked configuration where half the atoms in one layer lie atop half the atoms in the other. Stacking order and orientation greatly influence the optical and electronic properties of bilayer graphene [29-31]. There are numerous challenges (i.e., incorporating a polar mesoionic xanthine molecule within grapheme layers) for implementing our QC model in graphene such that we may end up abandoning this avenue. We mention it for illustrative purposes suggesting that our QC prototype may become a working model costing just pennies!

We have not finished feasibility research yet in this regard. An additional simplification is to utilize rf-modulated Quantum Hall Effects instead of ring lasers. Initial calculations indicate that frequencies amenable to such rf-modulated Quantum Hall Effects are in the 10-20 GHz range. We may or may not require a mesoionic-xanthine as the computing molecule, although it is currently our best choice of substrate based on empirical calculations and other relevant considerations. If we stay with the mesoionic-xanthine, there are several molecular variations, some of which contain polarizable bilayers; suggesting that the proper mesoionic-xanthine may be doped directly onto a substrate as the QC itself. This 3rd generation prototype would be very close to an inexpensive marketable commercial product; a scenario where delay has proffered rewards. A 2013 US corporation called Bering Strait Systems has been formed to attempt to fund this project. We are patiently waiting.

Recent developmental research on QCs has focused on simple 2-state qubit systems described by two geometric models of the 2-state transformations:

- 1) The SU(2) action of a complex projective line and
- 2) The SO(3) action on a Euclidean Bloch 2-sphere.

Because our model utilizes a method that surmounts the quantum uncertainty principle in a complex 12-space it is postulated that the current Bloch (Riemann) sphere representation of qubits (a classical 2-sphere model) may be too primitive and not suited for actualizing bulk universal QC. For the past several years our model was based on a relativistic (r-qubit) where the additional degree of freedom was an aid to surmounting uncertainty [2,5]. Recently we realized the 4D r-qubit, while on the right track was also insufficient. This arose from extending quantum theory to the regime of the Unified Field, $U_F$ primarily based on extended HD versions of Cramer's transactional interpretation and the de Broglie-Bohm interpretation.

This was as much a breakthrough in nilpotent cosmology as quantum theory. We discovered there was more to a quantum state than a Copenhagen 'particle in a box'; the quantum state was conformally scale-invariant requiring a representation utilizing a system of dual continuous-state Calabi-Yau mirror symmetric 3-tori (class of Kähler manifolds) [6-8]. One surprise is that this cosmology contains an inherent 'synchronization backbone' [1,2] which ends up like getting half the QC for free; and of course making the essential process of surmounting uncertainty almost simplistic [2]. We spend considerable effort to discuss such putative developments in a later section.

## 2. Qubit Basis, Geometry and Invariants

This summarizes the current thinking on representations of quantum states where the quantum wavefunction is the most complete description that can currently be given to a physical system:

- Physical information about a transition is encoded in a unit vector in a complex vector space.
- Physical process without measurement corresponds to unitary transformation of this vector representation.
- A measurement corresponds to the probabilistic choice of a covector to form an amplitude $\langle\Psi|\mathrm{U}|\Phi\rangle$ where the probability is $|\langle\psi|U|\phi\rangle|^2$.

We intend to show that this currently utilized vector algebra is not physical but rather a convenient mathematical representation. The Bloch sphere is a 2D representation of 4D reality. We show below a recent attempt at a 6D dual qubit as an indicia of our model which is cast in 12D which we believe is required to fully represent a properly physicalized qubit!

In the philosophy of physical science there is no *a priori* reason why nature must be described as a $U_F$ theory. The current drive in physics is to bring the four fundamental field interactions into a single unified framework as a form of quantum theory. Because of the inherent difficulty associated with renormalization and uniting gravity and quantum theory many physicists believe a framework other than a field theory such as a version of an 11D M-Theory may be a viable alternative avenue.

In the usual nonrelativistic quantum theory of computation it was necessary only to point to the number of states, $2^n$ for a description of $n$ qubits. In relativistic theory there are many special cases. Charged and neutral, massive and massless particles etc. should be described differently.

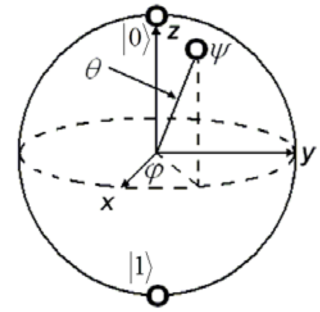


**Figure 2.** Usual representation of a qubit $|0\rangle+|1\rangle=\Psi^2$ as the complex Riemann Bloch 2-sphere.

The problem of extending the fundamental basis of the qubit is manifold. Many physicists do not accept dimensionality beyond four. Those that do, predominantly string theorists, now M-Theorists, are confounded by the search for a unique string vacuum claimed to have a Googolplex or $10^{\infty}$ possibilities. HAM cosmology has something going for it in that a unique string vacuum has been derived from its parameters [2]. Further restrictions arise from its unique form of inherent Calabi-Yau mirror symmetry. Thus a clear avenue is provided to 'divine' the complex HD space from which our 3D virtual reality is a resultant. Fortunately our model is empirically testable. Nine of the fourteen experimental protocols derived so far are summarized elsewhere in this volume [9,10].

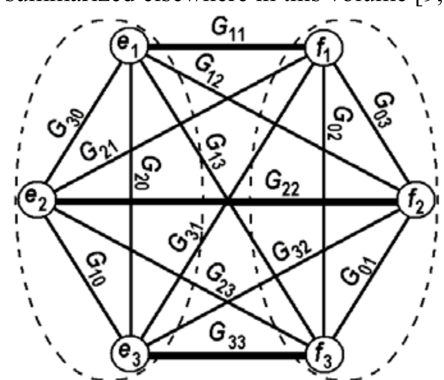


**Figure 3.** Combinatorial graph of vertices corresponding to basis vectors of a Bloch sphere for two qubits [e1, e2, e3] & [f1, f2, f3] and the edges to the corresponding bivector basis $G_{ij}$. Dashed ellipses enclose the induced subgraphs corresponding to the "local" subalgebras of each Bloch sphere model, while the perfect matching of a Cartan subalgebra is indicated by the bolder lines of edges G11,G22,G33. Figure redrawn from [11].

The perceived required redefinition of the qubit requires new logic gates and QC algorithms to take full advantage of the new physics. Operationally the new r-qubit basis entails a new set of transformations beyond the usual Galilean-Lorentz-Poincairé which have been temporally adjoint along an axis or light cone in Euclidean and then Minkowski coordinates. We have chosen to call the new transformation 'The Noetic

Transformation' because it is cast in an anthropic multiverse. What separates the Noetic Transform from its precursors (Galilean, Lorentz-Poincaré) is that it uncouples from the 3D or 4D realm of the observer and has no temporal component. This evolution from Classical to Quantum-Relativistic now continues to a new regime of Unified Field Theory, $U_F$.

We do not wish to say 'uncouples from reality', rather that fundamental reality should now be considered 12D instead of the 3(4)D of the Lorentz-Poincaré Transformation. The elimination of the concept of time occurs by a double superluminal boost, $x \leftrightarrow t_x \leftrightarrow w_x$ that also occurs along the *y* and *z* axes simultaneously. The infinities plaguing renormalization are indicia of this 12D reality (in the same way the infinities in the Raleigh-Jeans law for black body radiation were an indicia of the immanent discovery of quantum mechanics).

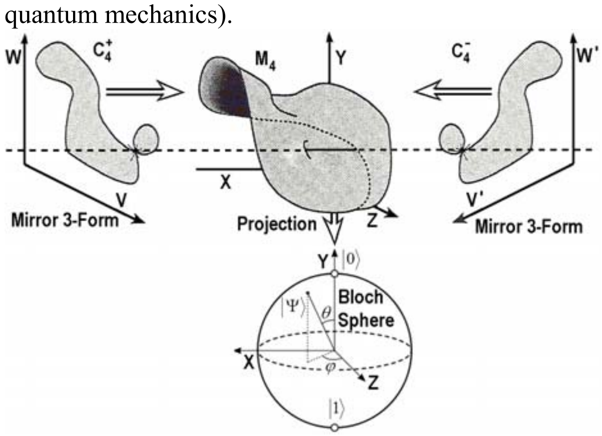


**Figure 4.** Alternative rendition of Fig. 7. Complex HD Calabi-Yau mirror symmetric 3-forms, $\pm C_4$ complex dimensions become embedded in Minkowski space, $M_4$. This resultant is projected as a continuous quantum state evolution considered a nilpotent Bloch sphere representing the lower portion that embeds in local spacetime. There is an additional duality above this projection embedded in the infinite potentia of the $U_F$ from which it arises. What this new LSXD reality means is that the usual consideration of a Bloch 2-sphere vector based qubit is insufficient for bulk QC.

During the late 1980s, a second set of quantum axioms based on geometric-topological ideas was proposed restricting parameters to a specific class of topological quantum field theories inaugurated most saliently with Atiyah and Segal, and notably expanded upon by Witten, Borcherds, and Kontsevich [32-36]. However, most of the physically relevant quantum field theories, such as the Standard Model, are not topological quantum field theories; the quantum field theory of the fractional quantum Hall effect is a notable exception [17]. The realized basis for Bulk Universal Quantum Computing diverges from the anticipated form by current quantum computing researchers utilizing the standard Copenhagen Interpretation (CI) of quantum theory.

We anticipate that the realized basis for bulk universal QC diverges from the anticipated form by current QC researchers utilizing the standard Copenhagen Interpretation (CI) of quantum theory. What this means is that the Bloch 2-sphere vector basis, $|\psi| = \alpha|0\rangle + \beta|1\rangle$ where $|\alpha|^2 + |\beta|^2 = 1$ (single qubit only) is archaic and not an appropriate model for QC gates or algorithms. As our starting point we follow recent efforts of Makhlin [12] Zhang et al. [13] and Havel [11,14], (MZH) who have pointed the way to our model with a geometric algebra rendition of a dual Bloch sphere.

This is then used by MZH to illustrate the Cartan decompositions and subalgebras of the 4D unitary group, which have recently been used to study the entangling capabilities of two-qubit unitaries. "*…we show how the geometric algebra of a 6D real Euclidean vector space naturally allows one to construct the special unitary group on a two-qubit* (*quantum bit*) *Hilbert space, in a fashion similar to that used in the well-established Bloch sphere model for a single qubit*" [11]. The group SU(2) is isomorphic to the group of quaternions of norm 1, and is thus diffeomorphic to the 3-sphere Since unit quaternions can be used to represent rotations in 3D space (up to sign), we have a surjective homeomorphism from SU(2) to the rotation group SO(3) whose kernel is {+*I*, −*I*}. The geometric structure of nonlocal gates is a 3-torus. The local equivalence classes of two-qubit gates are in one-to-one correspondence with the points in a tetrahedron except on the base [13].

The MZH model is based on complex Minkowski space and the Copenhagen Interpretation. Our model is different - cast in a 9D M-Theoretic Calabi-Yau mirror symmetry utilizing an operationally completed form of QT achieved by integrating LSXD forms of the de Broglie-Bohm Causal Interpretation [15] and Cramer's Transactional Interpretation [16] but that still makes correspondence with the MZH 6D model [11-14].

## 3. Case for Relativistic Qubits (R-Qubits)

Refer to Fig. 2 for the usual Block Sphere representation of a qubit, a geometrical representation of the pure state space of a two-level quantum mechanical system. Alternately, it is the pure state space of a 1 qubit quantum register. In the conventional consideration of quantum computing a quantum bit or qubit is any two-state quantum system defined as a superposition of two logical states of a usual bit with complex coefficients that can be mapped to the Riemann sphere by stereographic projection (Fig. 5). Formally a qubit is represented as: $\Psi = \xi|0\rangle + \eta|1\rangle$ with each ray $\xi, \eta \in C$ in complex Hilbert space and

$\|\Psi\|^2 = \xi\bar{\xi} + \eta\bar{\eta} = 1$, where $|0\rangle$ corresponds to the south or 0 pole of the Riemann sphere and $|1\rangle$ corresponds to the opposite, north or $\infty$ pole of the Riemann complex sphere. The conventional qubit maps to the complex plane of the Riemann sphere as:

$$\xi\bar{\eta} + \eta\bar{\xi} \to X,\ \xi\bar{\eta} - \eta\bar{\xi} \to iY,\ \xi\bar{\xi} - \eta\bar{\eta} \to Z\ . \quad (1)$$

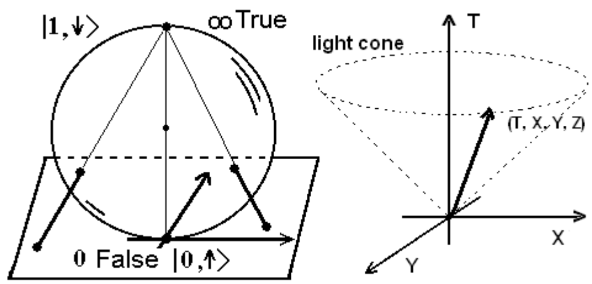


**Figure 5.** (a) Stereographic projection model of a qubit on a complex Riemann sphere. (b) Relativistic model of a qubit (r-qubit) with interacting quantum fields entailing an extra HD degree of freedom.

Unitary transformations of a qubit correspond to 3D rotations of the Riemann sphere. Following Vlasov [5] for relativistic consideration of a qubit (r-qubit) an additional 4D *W* parameter is added to equation (2):

$$\begin{aligned} &\xi\bar{\eta} + \eta\bar{\xi} \to X, \quad \xi\bar{\eta} - \eta\bar{\xi} \to iY, \\ &\xi\bar{\xi} - \eta\bar{\eta} \to Z, \quad \xi\bar{\xi} + \eta\bar{\eta} \to W \end{aligned} \quad (2)$$

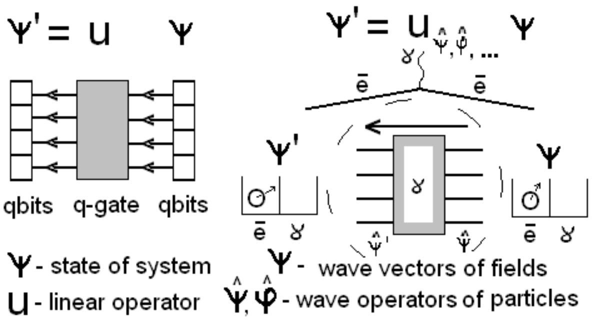


**Figure 6.** (a) Usual q-gate with constant number of states and particles. (b) Relativistic quantum bit (r-qubit) with constant particles but variable or infinite states.

In cartography and geometry, the stereographic projection is a mapping that projects each point on a sphere onto a tangent plane along a straight line from the antipode of the point of tangency (with one exception: the center of projection, antipodal to the point of tangency, is not projected to any point in the Euclidean plane; it is thought of as corresponding to a "point at infinity"). One approaches that point at infinity by continuing in any direction at all; in that respect this situation is unlike the real projective plane, which has many points at infinity.

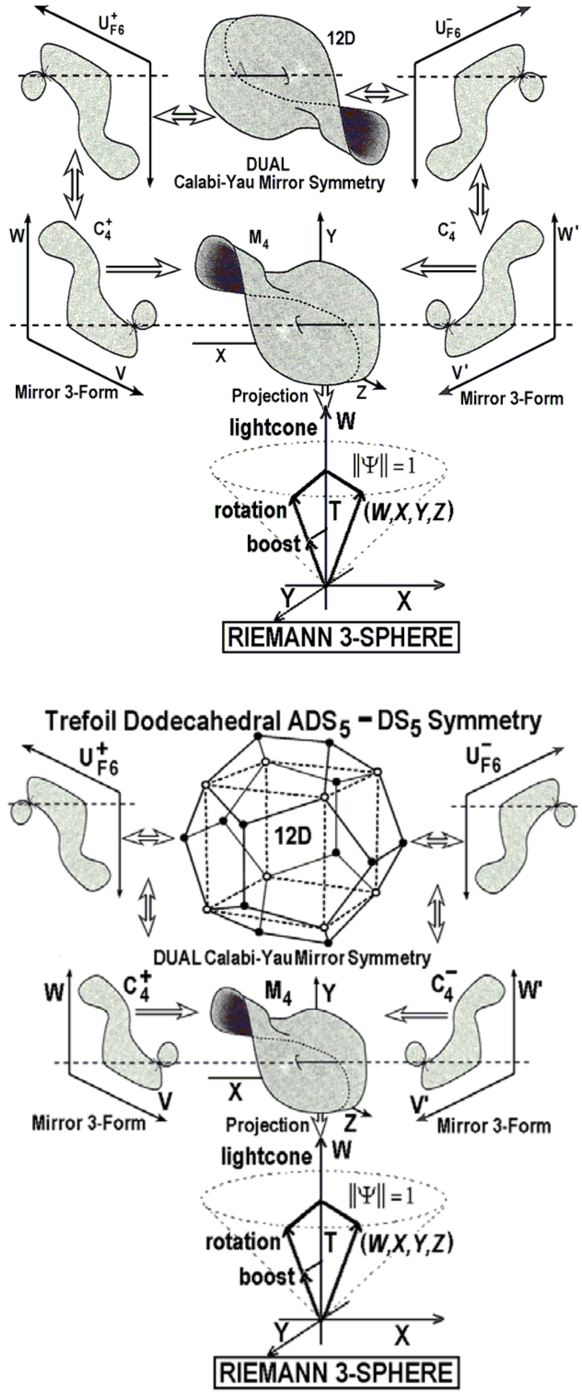


**Figure 7.** Completion of Fig. 4 from 8D to 12D illustrating full extended rendition of additional parameters for a relativistic LSXD quantum state in continuous-state dual Calabi-Yau mirror symmetric HAM cosmology in 7a) as far as currently understood. Replacing also the Bloch 2-sphere qubit representation with the new extended r-qubit Riemann 3-sphere resultant representation that has sufficient parameters to surmount the uncertainty principle. 7b) $ADS_5$ version.

Recent WMAP satellite observations have given good preliminary evidence that the fundamental topology of cosmology is a 'wrap-around' polyhedron of Poincaré-Dodecahedral (PD) form that correlates with Anti-de Sitter space, $AdS_5$ matching up conformal supersymmetry in 4D with AdS supersymmetry in 5D. There are $8N$ real SUSY generators and the bosonic part consists of the conformal AdS group Spin(4,2) times an internal group $SU(N)_T \times U(1)_A$.

For the case $N = 4$, there are 32 real SUSY generators and an internal group $SU(4)_T \times U(1)_A$. SU(4) ≅ Spin(6) and Spin(6) is the isometry group of $\mathbf{S}^5$with spinorial fields. The bosonic spatial isometry group of $AdS_5 \times \mathbf{S}^5$ is spin (4,2) × spin (6).

In $N = (2,0)$ 10D SUSY there are 32 real SUSY generators. In a generic curved spacetime, some of the SUSY generators are broken but in the special compactification of $AdS_5 \times \mathbf{S}^5$ with both factors having the same radius there are 32 real unbroken generators.

The integral of this 5-flux over $\mathbf{S}^5$ has to be a nonzero integer (if it's zero, we have no stress-energy tensor). Because the part of the 5-flux lying in $AdS_5$ contains a time component, it gives rise to negative curvature. The part of the 5-flux lying in $\mathbf{S}^5$ doesn't have a time component, and so, it gives rise to a positive curvature.

The near horizon geometry is approximately $AdS_5 \times \mathbf{S}^5$ with the approximation becoming more and more exact closer to the horizon. If we take the limit in which we are always in the near horizon region, the geometry becomes exactly $AdS_5 \times \mathbf{S}^5$ [38,39]. This is sufficient for HAM cosmology to embrace a PD $AdS_5$ backcloth especially since the possibilities of positive and negative curvature coincide with HAMs oscillating cosmological constant.

## 4. Basis for the Noetic Transformation

An event in spacetime is an idealized instant of time at a definite position in space labeled by time and position coordinates *t,x,y,z*. Coordinates have no absolute significance; they are arbitrary continuous single-valued labels given invariant meaning by the expression for the line element connecting two events [18,19]. The usual expression for a line element in Minkowski coordinates is

$$ds^2 = dt^2 - dx^2 - dy^2 - dz^2. \qquad (3)$$

For simplicity at this stage of development of the Noetic Transformation we devise the XD coordinates as orthogonal and evenly spaced. Firstly since the LSXD space is time independent we may drop the $dt^2$ term from the line element and introduce a new spatial form, $dl^2$ where $dl^2$ reduces to $ds^2$ and

$$dl^2 = dx^2 + dy^2 + dz^2 + dW^2 \qquad (4)$$

where $W = w^i + w^j + w^k$ (before complex dualing to Calabi-Yau mirror symmetry) as a 9D quaternion-like trivector representation. This is like an extension of the 3-sphere of Einstein's space where the set of points *x,y,z,W* are at a fixed distance *R* from the origin such that $R^2 = x^2 + y^2 + z^2 + W^2$ preserving the wanted three time independent space variables x,y,z and where the fourth LSXD variable $W^2$ is given by

$$W^2 = R^2 - r^2 \qquad (5)$$

where $r^2 = x^2 + y^2 + z^2$ such that (5) becomes

$$dW = \frac{r\ dr}{W} = \frac{r\ dr}{\left(R^2 - r^2\right)^{1/2}} \qquad (6)$$

So that the dual local-HD spatial line-element $dl^2$ becomes

$$dl^2 = dx^2 + dy^2 + dz^2 + \frac{r^2 dr^2}{R^2 - r^2} \qquad (7)$$

where *R* may be used to represent the center of dual Calabi-Yau mirror symmetric 3-tori. See Fig. 10.

Continuing to follow Peebles [18,19] this generalizes the usual 2D line element to 9D where the length *R* in the expressions is a constant for the model because spacetime is assumed to be static. For $r \ll R$ our extended Einstein line element approaches the usual Minkowski form (1). When $r = R$ the geometry makes correspondence to the surface of a Riemann 2-sphere which is utilized in the standard description of a qubit as a Bloch Sphere. (Fig. 2)

We may now look at the additional parameters this space allows us to add to the fundamental description of a quantum state beyond the usual inherent uncertainties of Copenhagen interpretation. Because of the conformal scale-invariance of the Nilpotent criteria an additional duality must be incorporated into the mirror symmetric parameters of $W^2$ which is a further correspondence to the standing wave-like properties of the Cramer Transactional Interpretation to simplistic-ally what might be labeled, $\pm W^2$. This addition as far as we currently understand would incorporate all the additional parameters for a complete description of a quantum state as embedded in the LSXD (Large Scale Extra Dimensionality) aspects of the $U_F$ requiring a new representation of the qubit to include the additional HD conformal scale-invariant parameters.

The Pythagorean Theorem $a^2 + b^2 + c^2 = d^2$ gives the length, *d* of the diagonal of a 3D cube, *a,b,c*. By adding additional terms to the equation it describes the diagonal of an nD hypercube. This is illustrated in Fig. 7b above. The locking together of the Calabi-Yau components in the resultant localized cube creates the quantum uncertainty principle which can be surmounted [2,3] if the Calabi-Yau nilpotent 'copies' are accessed by incursive resonance.

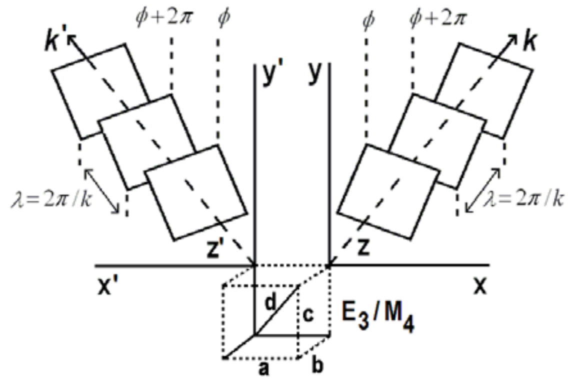


**Figure 8.** Conceptualized view of complex Riemann planes cast as Calabi-Yau future-past mirror symmetric potentia illustrated as tiered surfaces (additional topology suppressed) of constant phase in this case to represent cyclic components of evenly spaced orthogonal standing reality waves with the $E_3/M_4$ cubic resultant localized as the 3-cube at the bottom. The resultant Euclidean cube is locked in 4D by the uncertainty principle keeping the HD parameters inaccessible to the empirical tools available to the Copenhagen framework. k & k' will topologically infold into an HD continuous-state torus.

A surface of constant phase, $k \cdot r - \omega t = k_x x + k_y y + k_z z - \omega t =$ *constant* is a wavefront [2,17]. For a surface of constant phase if any wave equation has a time harmonic (sinusoidal) solution of the form $Ae^{i\phi}$ where *A* is the amplitude and the phase, $\phi$ a function of position with (*x,y,z*) constant and phase difference $2\pi$ separated by wavelength, $\lambda = 2\pi / k$. The direction cosines of the planes of constant phase are proportional to *k* and move in the direction of *k* equal to the phase velocity where

$$\mu = \frac{\omega}{k} = \frac{\omega}{\sqrt{k_x^2 + k_y^2 + k_z^2}}. \tag{8}$$

Where $\lambda = 2\pi / k = 2\pi\hbar / p = h / p$ is equivalent to the de Broglie matter wave relations, $E = \hbar\omega$, $\mathbf{p} = \hbar k$ [20].

We may now look at the additional parameters this space allows us to add to the fundamental description of a quantum state beyond the usual Copenhagen interpretation. Because of the conformal scale-invariance to the Nilpotent criteria an additional duality must be incorporated into the mirror symmetric parameters of $W^2$ which is a further correspondence to the standing wave-like properties of the Cramer Transactional Interpretation to simplistically what might be labeled, $\pm W^2$. This addition as far as we currently understand would incorporate all the additional parameters for a complete description of a quantum state as embedded in the HD aspects of the $U_F$ requiring a new representation of the qubit to include the additional parameters.

Most are familiar with the 3D Necker cube (center of Fig.8 is like a Necker cube) that when stared at certain vertices reverse. This is called topological switching. There is another paper child's toy called a 'cootie catcher' [37] that fits over the fingers and can switch positions. What the cootie catcher has over the Necker cube is that it has a better defined center or vertex point such that in the LCU exiplex [9] space-time background we have this topological switching [2]. It represents the frame that houses the gate which is like a lighthouse with the rotating beam on top. Additionally inside the structure there is a baton passing. The baton is like a shutter on the lens that the 'light' shines through. In the HD $U_F$ regime the light is always on omni-directionally. But in addition the baton passing is also a form of leap-frogging. The leap-frogging represents wave-particle duality (which as you may recall we elevated to a principle of cosmology). The leaping moment is the wave, and the crouched person being leapt over is the particulate moment. The particle moment acts like a domain wall and no light passes when its orientation is aligned towards the 3-D world. This is a primitive explanation of the knot provided by the uncertainty principle.

We can also attempt to describe this topological geometry with dual quaternion-like trefoil knots. The trefoil knot array (in Fig. 10 drawn as Planck scale quaternion vertices) is holomorphic to the circle. Since energy is conserved we may ignore the complexity of the HD symmetries and use the area of that circle as the Lagrangian, in this case a resultant of two trefoil knots as a 2-sphere quantum state as the coupling area. The figure also provides a conceptualized view of how HAM cosmology sees continuous-state evolution of conformal scale-invariant Calabi-Yau mirror symmetric topology. As QT has a semi-classical limit this might be termed semi-quantum in terms of the HD $U_F$. There is a 2nd LSXD level 'above' this one postulated as the regime of full $U_F$ potentia. The cycle goes from chaotic-uncertain to coherent-certain perhaps non-commutative to commutative according to the noetic transformation. This is represented in the Dirac string trick or Philippine wine dance [26].

The traditional quantum state, $|\psi| = \alpha|0\rangle + \beta|1\rangle$ where $|\alpha|^2 + |\beta|^2 = 1$ is the usual vector representation of a single qubit on a Bloch sphere. This is according to the Copenhagen interpretation of quantum theory where quantum logic gates are limited by the uncertainty principle limiting quantum computation to 10 or 20 qubits. The new HD quantum state/qubit representation extends to the conformal scale-invariant continuous-state properties to the $U_F$ which includes mirror symmetric 'potentia copies' making correspondence to the resultant standard Copenhagen quantum state but which are not limited by the uncertainty principle.

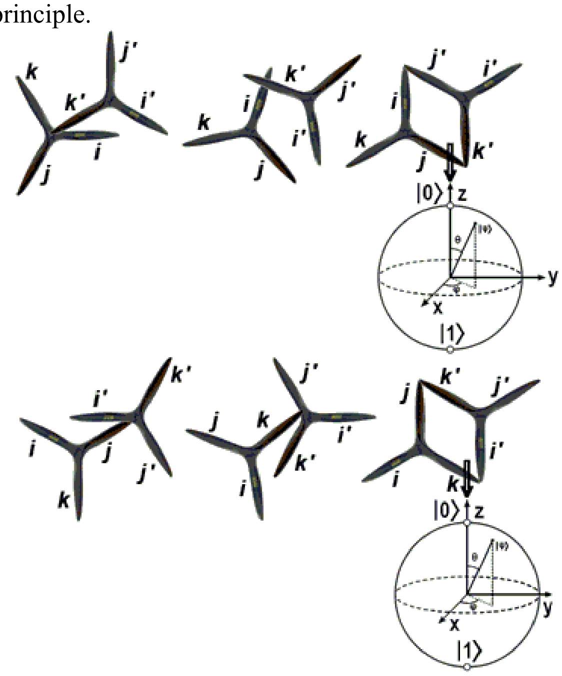


**Figure 9.** Alternative rendition of Fig. 4 in quaternionic form. Locus of HD mirror symmetric Calabi-Yau 3-tori (here depicted trefoil knots) spinning relativistically and evolving quantum mechanically time. Nodes in the cycle are sometimes chaotic (degenerate) and sometimes periodically couple into resultant quantum states in Euclidean 3-space depicted in the figure as faces of a 3-cube that reduce further to the Riemann Bloch 2-sphere.

## 5. Toward a Quaternion Trivector R-Qubit Algebra

A dual 3-form multivector is sometimes called a trivector which we choose here in view of some nomenclatural disparity as to precise usage and definition in the literature. We believe we need to use a dual quaternion triplet, a double set of 3 quaternions which could perhaps be defined as a dual trivector. Dual because of LSXD Calabi-Yau mirror symmetry.

Most physicists admit quantum theory is incomplete. In the Copenhagen interpretation, the Schrödinger equation is considered semi-classical and we have the bra-ket Block sphere 2D convenience representation of a qubit. We wish to consider a new LSXD $U_F$ view of the actual physical state represented. HAM cosmology naturally suggests this required change in what we consider as the physical quantum state. We can say the quantum regime is coupled to the classical world, but a completed QT will be in actuality coupled to the unified field, $U_F$. This allows us to 'Godelize' beyond the Copenhagen quantum state to 'see' the whole noumenal (thing in itself behind the phenomenology of appearance) basis of it. Which by using Ben Goertzel's term is as a form of 'quaternion mirror-house' [21] which also makes correspondence to the Rowlands' nilpotency which requires the 1st doubling. And then a second doubling required by HAM cosmology to render the complete Calabi-Yau mirror symmetric (or mirror house) rendering.

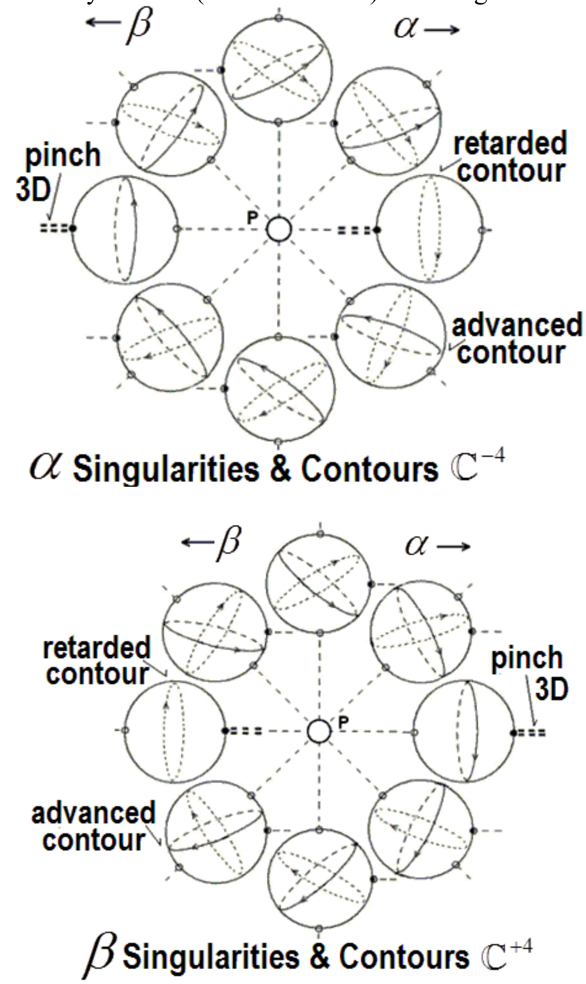


**Figure 10.** Two of six HD Nilpotent trivector r-qubit symmetries.

Thus in contrast to Havel's 6D bivector in complex Minkowski or Hilbert space we can illustrate HD qubit by the Philippine wine dance [26]. Each wine glass would represent one standard Bloch sphere; the dancer is like an atom and each glass represents one of the 2 possible spin states. Havel would have 2 entangled wine dancers standing near each other in Minkowski-Hilbert space. What we see is required to completely define a quantum state physically is that the wine dancers are like puppets standing additionally in a hall

of mirrors [21]. The puppet master is the super-quantum potential provided by parameters of the unified field. The mirror images are restricted on each side of the Cramer future-past Calabi-Yau mirror symmetry. By the continuous-state premise of this HD hierarchy - the left-right or future-past components become embedded in each other in the cycle [2,9,10]. The bottom (3D resultant) becomes the usual semi-classical phenomenological q-state we observe. At the 12D top the embedding is the causally free (ontological) quantum state copy.
A tabulation of vectors, scalars, quaternions and commutivity properties is as follows:

| | | | |
|---|---|---|---|
| $\mathbf{i}\ \mathbf{j}\ \mathbf{k}$ | $i\mathbf{i}\ i\mathbf{j}\ i\mathbf{k}$ | $i'$ | 1 |
| i j k | $i\mathrm{i}\ i\mathrm{j}\ i\mathrm{k}$ | $i'$ | 1 |
| *vector* | *bivector* | *trivector* | *scalar* |
| | *quaternions* | | |

Vectors

| | |
|---|---|
| $\mathbf{i}\ \mathbf{j}\ \mathbf{k}$ | anticommute |
| i j k | anticommute |
| $\mathbf{i}\mathrm{i}\ \mathbf{j}\mathrm{j}\ \mathbf{k}\mathrm{k}$ | commute |

Quaternions

| | |
|---|---|
| $i\ j\ k$ | *anticommute* |
| $\boldsymbol{i}\ \boldsymbol{j}\ \boldsymbol{k}$ | *anticommute* |
| $\boldsymbol{i}i\ \boldsymbol{i}j\ \boldsymbol{i}k$ | $\boldsymbol{j}\ i'\boldsymbol{k}$ *nilpotent* |
| $\boldsymbol{i}i\ \boldsymbol{i}j\ \boldsymbol{i}k$ | $\boldsymbol{j}$ - *nilpotent* |
| | (*5th term automatic*) |
| $ii'\ j\boldsymbol{j}\ k\boldsymbol{k}$ | *commute* |

In summary Havel uses a 6D bivector to represent 2 qubits. In our model a single qubit should be represented as some form of a dual trivector. What we get with this new qubit representation is QC logic gates able to surmount the uncertainty principle and proper algorithms for universal QC.

Normalized quaternions are simply Euclidean 4-vectors (length one) and thus fermionic vertices in spacetime or points on a unit hypersphere (this case a 3-sphere) embedded in 4D. Just as the unit sphere has two degrees of freedom, e.g., latitude and longitude, the unit hypersphere has three degrees of freedom.

According to Rowlands [22] quaternion cyclicity reduces the number of operators by a factor of 2 and prevents the possibility of defining further complex terms. To overcome this generalization of term limitations we explore utilizing shadow dualities employing additional copies of the quaternion algebra mapped into a 5D and 6D space to transform a new dualed 'trivector' quaternion algebra. As far as we know this can only occur under the auspices of a continuous-state cosmology within a dual metric where one coordinate system is fixed and then the other is fixed in a leap-frog baton passing fashion [23-25].

The coordinate fixing-unfixing mechanism is superbly illustrated by the 'walking of the Moai on Rapa Nui' [27,28].

However a 3rd complex metric is involved making an evolution from dual quaternions to a 3rd quaternion we choose to name a trivector that acts as a baton passing mechanism between the space-antispace or dual quaternion vector space. The trivector facilitates a 'leap-frogging' between anti-commutative and commutative modes of HD space. This inaugurates a Mobius transformation between the Riemann dual stereographic projection complex planes.

Geometrically, a standard Möbius transformation can be obtained by first performing stereographic projection from the plane to the unit 2-sphere, rotating and moving the sphere to a new location and orientation in space, and then performing stereographic projection (from the new position of the sphere) to the plane. These transformations preserve angles, map every straight line to a line or circle, and map every circle to a line or circle. Möbius transformations are defined on the extended complex plane (i.e. the complex plane augmented by the point at infinity): $\hat{\mathbb{C}} = \mathbb{C} \cup \{\infty\}$.

This extended complex plane can be thought of as a sphere, the Riemann sphere, or as the complex projective line. Every Möbius transformation is a bijective conformal map of the Riemann sphere to itself. Every such map is by necessity a Möbius transformation. Geometrically this map is the Riemann stereographic projection of a rotation by 90° around $\pm i$ with period 4, which takes the continuous cycle $0 \rightarrow 1 \rightarrow \infty \rightarrow -1 \rightarrow 0$.

This is an LSXD point particle representation of a fermionic singularity [9,10]. The 8 + 8 or 16 ($\mathbb{C}^{\pm 4}$ complex space) 2-spheres with future-past retarded-advanced contours are representations of HD components of a Cramer 'standing-wave' transaction. This can be considered in terms of Figs. (4,7,8,10,11) as Calabi-Yau dual mirror symmetries. To produce the quaternion trivector representation (Fig. 11) a 3rd singularity-contour map is required which is then also dualed, i.e. resulting in 6 singularity/contour maps. This may be required to oscillate from anticommutivity to commutivity in order to provide the cyclic opportunity to violate 4D quantum uncertainty [2,3]!

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