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# **Eight Things a First Principles Theory of Everything Should Possess**

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**ABSTRACT:** A first principles theory of everything has never been achieved. An E8 derived code of quantized spacetime could meet the following suggested requirements: (1) First principles explanation of time dilation, inertia, the magnitude of the Planck constant and the speed of light (2) First principles explanation of conservation laws and gauge transformation symmetry. (2) Must be fundamentally relativistic with nothing that is invariant being absolute. (4) Pursuant to the deduction that reality is fundamentally information-theoretic, all information must be generated by observation/measurement at the simplest Planck scale of the code/language. (5) Must be non-deterministic. (6) Must be computationally efficient. (7) Must be a code describing “jagged” (quantized) waveform – a waveform language. (8) Must have a first principles explanation for preferred chirality in nature.

Following, is a list and brief justification for eight qualities that a first principles theory of everything must possess. This draft has not yet had references inserted. We apologize to the reader and can provide references upon request until such time that we updated the draft with references.

1. **First principles explanation of time dilation, inertia, the magnitude of the Planck constant and the speed of light.** These two constants describe all others.
2. **First principles explanation of conservation laws and gauge transformation symmetry.** The convertible (variant) gauge transformations of standard model particles/forces and gravity into one another are known to correspond to the invariant E8 polytope. A fundamental model must explain this correspondence from first principles.
3. **Must be fundamentally relativistic with nothing that is invariant being absolute.** All particles and forces would be decomposed into the invariant E8 lattice and the prototile cells of its cut and projected quasicrystals.
4. **Pursuant to the deduction that reality is fundamentally information-theoretic, all information must be generated by observation/measurement at the simplest Planck scale of the code/language.** A mathematical operator in the language must possess some notion of consciousness, which implies choice. The simplest choice scheme possible is binary, where a choice exists between two states. The code may not require a binary choice, but if there appears to be a more complex choice of states than binary, we must eliminate the possibility of decomposing the choice scheme to a binary one.
5. **Must be non-deterministic.** Quantum mechanics indicates that if a quantum gravity code exists, it should have a non-deterministic (random) component. Certain popular theories in philosophy and psychology indicate that free will is real. For these reasons, we adopt the axiom that either randomness and/or freewill are real, which does not permit the code to behave as a deterministic algorithm. It is a non-deterministic algorithm, wherein one or more steps in the base algorithm are either random or are operated by mathematical operator making choices that are equivalent to measurements/observations. We call this mathematical action/choice

the “hinge variable”. Of the two possibilities of “randomness” acting on the hinge variable or freewill choice of a conscious-type operator, the latter option is preferable because of the fact that abstract information cannot exist outside of a conscious “actualizer” of the information. And we have deduced that reality is information-theoretic. Also, a model with randomness would require a first principles explanation for randomness if it were to be a true first principles theory of everything. Consciousness, on the other hand, has some reasonable explanations from modern science in the form of notions of emergence, self-organization resulting from simple rules, evolution and neural networks.

6. **Must be computationally efficient.** One of the most fundamental aspects of nature is the principle of least action and the derivative idea used in all modern unification theories, Noether’s (2<sup>nd</sup>) theorem. These are classical or “smooth” equations. A first principles quantized explanation for these equations must be explained by the quantized spacetime code/language we speak of. In 2007, Robert Numrich published his theory of the principle of computational least action. Our formalism will treat Planck’s constant as a unit of measurement by the aforementioned mathematical operator. The measurement of this operator registers and relates a unit of information – a symbol used in the code/language of a quantized spacetime network. The objective of nature – of this language operated by operators with some semblance of consciousness – is to generate as much pattern as possible with as few “choices” or units of computational/observational action. There is a logical need to have this behavior serve as an explanation for the principle of least action. But, we will not just invent or seek for this behavior to exist in the code. It will be shown from first principles why it is so. The deepest reason explains why the principle of least action is so deeply part of Noether’s theorem and its relationship to unification theories. Both Noether’s theorem and the principle of least action will be shown to have their explanatory source in the Sum of Squares Law and the general idea of transdimensional conversion of a polytope in one dimension to a polytope in a lower dimension. In very simple and almost trivial terms: The projective transformation occurs in the most efficient way possible, as can be shown from geometric first principles.
7. **Must be a code describing “jagged” (quantized) waveform – a waveform language.** Various authors have published ideas about how the notion of a wave particle duality is a forced correspondence from an older era of thought and that, really, we can see everything as fundamentally vibration/waveform. However, the quantum view indicates that geometries of these waves (wavelength and amplitude) should be discrete. Time or change is discrete (frozen states instantly changing) and curvature can be thought of as emergent from some Planck length spacetime tiles with discrete angles. The objective is to come up with a “jagged” or quantized wave code/language, similar to waves in Penrose tilings, where a language of tile matching rules can be used to describe wavelike (phason) patterns.
8. **Must have a first principles explanation for preferred chirality in nature.** Garrett Lisi’s theory of E8 unification physics was an inspiration to us. However, the major peer criticism is that his model does not explain chirality. Nature is mysteriously prejudiced toward right handed chirality, as the weak nuclear force acts only on right handed particles.

All eight of these requirements can be satisfied using an E8 derived quasicrystal (QC) language. A discussion of each follows.

1. **First principles explanation of time dilation, inertia, the magnitude of the Planck constant and the speed of light.** The E8 quasicrystal model considers Planck length tetrahedra that can relate in only a few ways, according to the natural rules of the QC. One fundamental allowed configuration is called the “57-Group”, which is the electron. It is 56 tetrahedra around one and looks similar to four intersecting icosahedra, where each is made of 20 tetrahedra. Because they intersect, they share tetrahedra and only require 57 total. A Hamiltonian circuit can flow through this object, which itself is a pattern within the quantized spacetime dynamic “mosaic” of the QC. The circuit in the 57-Group occurs as a result of changes allowed in the dynamical code and the pattern has a shape resembling a type of 3D trefoil knot. This Hamiltonian circuit has a specific cycle, where a certain number of computational phason flips (prototile orientation changes) occur before it repeats its pattern. For simplicity, let us say this circuit has 10 flips that complete the full knot-like circuit that flows within it. We’ll call that a tick of the clock of the electron – its internal time. Time at this level is just in pattern. We will call each phason flip Planck unit – the minimum quantum of change or angular momentum. This is the non-divisible expression of energy. So let us allocate 20 quanta of energy to this electron. With that, we can allow it to experience two full Hamiltonian circuits, 10 phason flips or quanta of energy/change per cycle. So we can say that it experienced its change or internal time in such a way that all 20 units of change were invested in its internal change, its two cycles. However, no electron is at rest. And in order for such a pattern in a mosaic-like system of a dynamic QC to propagate like a wave or particle, phason flips must be invested in the propagation also. The ratio can change. But if we invest 10 phason flips to propagate the pattern forward in the spacetime QC, then we only have 10 units left for its cycles of internal change. However, if we slow down its propagation through space by using only 5 phason flips for forward motion, we now have 15 left for its cycles, so no time goes faster for the electron. Or we can simply say that it experiences more change internally and less travel through the mosaic like QC – less velocity. This is a fast explanation of time dilation within our framework. Inertia is more complex. As something changes velocity, it requires more computation to do the changing than it does to settle into a new ratio of phasons used for forward propagation versus internal clock cycling. Each shift to a new rational ratio of these two types of change (internal time versus movement through the QC mosaic), wastes phason flips. A simple analogy is to imagine a chess piece on a board. We can say that some ratio of investment of your quanta of change in a fixed velocity and fixed internal clock speed requires zero transitional quanta of change because your values, the ratio, is fixed. But if you change the ratio, you have to use quanta of change that are invested in neither forward propagation through space nor internal cycles of time/change. The chess piece moving in a straight line on the board 5 moves is very efficient at moving in that ratio. But changing to another row of squares requires you to use one move to shift the piece to the right or to the left. This moves you forward on neither of the two rows. This analogy could be too simple and confuse the reader. The chess board we are talking about is a 4D QC of spacetime projected from E8 in 8D to 4D. The code is a selection process from possible ratios of propagation through space versus internal knot-like rotations that wind in one direction and then another, on average winding towards the center of the 57-Group.

So when changing velocity, quanta of energy/change must be used for the change itself. And so during the change, a drag force will be exerted on the 57-Group electron opposite the direction of propagation. This is due to the abrupt change of ratio, where, temporarily during the change, phason flips are robbed from both internal rotation and from propagation. Time will slow down for the electron under this force that is equivalent to a strong gravitational field and so too will a

resistance to the forward motion be felt in the form of a compression of the 57-Group along and opposite its direction of acceleration.

Now to explain the speed of light, let us go back to the example of giving the 57-group a total of 20 units of change/phason-flips. Let us say that we dial in the ratio of 0:20 where all 20 flips are invested in propagating this pattern forward and 0 are used for its internal cycling. At that point, time would stop for the electron. It would experience absolutely no change. But it would be moving very fast. In fact, it could not possibly move any faster for that particular number of 20 units of phason flip change. A photon is not a knot like pattern that cycles back inwards toward itself in its Hamiltonian circuit of phason flips. It looks more like a helix pattern of tetrahedra. It has no internal clock because it has no circuit – not cycles. It therefore always propagates with all its allocated energy – its units of change/phason-flips – at a ratio of 0:N, where any amount of energy is invested 100% in forward propagation. There is a natural speed limit for this cork-screw shaped pattern. Its units are Planck length. Its Planck units of action – the quantized units of rotation – are of a specific value relative to the Planck length. Its propagation magnitude, the speed of light, is something that we measure relative to a class of change we label as “time” but which at this level is just a different pattern of phason flips in the quasicrystal tiles. Our notion of time and that of our equipment and our minds is based on fermions, such as electrons that have an internal clock time. That clock time has a theoretic maximum when the ratio of cycle investment to velocity investment of change quanta is N:0. This is the electron at rest, where time goes as fast as possible for it. The magnitudes of the speed of light and the electron rest mass can be explained relative to the ratio range that we have discussed herein. As this body of work takes more rigorous mathematical form, this discussion herein will evolve with equations that link it to the first principles values allowed by the natural E8 to 3D QC language.

2. **First principles explanation of conservation laws and gauge transformation symmetry.** Gauge transformation symmetry of standard model particles and forces and gravity is known to correspond to the E8 polytope/lattice. This is non-trivial and must be explained from first principles by any theory of everything. E8 is a deeply fundamental object, as the maximum sphere packing in 8D, an object living in the largest exceptional Lie group. Our E8 based QCs encode this unifying gauge symmetry. A first principles explanation for conservation laws exists in the idea that a projection of a polytope conserves lengths and angles under the Sum of Squares Law and other Euclidean geometry axioms. A QC is a projection of multiple copies of one or more polytopes, where there exists a fixed ratio of prototile and vertex types, regardless of the infinite number of ways the tiles can be arranged within the matching rules and degrees of freedom. In other words, these values are conserved under various allowed expressions. A projection of a crystal or polytope can be thought of as a distribution of a conserved quantity of edge lengths, where the conserved distribution looks different to different observers but where the fundamental building blocks, the sum of squares of the edge lengths, is conserved regardless of the observer. Here the term “observer” is identical to the projection subspace.
3. **Must be fundamentally relativistic with nothing that is invariant being absolute.** Particles, forces, space and time are all variant – convertible to one another according to E8 related gauge symmetry transformations. Everything in our framework is generated via observation, specifically projection, of mathematical “choosers” that decide what to transform. They choose according to the rules and freedom of a code. The fundamental action is that of a point

projector registering/measuring a single tetrahedral cell by selecting from a small set of possible perspectives. Each perspective results in a transformation of the tetrahedron, relative to that particular point projector.

#### 4. The “uncomfortable” requirement for conscious choice as a mathematical operator within a Planck scale quantum gravity formalism

All theories start with at least primitive of axiomatic assumptions. Here, we take the most conservative approach in assuming that physical reality is fundamentally made of information, an approach argued logically by scientists such as John Wheeler. The assumption that energy or spacetime are fundamentally something more than information is an aggressive speculation with no known logical support. We begin here with the deduced assumption that the base “stuff” of reality is information. This leads to a fascinating requirement of a computational entity or consciousness of some sort to actualize the information of the universe. For brevity’s sake, we will not expound here how the very definition of information is tied into the notion of a perceiver/measurer/chooser. One may say that the perceiver is also made of information. Or one may say that the information resides within the perceiver and is therefore also made of consciousness. But the two cannot be separated.

Frank Wilczek (physics Nobel 2004) expressed how this uncomfortable problem must be faced if one hopes to make deep scientific progress in a theory of everything: *The leading interpretations of quantum theory introduce concepts that are extrinsic to its equations (“observers”), or even contradict them (“collapse of the wave function”). The relevant literature is famously contentious and obscure. I believe it will remain so until someone constructs, within the formalism of quantum mechanics, an “observer”, that is, a model entity whose states correspond to a recognizable caricature of conscious awareness; and demonstrates that the perceived interaction of this entity with the physical world, following the equations of quantum theory, accords with our experience. That is a formidable project, extending well beyond what is conventionally considered physics.*

We agree with Wilczek. A Planck scale mathematical entity must act as the “conscious” actualizer of possible information into registered “physical” information. Such an operator must make choices of measurement and interpretation. If it operates within an algorithmic framework, the aforementioned “hinge variable” step is required in order to make the system a code/language and be compatible with the notion of self-reference and choice – defining characteristics of “consciousness”.

We need not pigeonhole the notion of consciousness as being like that of a human being. A more general definition can include a dog or a plant or a microbe. And when we get to things near our arbitrary dividing line between living and not living, such as viruses or crystals, we might say that a consciousness does something similar to all patterns and systems – it tries to propagate itself. Much work has been published about how patterns in general, both “living” and “non-living”, seek to express themselves and evolve with the least amount of energy or computation possible. The most fundamental aspect of consciousness may be self-reference and feedback systems. Both self-reference and feedback are streams of relationship measurements – the relationship of the pattern/entity to its environment and to aspects of itself, such as temperature or hunger. Indeed, feedback and self-reference exist in primitive form in all dynamic patterns (all patterns are dynamic) including those not considered living,

such as streams, weather systems, snowflakes, planetary systems and galaxies. Patterns have a primitive “desire” to maintain their form for as long as possible. And to do so, they use feedback to guide the quanta of changes within them. Feedback is fundamentally self-referential and measurement based. Any measurement is ultimately a package of geometric relationships between points of the measurer (whether it technological equipment or a biological entity) and points in the system being measured.

So if the hard-to-pin-down term “consciousness” could be generalized to be “self-referential patterns”, i.e., all patterns, then we have room for a range of such patterns, where some can be arbitrarily labeled as “alive” and some as “not alive”. And a less arbitrary ranking system could be reasonable, where consciousnesses such as humans and deep-future consciousnesses beyond us, could possess more highly networked degrees of self-reference. Perhaps the degree of consciousness could be based on the connectivity of the pattern within itself (such as a neural network) and with the outside world (outside feedback loops) and the total connectivity of systems of systems within it and its environment. In this framework, patterns with the greatest potential for connectivity would be those with the greatest number of points. This is the case with neural networks. The greatest number of nodes offers the greatest potential connectivity but does not ensure that potential. For example, two humans with the same number of neurons have different degrees of connectivity. But in general, a network with 100 times fewer neurons will not approach the connectivity of the larger network.

Accordingly, the pattern with the greatest potential for connectivity is the pattern with the greatest number of points – the entire spacetime universe, which includes the deep past and far deeper future.

Quantum computers employ the concepts of quantum entanglement and superposition. Superposition is the idea that particles occupy multiple locations and energy states at the same time. Quantum entanglement is when two or more particles behave as though they are the same object. It occurs in experiments when, say, 3 electrons share the same space in a substance called a Bose Einstein condensate and are later separated. Once separated, they remain connected – as though they are one – and ignore all common sense notions of locality. For example, you can put one of the three electrons on Earth and the other two in another galaxy 1 billion light years away. If you rotate the electron on Earth, the other electrons will change in real time, even though a signal between them traveling at the speed of light would take 1 billion years. The big bang theory tells us that the inception of the universe was a moment when all particles shared the same space – similar to the idea of a Bose Einstein condensate – before spreading out to form the universe as we know it. Theoretically, all particles across spacetime are quantum entangled in a real-time neural network.

**Pursuant to the deduction that reality is fundamentally information-theoretic, all information must be generated by observation/measurement at the simplest Planck scale of the code/language.** The big bang and the idea of energy being something other than information are both big audacious assumptions. But with the big bang, we are forced to consider it because of physical experimentation and mathematical reasoning. However, there is no reasoning we have heard of to urge us to assume that energy and spacetime are anything beyond abstract information. This is groundless assumption, much like non-scientific belief or taste preference. On the other hand, the theory that reality is information theoretic has been very well developed in the literature with a large minority of scientists agreeing with it.

Some entity capable of choosing a measurement and an interpretation must exist at the Planck scale both according to deep implications of quantum mechanics and to our deduction that reality is information theoretic – i.e., energy and spacetime are made of abstract information.

Conjectures of how such an entity could exist are logical and supported by the known behaviors of the universe, namely the concepts of (1) emergence, (2) self-organization, (3) evolution and (4) special relativity. Nature is about emergence – systems of systems of systems – all interacting with one another. The human being is an excellent example, where quarks and electrons organize into about 100 different elements, which organize into countless compounds and into hundreds of cell types and numerous organ types. Trillions of cells and larger systems interact in a dizzying hierarchical neural network throughout our body such that a consciousness capable of poetry and theoretical physics emerges. All of that high order emergence occurred according to a deep self-organizational and evolutionary principle of the universe that will not be fully understood until we have a predictive quantum gravity theory – a theory of everything. The notion of evolution is key. Old style evolutionary theory, where survival of the fittest and random mutation are the only mechanisms, are not being appreciated in academia these days. There is work going on around the idea that there are additional influences working alongside competitive evolution. For example, potential future organizational states of an evolving system may act as “attractors” to earlier states, like a “minimum energy well”, acting on the evolutionary process at one point in spacetime from a more distant point in the evolutionary hierarchy.

The evolving tools and social behaviors of a species are interactive aspects of the overall organization of energy/information into patterns in and around the species. For example, we are beginning to hack our own evolutionary process by tapping into the genetic code. Our technology has gone into a strange phase of growth that is exponential with fantastic ramifications, as we enter the era of quantum computation. If humans take this runaway evolution of intelligence and technology into the future with knowledge of a deep first principles theory of everything, where manipulation of spacetime enters into the realm only dreamed of by science fiction, then something interesting can happen. It is possible that high technology and high creativity and intelligence, exploding exponentially, can turn vast areas of the universe into a neural network. If wormhole-like time travel is possible or moving information around non-locally becomes possible due to a deep understanding of some new quantum physics, then consciousness can become a transformative force, steering the evolution of the universe in surprising ways in the same way that your consciousness steers a large number of quarks and electrons.

Understanding exponential growth is helpful for consideration of this idea. Consider the changes in computational power and our ability to change the atmosphere and our ability to leave the planet. Think about how those things have advanced over, let's say, the last 40 years. We know that the rate of change over that 40 years has exponentially changed, each year. This is not science fiction. However, writing in 1930 about the exponential technological and scientific changes that just occurred in the last 40 years would have sounded like fiction at that time. Because this phenomenon is now really happening for everyone to see, it has become respectable for people like Ray Kurzweil and other futurists to pencil out our exponential trajectory further into the near future, where unbelievable levels of technology emerge due to the strangeness of how exponential doubling algorithms work. Humans, with our high



technology and high consciousness, have already begun leaving the planet. As we colonize other worlds, the possibility of extinction of high consciousness approaches zero. Futurists like Kurzweil project a few decades into the future to bring us to Star Trek levels of exponential growth (if indeed we are the only high consciousness/high-tech life). However, for our purposes of cosmological physics and the search for a first principles theory of everything, we must consider this principle of evolution and emergent intelligence in a very serious manner over deep time. We logically consider what happens with runaway exponential technological growth in, say, 1 billion years. What happens to the evolution of consciousness and intelligence as we hack our own biology, choosing whatever level of mental computational ability our runaway technology allows? How about 10 billion years? Well before this time, humans would have speciated out to trillions of different ultrahigh tech and high consciousness beings, living throughout vast stretches of the universe. And if a foundational quantum gravity theory were discovered along the way, this speciated high consciousness population of the universe could form a non-local neural network, where information is moved around, not with light but by instant real-time connectivity. Cracking the code of quantized spacetime might allow high intelligence to seed parts of the universe without the need to drive a vehicle at the speed of light. The exponential growth of intelligence would be able to spread to all regions of spacetime, according to the decision of the beings. And in these distant locations, with no upward limit on density, conscious organization of physical information could exchange information in real time without the need to use light signals.

Now, take the generalized concept of a “neural network”. The biosphere of Earth is sometimes modeled in neural network-like ways in the literature. The internet has the potential to act as a sort of neural network, where collective behavior such as distributed computing shows emergent computational behavior not possible with any single computer. But the human brain is clearly the most impressive neural network. Imagine the universe in, say, 100 billion years with  $10^{30}$  different high consciousness/high technology species in virtually every star system in the universe and in countless interstellar islands. This does not need to be the universe from our vantage point in spacetime in order for it to be connected with us in a physical manner.

Follow the logic seriously by adding the notion of neural networking to this new organization of information (beings) in the universe over deep time. The idea of a neural network is where entities of a given level of intelligence – brain cells, for example – exhibit emergent intelligence by exchanging information and acting out group behavior. The strangeness of quantum computation and the experiments of quantum entanglement enjoy non-classical and non-Einsteinian notions of relationships not bound by locality or the speed of light. Imagine a new physics that allows non-local information exchange. It is difficult to pound one’s fist on the table to say that such a thing cannot exist. Mankind does not yet possess a theory of everything. We don’t even yet have a unification theory that successfully predicts anything or is free of numerous forced plugs. So again, when dealing with the largest cosmological problems, like the origin of the universe or the computational substrate that might exist if reality is information theoretic, we must drop hidden dogma. We propose that if high consciousness can leave a planet and seed the rest of the universe with exponentially advancing and non-local (real time) neural networking, that such a neural network and its intelligence tends toward infinity over deep time. Once the genie is out of the bottle and high consciousness seeds a meaningful minority of the universe, it cannot be stopped by an exploding star or a nuclear war. Remember, the universe is not 14 billion years old. That is the amount of it that we can see

from our location in spacetime. It is much, much older. And over a long enough time, whatever can happen will happen.

The final principle mentioned at the beginning of this section was special relativity. The ultra-deep future, say 100 billion years from now, exists as real as the present moment exists. It is physical and part of the same spacetime geometry as we are. Photons cannot travel fast enough for us to connect with distant parts of spacetime. But if there is an underlying code, there should be an underlying computational/consciousness based substrate within which that pure abstract information of the code exists. And as deduced, information can only exist via choice/observation/interpretation. These are defining aspects of consciousness, even very primitive self-referential patterns (feedback systems). So the most plausible explanation for such a computational entity, which could have a large number of individual points of reference to operate the code locally (our concept of “point projectors”) is some deep-time emergent universal neural network. This means that the emergent entity exists because of the free but coordinated behavior of the parts. And the parts only exist because of the emergent entity – a fully self-referential and self-embedded system. The parts are embedded in the whole and the whole is the emergent behavior of the parts.

In short, emergence, self-organization and evolution have already conspired to create ultra-high human consciousness that has recently given birth to exponentially changing digital computation. And in 2014, it gave birth to the first practical quantum computer. Neural networking in nature is not very well understood, as admitted by neurologists studying human consciousness. Whatever emerges over ultra-deep time will emerge exponentially and so is well beyond our current imaginations. And whatever it is, may very well be non-locally networked. The notion of it being “conscious”, like an advanced neural network is reasonable. The notion of it playing a highly formative role in the universe, just as humans have recently begun to play a formative role on Earth, is also reasonable. The outrageous speculation, however, is this. Perhaps this inevitable universal intelligence looped back in spacetime to “have always been” the computational substrate within which the genesis of the quasicrystal based code began at the big bang. When thinking in Einsteinian terms, one must realize that future events, even very deep future events, exist together in the same spacetime system as the big bang. As long as there is no speculation of faster than light movement, one can speculate on a meta system of spacetime or pre-space time, where instant connectivity exists, non-local connectivity, like in quantum entanglement but with a deeper exploitation of the underlying code of reality permitted by some new quantum gravity physics that is not yet understood.

5. **Must be non-deterministic.** QCs have a naturally occurring hinge variable, where, within the matching rules, a binary choice of tile orientation exists. As long as the rules are followed, there is no deterministic algorithm in a dynamical pattern of interacting waves in a quasicrystal.
6. **Must be computationally efficient.** The projection of a lattice to a QC with regular symmetry conserves lengths and angles and conserves the ratio of vertex types and prototile types. What emerges is a code/language that is as compact as possible, i.e., has as few characters as possible and as simple of syntax as possible. The expression of interacting waves, which can be a physically realistic model of spacetime and particles, has minimum computational requirements, as can be demonstrated from geometric first principles related to the Sum of Squares law and basic Euclidean geometry.

7. **Must be a code of describing “jagged” (quantized) waveform – a waveform language.**  
Dynamical QC languages are interactions of jagged waves.
8. **Must have a first principles explanation for preferred chirality in nature.** Our 3D quasicrystals require a chirality. And quasicrystal based spacetime, as a whole, must have either a right handed or left handed chirality. While not explained well in this synopsis of our program, what we do is use regular tetrahedra in 3D quasicrystals instead of the distorted space-filling type from ordinary cut+projection methods. Basically, transdimensional “tension” exists when projecting tetrahedra living in a hyperdimensional crystal down to 3D. This tension can be released in the ordinary way via edge distortion of the cells. Our group works on an alternate method. We keep the tetrahedra regular as they move from a hyper-dimension to 3D. Accordingly, we must release the tension via rotation and disclination. And in so doing, we must make a chirality choice for the system overall. A universe based on this formalism would possess a deep first principles reason for a preferred handedness, we indeed we observe in nature.

Below are additional ideas we employ in our work and elaboration of some of the above concepts.

### Language

A language is a finite set of symbols and relational rules with limited combinatorial freedom used to express meaning. A language which expresses the meaning of vibrational pattern can be called a “waveform language”. What we label as spacetime and energy are patterns made of fundamentally abstract mathematical information – a simple but undiscovered waveform language of quantized spacetime. At this most fundamental level, this wave interaction language has no friction (friction is a higher order phenomenon). Accordingly, it is a superfluid language.

### Graph Theoretic Inspiration

Graph theory might have been better named “connection theory”. At the deepest level, quantized spacetime is an abstract language – like a cellular automaton with a hinge variable. And expressions of language are fundamentally connection networks of meaning. In other words, the connection between groups of meaning need not be linear or local. For example, in the sentence, “Larry hated his job until he learned they were planning on promoting him”, we can see that there are local connections of meaning such as between “he” and “learned”. But we can also see there are non-local connections/relationships between groups, such as the relationship of meaning between “Larry hated” and “promoting him”. A better example might be a novel, where we enjoy non-linear connections of meaning at multiple levels of the story. The relationship between networks, languages and quasicrystals may be unclear at first glance. To help clarify, “meaning” at the simplest level of this wave-language is generally local and expresses the meaning of “jagged” or “pixilated” waveform patterns or oscillations in a quasicrystal geometric framework. The most reduced form of these waves are 1D quasicrystal patterns, such as Fibonacci sequences. This is analogous to the linear or local relationships of meaning in the example sentence with Larry above. At slightly higher levels of meaning, the 1D sequences form 2D, 3D and 4D dynamical quasicrystal systems, which have various emergent relationship groups that are not always nearest neighbor (local). At these level in the emergent hierarchy, though, the relationships, both local and non-local, are distinctly wavelike. But as the hierarchy of emergence continues, patterns in this spacetime superfluid, including the particle-like patterns allowed in the mosaic rules, begin to seem less and

less like waves, even though ultimately most things can be modeled with waves. For example, it is difficult to see the pattern of memes flowing over time on the WWW as wavelike or the behavior of the stock market as being wavelike without careful analytical approaches.

### **The question of conservation of information**

Modern physics has excluded biological systems as a meaningful player in the evolution of the universe. The idea that reality is fundamentally information residing in some neural-network type of system (also made of information) where consciousness is the fundamental “stuff”, compels us to look a little more carefully at the possible role of “life” in the evolution of the universe. Special relativity reminds us that the future evolution of a system exists in the same system as earlier states of the system. For example, we know that the human race in the year 2,100 exists within the same geometry of spacetime as the human race in the year 1984. Special relativity does not permit the notion of light based information exchange between these two subparts. However, quantum mechanics related experiments indicate that near the time of the big bang, all the bosons in the universe shared the same space and there should exist an intractable connection network of “quantum entangled” pairs making up all of reality, where one partner is in one area of spacetime and the other is in a very different area. Here, there is no need for light propagation in order to thinking about emergent characteristics that might exist in this entangled system. Could the system behave as a sort of neural network? That question is reasonable. A firm answer, though, is not reasonable. Until a first principles quantum gravity theory is developed to replace the place-holder theories of quantum mechanics and relativity theory, we must be aware that no scientist should be able to pound their fist on the table about their guess.

We are open to the notion of interactions between past and future states of an evolutionary system. In fact, some experiments (e.g., D. Bem of Cornell) indicate that of retro-causality is a phenomenon.

For now, since we deduce that the base of reality is, in the words of John Wheeler, information-theoretic, we suspect that the mathematical equivalencies between the 2<sup>nd</sup> law of thermodynamics (energy) and Shannon entropy (information) are very deep and relevant to a foundational quantum gravity theory. In fact, the physicality of abstract information has been demonstrated via experiment in 2010 by Toyabe et al using a phase contract microscope equipped with a high speed camera connected to a computer.

Such possibilities lead to a very important question: If information and energy are shown to be equivalent in some future quantum gravity theory, in what sense is information conserved?

Even without having a final quantum gravity theory, we can deduce a few ideas around the edges of this question. First, total information is not conserved. For example, one can consider a human being with x amount of energy as compared to a large rock with the same amount of energy. We can also assume that both systems required the same value of input energy in order to organize their respective informational values. However, the rock can have many orders of magnitude less overall information than the human being. This is due to the phenomenon of emergent evolutionary information. At the non-emergent level of information, we can measure, say, the information of each atom in the rock and the human. If the rock contained the same ratio of elements and the same total weight, it would contain the same amount of base information as the human. Both systems have emergent information in a complex hierarchy of systems of systems of

systems of information. But the human hierarchy of emergent information extends far beyond the rock. The beauty of this principle is that emergent forms of information do not cannibalize the lower tiers of information within which they float. In fact, each emergent strata interacts with all other strata in a complex network of interaction which itself adds to the net amount of emergent information of the system.

The problem with eliminating high technology enabled consciousness from playing a major role in the evolution of the universe is that it projects out exponentially on paper to become enormous. Here at the dawn of the 21<sup>st</sup> century, we are getting a glimpse of what it might mean for exponential computational power to continue for another 20 years as we move towards new forms of computation altogether. We are beginning to see the exponential potential of what happens with a species that uses genetics to program its own DNA – taking biological evolution into the strange realm of exponential growth. The analogy of million bacteria on an apple comes to mind. At fairly advanced stages of the exponential multiplication of the bacteria interacting with the apple, we can see nothing. But at some point, the doubling algorithm explodes the influence of the bacteria into the macro realm and they control the fate of the decomposition of the entire system – the apple and the bacteria. High-consciousness, like that of humans and far beyond humans, coupled with high-technology, like that which could emerge from the foundations of a first principles microscopic theory of everything, will surprise us in terms of how it could connect the universe into a sort of neural network of information exchange. We do not know if it is possible to connect things without use of photons. But we also do not have a good theory of everything that allows us to say that it is impossible.

So summarize this section: Information is not conserved. We live in information only universe exponentially evolving in complexity. For example, the Large Hadron collider is the most sophisticated aggregation of technology that has existed on Earth in 4.5 billion years. So when measuring complexity of this pocket of the universe around Earth, we can say that the universe here has never been so evolved and complex information-wise as it is today, circa 2015. We suggest a phason transition in local pockets of the universe, where biology becomes hyper-influential. In principle, non-local information exchange technologies based on future new physics could allow the entire universe to become enveloped by a sort of neural network of high consciousness and technology enabled entities. Our thesis is that, when the Einsteinian viewpoint is taken, that future evolution exists “here” in the same overall spacetime system that our present exists and that the big bang exists. And we speculate that the overall system across all of spacetime, after folding in highly influential deep-future states of the universe, where consciousness explodes virally, acts as its own substrate. In other words, the assumption of information existing within consciousness, starting at the big bang (or before), is assumed to act as its own operating system or substrate – a substrate which exists in the full system over spacetime, including the phases of the universe where, like the bacteria and the apple, high consciousness emerges as a sort of neural network where emergent entities such as the human species as a whole and individuals play a role is “neural nodes” in the system-wide consciousness. The primitive CA-like entities and choosing mathematical operators mentioned earlier exist within a meta-system that is a mind-like (not in the human sense).

We have painted here a far reaching picture of how evolution of emergent consciousness can loop back to act as its own base “stuff” in an information only universe. We see a microcosm of this concept occurring at a relatively primitive stage of evolution of Earth as a system. Today, human consciousness and technology at the group level is influencing weather systems, the rest of the biosphere and vast subsystems of the ordinary physical structure of the planet. In some cases,

exponential evolution can destroy itself and the system. In other cases, such evolution steers the entire system towards overall meta-evolution.

### **Choice/freewill/perception/interpretation**

At the core of the idea of consciousness measurement actualizing physical information into existence is the notion of choice or freewill. Freewill does not preclude the idea of influence. It coordinates influence. At a deep level, perception or interpretation must also play a role, since any possible information actualized by the choice of observation/measurement also involves a choice of interpretation of the observation. Our program uses the notion of language, where a certain agreed upon set of general definitions of interpretation are used (such as in the English language). We speculate that an ultra-simple CA-type code of rules and degrees of freedom are employed in a system where the simplest operator is a binary “chooser” of active or inactive points in a quasicrystalline based quantized spacetime code. The choosers are ultimately composed 0-dimensional frames of reference of an emergent consciousness that spans the entire spacetime system of future and past.