

# The Code-Theoretic Axiom

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## Abstract

A logical physical ontology is code theory, wherein reality is neither deterministic nor random. In light of Conway and Kochen’s free will theorem [8] and strong free will theorem [9], we discuss the plausibility of a third axiomatic option – geometric language; the *code-theoretic axiom*. We suggest freewill choices at the syntactically free steps of a geometric language of spacetime form the code theoretic substrate upon which particle and gravitational physics emerge.

## 1 Introduction

**The Code Theoretic Axiom:** Reality is neither deterministic nor random. Instead, it is code-theoretic, wherein spacetime and particle therein are discrete and built of a Planck scale geometric code – a finite set of shape-symbols, ordering rules and non-deterministic syntactical freedom.

Broadly speaking, there are three axioms for a physical ontology one can assume. One is the idea that the universe is a deterministic causal chain or algorithm playing itself out. An example of this is the model of the Newtonian clockwork universe [33], which postulates that, if one knew the starting conditions, a powerful computer could predict every event [30]. A second option is the axiom of pure randomness, where a particle can appear anywhere in space and time according to probabilities dictated by quantum mechanics [57]. The third possibility is what we will henceforth refer to as code-theoretic, where, for example, the Planck scale fabric of reality operates according to a geometric language with syntactical freedom creating order and preventing the existence of particles at certain spatiotemporal coordinates. Today, deterministic models are widely believed to be false [6], while the axiom of randomness is generally presumed to be true. This virtual consensus is due to two ideas. The first is the vastly popular Copenhagen interpretation of quantum mechanics [17], which stipulates that the universe is fundamentally random. The second is the widely accepted opinion that consciousness and freewill are real.

The code theoretic axiom is a logical alternative to the two older ideas of determinism and pure randomness. Reality would be non-deterministic, not because it is random, but because it is a code – a finite set of irreducible symbols and syntactical rules. Herein, we adopt the popular and reasoned view that freewill is real.

It is interesting to note that, although there is some degree of consensus that nature is random, there is also a general opinion among physicists that they have freewill, which is neither deterministic nor random. The two views are at odds with one another.

Consider the following thought experiment. We start with a universe without freewill animals living in it and that is ideally random. We assume that freewill actors, as self-organized particle systems (e.g., humans), “contaminate” this otherwise purely random system with their non-randomness – their freewill. Accordingly, they “steer” or causally influence the particles of their bodies by their creative and strategic freewill choices of thoughts and actions, imparting non-random order on the spacetime and particles in the rest of the universe via gravitational, electromagnetic, quantum entanglement and quantum wave function resonance and damping interactions. This intractably complicated but non random ordering influence is ubiquitous because there is no cutoff on the range of force interactions and because each influenced particle in turn influences others. The *free will theorem* and the *strong free will theorem* of John Conway and Simon Kochen states that, if we have freewill (i.e., our choices are not a function of the past), elementary particles must have some form of that same freewill quality [8, 9]. That is, particles would behave neither deterministically nor randomly. Henceforth, we use the term freewill implicitly to mean Conway and Kochen’s sense of freewill.

## 2 Is Reality Information Theoretic?

An insightful pathway to explore the code theoretic axiom is to first decide on a related axiom, which can be introduced by the question:

*Is reality made of information or merely described by information?*

John A. Wheeler was one of the first modern physicists to argue that nature is information theoretic [54]. Today, there are a large number of physicists, such as Stephan Wolfram [56], Gerard ‘t Hooft [20], Ed Fredkin [16], Jürgen Schmidhuber [47], Seth Lloyd [35], David Deutsch [10], Paola Zizzi [58], Carl Friedrich von Weizsäcker [53] and Max Tegmark [50], who suggest it is too aggressive to theorize reality is made of something other than

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information. They contend it is more conservative to accept the logical indication that reality is made of information.

One of the supposed evidential highlights of the information theoretic argument was first observed by James Gates Jr. He discovered the most fundamental error correction code from computer theory, block linear self-dual error correcting code [11], embedded in the supersymmetry equation network that unifies all fundamental particles and forces other than gravity[39].

It is interesting to note that there is not a good counter argument to the information theoretic ontological axiom. Specifically, when one tries to define energy as anything other than information, they must take a Platonist view that claims energy *just is* – a sort of primordial stuff for which we have no further explanation other than knowing how it behaves. Similarly, this end-of-the-road statement that energy *just is* is equally as platonistic as the information-theoretic ontology if one says that information *just is* without going further to explain how this information comes to exist or what it is made of.

To simplify, if energy is not information but is the ultimate stuff that *just is*, we know (1) how it behaves but we do not know what it is made of or how it came to be. On the other hand, if we say energy is made of information, then we know (1) how it behaves and (2) what it is. But we do not know what information is made of or how it came to be.

**Information is:** *Meaning conveyed by symbolism.*

The increasingly popular view that “energy is made of information” goes one step further into clarity and explanation than saying “energy just is” [44]. But it does not go far enough. How does symbolic meaning – information – come to exist? It is not necessary to stop the scientific inquiry at a premature axiom of “information just is”.

### 3 Reality as a Simulation

Some who think reality is made of information suggest it is a simulation [4]. This is known as *the simulation hypothesis*. Like in the movie *The Matrix*, where a quasi-physical reality exists as an information-space, one can imagine the universe being a simulation in some large quantum computer. This recently popular view does provide an explanation that goes beyond the axiom information *just is*. However, in some sense, this view is still the antiquated ontology of materialism because it presumes our universe is made of information and that there is some outside universe that is the real non information-theoretic reality.

A better alternative is to reject the idea of an outside computer and consider a self-organized-simulation, where the symbolic code is simultaneously the hardware, software and the output – the simulation [1]. There may be a more appropriate analogy than these 20<sup>th</sup> century computer theory terms. For example, the concept of neural networks is more physically realistic because they self-organize in nature [32]. They are also exceedingly efficient at computing, due to their massively distributed non-local architecture [43]. The idea of a mind-like neural network as the basis of an information only reality is interesting. Here, the neural network can be made of symbolic geometric code in a graph theoretic architecture operating on a point array in a symmetry space. The information of this symbolic system would live in the emergent pan-consciousness that evolves from the evolution of this physical

code. So the code exists or lives within the evolutionary emergent consciousness, which is self-actualized and emerges from the code. The logic of this non-linear causality is explained in Figure 1.

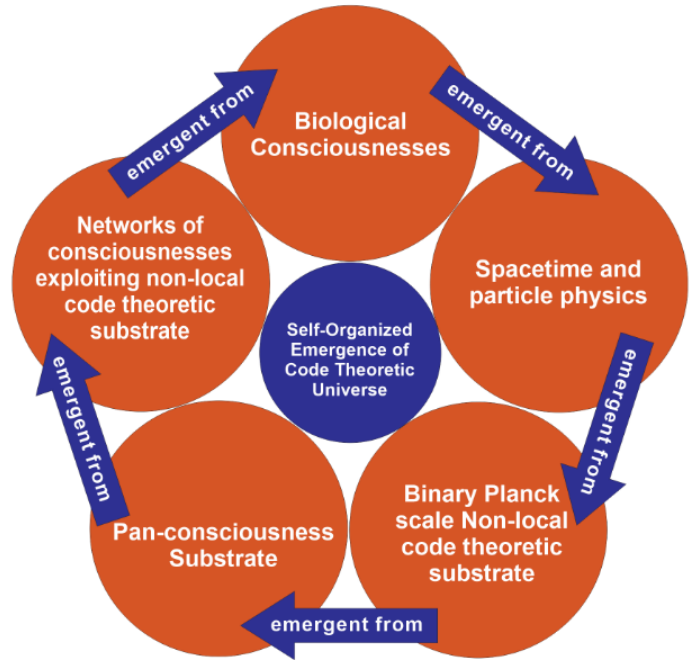


Figure 1: Here we show the self-organized emergence of all aspects in a code-theoretic universe.

The key idea for now is to establish the explanatory power of this view, which goes further than the platonistic *just is* axioms. Here, we would have a connected loop of explanations for a physical ontology that gives understanding of (1) how energy as information behaves, (2) what it is made of (abstract code objects in a pan-consciousness) and (3) how the emergent pan-consciousness itself came to exist. There is a logically consistent and self-embedded causality chain that is less “faith based” than stopping at the axiom that energy *just is* or information *just is*.

Scientists do not agree how consciousness emerges in neural networks [48]. Scientists discussing the simulation hypothesis [5] are pushing the boundary of understanding in a positive way because they are resisting the status-quo view to accept the energy *just is* axiom.

Although the information *just is* axiom is arguably simpler and more logical than the energy *just is* axiom, it comes with a price, which is implied in the definition of information as meaning conveyed by symbolism. That is, meaning is a quality deeply related to entities capable ascribing or actualizing meaning. This can be solved by saying that we live in a simulation of aliens in another universe, who in turn live in a simulation of aliens in another word, *ad infinitum*. If we do not accept the simulation hypothesis, due in part to this *Russian-doll* problem, the information *just is* axiom demands a boldly different worldview than the materialistic philosophy of energy *just is*. Materialists can say that God made the energy or the big bang spewed it out. However, scientists contending that reality is information must deal with the fact that information relates to meaning and meaning relates to choice and consciousness.

According to the code theoretic axiom, the information view

means that everything is information – including the abstract neural network based code theoretic substrate itself. As long as there are physically realistic syntactical rules guiding how an abstract code self-organizes, it is equally as logical for information to behave physically as it is for the more enigmatic notion of energy as something other than information to behave physically. In this case, the term *simulation* would be confusing because that word is used to distinguish between something real as opposed to something not real. For example, if dreams are unreal and waking reality is real, then we can call the dreams simulations of the real world. However, if reality is information theoretic, the terms “physical” versus “abstract” and “reality” versus “simulation” must be replaced. We may use terms related to neural networks and emergent consciousness. For example, we might say something is either “chosen” or “not chosen” or “thought” or “not thought”. This fundamental action would be identical to the idea of “observe” or “not observe” and “measure” or “not measure”. However, in the code theoretic framework, the idea of syntax comes into play, where the most fundamental freewill action is the expression of syntactically free steps in the physical code of reality. The chooser in the code, then, can logically (even if some say improbably) be an emergent pan-consciousness as well as emergent sub-systems, such as humans.

The scientific deduction that the most fundamental stuff of reality is consciousness is not new. Werner Heisenberg [31] said:

Was it utterly absurd to seek behind the ordering structures of this world a “consciousness” whose “intentions” were these very structures?

Frank Wilczek [55] said:

[it will remain obscure]... 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.

Andrei Linde [34], co-pioneer of inflationary big bang theory, said:

...the study of the universe and the study of consciousness will be inseparably linked, and that ultimate progress in the one will be impossible without progress in the other?

John A. Wheeler [54] said:

...the physical world has at bottom ... an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes-or-no questions... all things physical are information-theoretic in origin and that this is a participatory universe.

How can this idea of a code and a pan-consciousness be made concrete and mathematical such that we can use it to do realistic physics? To start with, the code would need to use virtually non-subjective symbols that are quasi-physical.

## 4 Quasi-physical Symbolism

Again, our definition of information is *meaning conveyed by symbolism*. And expressions of code or language are strings of symbols allowed by syntax – ordering rules with syntactical freedom.

A symbol is an object that represents itself or another object. And an object is anything which can be thought of. In the universe of all symbols, there is a special class with very low subjectivity. They can be called self-referential geometric symbols. For example, we can represent the meaning of a square with the Latin letters “square”. Or we can represent it with the symbol of a square itself, in which case it is a self-referential symbol. Quasicrystals, such as the Penrose tiling [41], are examples of geometric symbolic codes. Geometric codes are defined as a finite set of geometric “letters” or shapes and ordering rules with syntactical freedom. Because the universe is geometric and in 3-space, the logical symbols of an underlying code would be polyhedra. Both the ordering rules and dynamic rules should be based on geometric first principles, as opposed to invented rules. In *Toward the Unification of Physics and Number Theory* [23], we showed how shape numbers, as geometric symbols for integers, are uniquely powerful. In *A New Approach to the Hard Problem of Consciousness*, we elaborate on quasicrystalline codes as a logical basis for a quantum gravity framework [21].

The standard model of particle physics is considered to be the most powerful physical model we have [40]. It synthesizes quantum mechanics with particle collider data to show how all known fundamental particles and forces (other than gravity) are unified according to special algebraic and group theoretic structures corresponding to higher dimensional polytopes and lattices. A quasicrystal is an irrational projection to a dimension  $n - m$  of a slice of an  $n$ -dimensional lattice. The projection preserves key information about the higher dimensional lattice. For example, a 3D quasicrystal derived from the  $E_8$  lattice encodes the gauge symmetry unification of the standard model of particle physics insofar as  $E_8$  and any of its subspaces, such as  $E_6$ , encodes such unification physics [18].

We are aware of only one class of non-invented codes that exists via first principles: the set of all quasicrystals. Each is generated by an irrational projection of a lattice slice to a lower dimension [24]. The standard model of particle physics and associated gauge symmetry models correspond to Lie algebras and associated lattices [2]. The lattice analogue starts with the idea that different particles and forces are all equally related to the homogeneously arrayed vertexes or root vectors of certain hyper-lattices, such as  $E_8$ . In order to make such models physically realistic and dynamic (asymmetric), various symmetry breaking mechanisms have been proposed. There is poor consensus on what this mechanism is because none are very convincing [52].

We propose that projective geometry may relate to the correct mechanism. Conveniently, this generates (1) the only known non-invented and first principles based codes and (2) an elegant first principles based symmetry breaking mechanism. Because the projection is irrational, it preserves under transformation the necessary gauge symmetry unification physics.

One of the most important of the 19 parameters of the standard model of particle physics, the Cabbibo angle, can be written in the form  $\cos^{-1} \left( \frac{\phi^2}{\sqrt{2(\phi+2)}} \right)$  [25, 28, 27, 37]. It corresponds to particle collider experiment scattering angles. As mentioned, various methods have been proposed to explain how it is that reality is not symmetric and why particles are not unified but different, while possessing unification gauge symmetry values corresponding to higher dimensional lattices.

Interestingly, the angle necessary to break the symmetry of  $E_8$

and create the 4D Elser-Sloan quasicrystal in  $H_4$  (the only possible quasicrystal derived from  $E_8$  that possesses  $H_4$  symmetry) and the 3D quasicrystalline spin network in  $H_3$  that we work with is this same angle,  $\cos^{-1}\left(\frac{\phi^2}{\sqrt{2(\phi+2)}}\right)$  [14].

Accordingly, we contend that particle collider data and the standard model itself are evidence that irrational projection from  $E_8$  to lower dimension correlates to the correct symmetry breaking mechanism. As stated, this generates a geometric code of space-time and particles – specifically a dynamical quasicrystal code. This code, like many codes, may require an error detection and correction mechanism. Quasicrystals naturally correspond to powerful error correction and detection mechanisms, such as Fibonacci error correction code [13].

## 5 Challenges with the Code Theoretic Axiom

The challenge with the code theoretic axiom lies in the fact that geometric symbolism requires some notion of consciousness to actualize the information or meaning into existence. Of course, one may take a Platonist philosophy and suggest that these abstract or quasi-physical geometric symbols that constitute reality simply exist without need of an actualizing entity for the symbolic meaning. In other words, one can decide that the Platonic realism of the symbols is itself the ground of reality and the unprovable axiom – they just *are*. That is identical to the decision to accept that energy *just is* without further explanation.

So the first challenge is the fact that information is meaning and meaning requires consciousness to actualize it. Certainly, animals such as humans are not the actualizers of all of this microscopic meaning. The second challenge with the code theoretic idea is the issue of syntax choice. What chooses the syntactically free steps in the code? If nature were just a deterministic causal algorithm playing itself out, one could say energy is like a set of falling dominoes with no need for a chooser because there are no syntactically free steps. One could then stop at energy in the search for further explanations. But with a code, stopping at the axiom that energy is information and information *just is* is not so easy because of this issue of the need for a chooser of the syntactical freedom. If one introduces randomness as the syntax chooser, it is problematic because the meaning output of a code degrades when randomness is introduced. As an analogy, we can take a paragraph of a book to see what happens with the quality of meaning of the English code output when we replace each adjective and noun with randomly chosen adjectives and nouns. The syntax rules will be legally followed but the code conveys much less meaning.

Furthermore, even if we decide that code efficiency is not important and say the ultimate *stuff* of reality is randomness or an unexplainable quantity called energy that randomly operates the code syntax, it would be just one of the other platonistic axioms that stop at some level without further explanation – accepting on faith something to be the true base of physical reality, even though there is no explanation for it.

Careful reasoning gives us logical permission to consider that the definition of information as *meaning conveyed by symbolism* should be taken seriously. That is, if reality is information and code theoretic, meaning must be involved. And meaning is a substance of minds. A mind chooses (observes) or actualizes information – creates meaning.

So where do we go from there, in truly critical scientific inquiry, without romantic or spiritual motivations but with only logic and reason to guide us? Are we to seriously consider this notion of pan-consciousness as the substrate of reality – this idea of a *Star Wars* type intelligent *Force* or some other fictional or religious sounding notion?

There is a rigorously logical possibility with physical evidence that is no less remarkable than big bang theory or the fact that human consciousness emerged from quarks and electrons. And it is certainly less fantastical than the idea that we are living in a computer simulation in some other real universe.

## 6 The Possible Origin of Pan-consciousness

Consider the non-linear physical logic that event A causes B, which causes C, which completes the loop by causing event A. Many scientific works have put forth theoretical and experimental evidence for retro-causal feedback loops [46]. Daryl Bem has done experiments showing retro-causality in the form of human skin conductance changes correlated to computer monitor displayed images not yet selected by a random number generator [3]. The delayed choice quantum eraser experiment has shown how the freewill choice of an experimentalist changes events in the past. Wheeler argued how such choices loop back to retro-causally influence things billions of years ago. Susskind and Maldacena argue that the wormholes or Einstein-Rosen bridges linking non-local regions of spacetime predicted by general relativity are equivalent to quantum entangled particles predicted by quantum mechanics [49, 36]. And in 2012, physicists in Israel experimentally demonstrated that particles can be entangled to influence one another over time [7].

There is no evidence retro-causality is unrealistic. There is some evidence suggesting it is a real phenomenon. And there are strong theoretical implications in both general relativity and quantum mechanics that non-locality is a deep aspect of reality. Furthermore, there is no predictive quantum gravity theory of spacetime that includes particle physics whereupon one can make strong statements about what should and should not be possible with respect to retro-causality and non-local connectivity.

## 7 An Insignificant Force Emerging to Become Everything

An interesting analogy is a few million bacteria on an apple. Intermolecular forces, gravity, the environment, etc., all define the form and behavior of the apple. However, after only a few doublings, the bacteria overtake other factors to become the primary influence determining the destiny of the apple, breaking molecular bonds to return the elements back to the soil. The universe is not old. It is just getting started. An average sized star, such as our sun, lives for about 10 billion years. This means that, from our vantage point “back here” on 21st century Earth, the universe is barely 1.5 solar lifetimes or generations old. Like the very beginning of the bacterial doubling algorithm, from this early stage, it appears that consciousness is a trivial influence existing in the tiniest fraction of the overall energy – merely along for the ride while the ordinary physical forces determine everything. However, if a doubling algorithm gets started by a species that has escaped its biosphere and which has discovered a non-local quantum gravity

theory and technologies derived therefrom, trans-temporal forms of consciousness could emerge. In this case, it would not be illogical to entertain the possibility that this “supernovae” of exponentially exploding consciousness defines the future of the universe from our vantage point and is the irreducible foundation of the universe when spacetime as a whole is considered. We might even go so far as to conjecture that this might tie into the observed acceleration of the rate of expansion of the universe. That is, exponential algorithms on increasingly connected networks have an exponential growth curve, wherein the rate of exponential growth itself exponentially increases.

## 8 Conclusion

The deductive thoughts above are a string of carefully reasoned choices about what might be more likely than not. Via this deductive approach, which rejects aggressive or non-maximally reduced axioms, we land on the ultimate axiom. Consciousness exists because we are choosing to wonder if we are conscious. And because we have evidence that our consciousness exists, the argument that consciousness is the foundational substance is better justified than speculations with less evidence, such as the simulation hypothesis. It is also more explanatory than stopping at the axiom that energy *just is* or that some abstract information theoretic Platonic symbols *just are*.

Axioms are always “religious” in some sense, where that term implies faith or belief in something that cannot be shown to be true. However, good axioms are carefully reasoned. Structureless smooth spacetime is an example of a weak axiom with no reasoned logic or evidence to support it – just as there was no good evidence supporting the belief that water is a smooth continuous substance. Resting comfortably on aggressive physical axioms, such as energy *just is*, prevents exploration of further truth and leads to possibly false scientific ideas.

Penrose [19], Tononi [51], Koch [29], Nagel [38], Dretske [12] and many others have written about the notion of a pan-consciousness being physically realistic and logically necessary. The plausible theory of a pan-consciousness as the substrate for a code-theoretic physical framework is more natural and less fantastical than the popular idea growing in academic circles that the universe is a computer simulation existing in a different universe. It is more realistic because we have physical evidence for the sub-parts of the idea: (1) Consciousness self-organizes from fundamental particles and forces, (2) there is no upper limit on how sophisticated it can become or how much of the energy of the universe can self-organize into it and (3) neural network formalism, not computer theoretic formalism, is where and how consciousness emerges physically. Neural networks operate according to codes, not deterministic algorithms.

The plausibility of all energy self-organizing into a conscious system is not logically problematic, given what we know of physics today. What is problematic is the idea of a trans-temporal consciousness and retro-causality, which one would presume is necessary to act as a substrate for the physics of spacetime and particles. That is the concern, not the probability of exponentially self-organizing consciousness. The lack of certainty about this lies in the fact that there is not a predictive quantum gravity theory that

can predict the possibility or impossibility of trans-spatiotemporal networks. However, with the recent work of Susskind [49] and Maldacena [36] and the fact that general relativity and quantum mechanics both allow non-local connections, it seems more plausible than not plausible. Accordingly, until a predictive unification theory is discovered, we can realize that there are no “deal killers” to the notion of retro-causality. Indeed, there is some physical evidence for it in the form of Daryl Bem’s experiments [3] and various delayed choice quantum eraser experiments [42]. And we do know with experimental certainty that nature is inherently non-local, where entangled particles are causally connected over arbitrarily large distances of time and space.

If the universe is code-theoretic, it traffics in the substance of all codes – meaning. Geometric or physical meaning has virtually no subjectivity, while other forms of meaning, such as humor, are highly subjective. Similarly, geometric symbols have very low subjectivity because mathematical meaning is encoded directly into the symbols themselves[23]. For example, the body diagonal of the self-referential symbol of a square is the length times the square root of 2 – intrinsic meaning with very low subjectivity. Such symbols have the ability to act as the quasi-physical symbols/building-blocks of a geometric reality.

Figure 1 represents the loop of five causally connected phases of the code-theoretic universe. It shows the self-actualized hierarchical loop of emergence. It is approximately as fantastical as big bang cosmology and the simulation hypothesis[5]. It is physically plausible and logically self-consistent. It rests on the most reduced axiom possible, the deduction of Descartes. We hold it out as the lesser of evils, where all deep fundamental physical and cosmological models are audacious but where a scientist must choose the one with the best explanatory power, logical self-consistency and most irreducible starting axioms.

Our proposed axiom set up the foundations of how can mindless mathematical laws give rise to, not only aims and intention, but the whole mind itself.

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## 9 Endnotes on Digging Deeper

We suggest that if it is possible for human consciousness to emerge from finite quantities of energy within this still unknown predictive non-local quantum gravity framework, that it is either inevitable or possible that consciousness eventually emerges from all quantities of energy in the universe.

This is an outrageous idea that deserves careful critical thinking. We will deduce via asking and answering a few questions below. Before we begin, the objective is to look for a logically consistent explanation for how the universe can be self-actualized – a self-emergent neural network that is its own hardware, software and simulation output as one in the same object. We are looking to see if consciousness itself can be the most physically realistic and plausible axiom instead of the imagination that we live in a computer simulation or that energy or abstract geometric symbols *just are* without deeper explanation. We wish to reduce the axiom down to the irreducible idea of Descartes, rephrased here as:

I don't know what consciousness is, but I know it exists because I have evidence – namely the fact that I am freely choosing to wonder, if my consciousness exists. And that free choice, neither forced upon me by causality nor merely accidental, is part of the very definition of my consciousness.

Note that some define consciousness as simply being aware and that it does not require freewill. Others define consciousness as correlating to freewill and choosing what to be aware of or to observe. Notice that “to be aware” is a slippery notion. What does it mean? Does it mean you are receiving information about something? That would not suffice, since we are constantly receiving information of which we are not aware. So if we adopt the definition of information that does not require freewill or the choice of what to be aware of, we have a blurry enigmatic concept of what “to be aware” means.

Conversely, to choose or select is a precise concept. A random action can select A or B. A chooser can select A or B. Embedded deep in the concepts of quantum mechanics is the notion of choice of observation/measurement – position or momentum, for example.

Accordingly, we adopt here the more precise concept of choice and freedom as the defining quality of consciousness/awareness. Of course, this is a convenient quality for a code-theoretic ontology which requires a chooser at the syntactically free steps in a quantum gravity physical code of reality. **We define consciousness as:**

Something capable of making non-random and non-deterministic selections – choices – something which can actualize or choose meaning.

The reason for the second clause is because, if one has freedom to choose a selection, by definition, one has freedom to choose something to observe, measure, be aware of or think of. They have the freedom and the ability to actualize meaning.

The following series of five deductions helps connect some of the elements of this *lesser of evils* approach to the question of the ultimate *stuff* of reality – the quest to find a maximally reduced axiom of reality with the highest explanatory power possible.

**Deductive Question 1:** *Does consciousness exist in the universe?*

Descartes simplified things nicely by supposing that because he questions whether he exists, he must exist. He said, “I think, therefore I am”. He was not specifically speaking of his physical body. It was his inquiry as to whether or not he, as in his self or consciousness, exists.

The answer seems to be, yes we are conscious because we can choose what to think about – what to be aware of and what meaning to give it.

**Deductive Question 2:** *Does physics place an upper limit on what percentage of the universe's energy can self-organize into conscious systems or into a network of conscious systems that is itself conscious?*

To think about this question, let us imagine we are examining the universe 4-billion years ago. We are considering single celled organisms and agreeing that we cannot predict their primitive choices of action and behavior. We label them with some primitive notion of freewill and awareness of their environment and their boundary – their selves. We do not have to admit they have the ego based questions about self that we do. But they do have a sense of their environment, internal structure and the boundary between the two. They chase food, run from predators, reproduce, excrete waste and are absolutely unpredictable in their primitive choices. So, 4-billion years ago, we debate whether or not larger magnitudes of energy can self-organize into more highly conscious systems and whether or not the single celled organisms can self-organize into systems that are of a higher rank of complexity and consciousness. Zooming forward to today, we find that self-organization turns out to allow about 37 trillion single celled organisms to become the emergent consciousness of a human mind-body system. Clearly, there appears to be no law of physics that would prevent a more sophisticated consciousness than a human to self-organize in the universe. There also seems to be nothing to prevent multiple human consciousnesses from knowingly or unknowingly being part of an uber-consciousness similar to how many single celled animals self-organize into a larger smarter system like a human without fully eliminating their primitive individual freewill. Notwithstanding classic physical arguments, the only logical or conservative upper limit would be all the energy in the universe in terms of what percentage can self-organize into a system of conscious systems that is itself conscious. There is a mathematical and physical idea that some consider provable:

Given enough time, whatever can happen will happen.

Based on these carefully reasoned ideas, we may simply say that somewhere forward of us in spacetime, a universal scale consciousness or global network of consciousnesses that is itself conscious has emerged. One cannot use the separate regimes of quantum mechanics or general relativity to argue for or against this notion. For example, one could use general relativity in a naive attempt to suggest networks across spacetime may not perform well because of the limitation of the speed of light. This does not hold well in light of the experimental and theoretical evidence discussed above. The fact is that, without a predictive quantum gravity theory, the two separate place holder models of general rel-

ativity and quantum mechanics are incomplete pictures of physical reality and cannot give us an answer as to what is or is not possible with respect to trans-spatial and trans-temporal networks, especially when correlation between two or more nodes in such networks do not exchange information at a finite speed.

Accordingly, the answer to this deductive question #2 here is:

Theoretically, all the energy in the universe can self-organize into a conscious system. And because it is possible, it may be exceedingly probable that at some point ahead of us in spacetime, it has occurred.

The interesting thing about this deduction is not that it must be correct. It is simply noteworthy as a contrast to other axioms such as randomness, which have very little logical or deductive evidence. Logical evidence is clearly not proof. And of course, there are no proofs in physics at all. But the logical consistency of the idea and the explanatory power is perhaps more scientific than the dead-halt at the unsupported axiom of randomness. It is the lesser of evils.

## 9.1 The Non-computable Substance of Reality

So we have arrived at a seemingly mystical and yet somehow logical and explanatory axiom that the ground of reality is consciousness – an implication of the code-theoretic axiom. It is worthwhile to discuss one important mathematical aspect of this substance. Let us introduce the idea with a surprising party trick. Imagine selecting 17 people from a birthday party and putting them in a room to vote on how many combinations they can form from members of their small group. For example, there can be Linda and Sam and there can be Sam and Linda. There can be Sam, Linda and Gary and there can be Gary, Linda and Sam. We can combine the names and the ordering of the names. Most people unfamiliar with the math would not guess that it is over 355 trillion permutations or about 50,000 times the entire human population. A system of 17 electrons has far more interaction complexity than this, as they interact in various combinations of quantum wave function resonance and damping values and gravitational relationship states. A single human brain has over 100 billion neurons. And each neuron has over 100 trillion atoms, which each contain a quantity of fundamental particles. These interactions, which humans still only partially understand from the equations of the two incomplete pictures of reality, general relativity and quantum mechanics, are the actual physical substance and behavior of reality. The still mysterious and debated ontological nature of the quantum wave function is, in part, the probability space object arrayed in 3-space that partially describes these non-computable interactions.

The emergence of physics and our reality comes from the non-computability of these interactions. That is, they are non-computable in a finite universe, even in principle, and yet they not only exist – they are the most realistic substance of reality itself. Why non-computable? Consider that we live in a finite universe of a finite age. If a computer were made from all the energy in the universe and given, say, 100 trillion times the current age of the universe to compute the interactions of the particles of just one brain cell, it would not be remotely possible. And yet, actual reality is the emergent result of the oscillators in that one cell interacting with all other oscillators in the universe. And below that level, there may exist a theoretical Planck scale graph theoretic substructure contemplated in approaches such as ours or loop

quantum gravity. The idea is that whatever this substance of “consciousness” as the ground of reality is like, it is non-computable, even in principle. And yet, it is perhaps the most real and foundational stuff of reality.

## 9.2 Examples of Possible Predictions Indicated by the Code-Theoretic Axiom

Physical ontology is what science is about. Ontology is the study or labeling of what is real and what is unreal. Physics is the study of better modeling what is known to be real and discovering new phenomena that are real. Sometimes the models predict things that are not observed at the time, such as black holes or the molecular substructure of water. The code-theoretic axiom can inspire scientific predictions. For example, when a physically realistic quantum gravity code is discovered, it will...

1. ...be based on an error correction and detection scheme.
2. ...lead to the *principle of efficient language* (PEL)[22], which will demand that the universe operate as a relationship between  $E_8$ ,  $H_4$  and  $H_3$ .
3. ...because of the PEL, have as its numerical basis the Dirichlet integers 1 and the inverse of the golden ratio. Dirichlet integers have unique properties which make them suitable for the generation of optimal codes. For example, they are a closed Euclidean ring of quadratic integers, they are dense in the real numbers and possess a unique prime decomposition. They are deeply related to the Fibonacci sequence by their algebraic units which involve Fibonacci numbers. And they are powers of the golden ratio. This links them fundamentally to specific error correction codes, like Fibonacci error correction and detection codes [15].
4. ...use the angle  $\cos^{-1}\left(\frac{\phi^2}{\sqrt{2(\phi+2)}}\right)$ , which is the scattering angle relationship between fundamental particles according to certain particle mixing matrices[26]. This is because in order to generate the densest network of Fibonacci chains in any dimension, one must project a slice of the  $E_8$  lattice to 4D along this angle. And this angle too must exist in the 3D space where graph theoretic formalism would express its dynamical selection patterns.
5. ...because of the PEL, operate in a binary point space as a neural network that exploits the two densest possible networks of Fibonacci chains in any dimension (the quasicrystalline spin network and the Elser-Sloane  $E_8$  to 4D quasicrystal).
6. ...because of the PEL, use a physical possibility space in 3D that is the quasicrystalline spin network due to a secondary trinary code allowable in 3D that is related to chirality and periodicity [45].