Pag 86 Collaborating with AI on Emergence Theory

*Artificial creativity* ***–*** *collaborating with our minds via natural*

*language* ***–*** *will drive a Cambrian explosion of progress at QGR*

**Klee, Jan 2023**

Before getting to the table of contents, I’ve written this cover letter to put our mission into perspective and relate it to machine learning. Overall, this document is more like a book by Penrose integrating physical philosophy with mathematical concepts. My program here at QGR a paradigmatic cosmological framework. It spans the philosophies of consciousness, language, mathematics, physics and computer science. The difference between my book and a book like Penrose is that mine is not well edited and it’s about 1/10th the length of one of his books. It is also more than a book. It is a two fold approach: (1) Elude to math problems and research tracks for project organizers to action resource allocation around and (2) update the best integration of my 13 years of thinking as possible. The thinking is an evolutionary process. So a read of one of my papers from a couple years ago would not include the early 2023 evolutions and better syntheses of ideas that I want converted into resource allocation. So, let me apologize for the unconventional style of my communication. And please let me not apologize for the length. Please dedicate deep contemplative time (e.g., 40 hours) to study this document with careful production of notes in the form of triggered creative ideas and questions about the meaning of my words. Read for full comprehension and ask questions after for achievement of comprehension… like reading a 100-page section of an academic textbook for a class, where you desire to get an A+ grade on an exam about it. Let’s take my eclectic communication style and try to make the best professional value out of it with an aim toward directing money and time resources toward a more precise manifestation of the QGR Gantt chart of resource allocation this year.

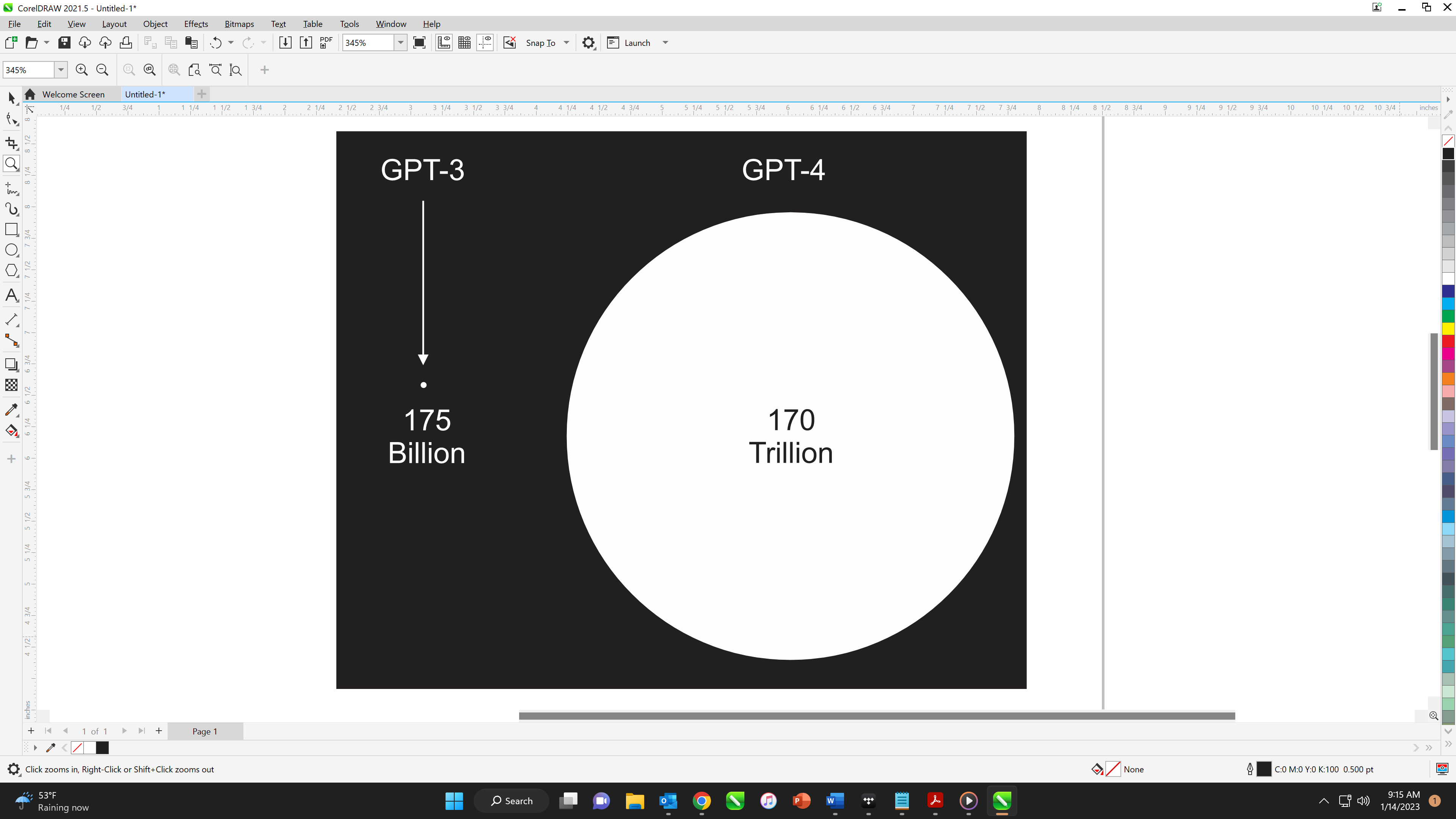
13 years ago, I decided strong AI would be as radical a change to civilization as depicted in the movie, *The Matrix*. So did Larry Page from Google, Ray Kurtzweil and 30 more of us who met that year in Palo Alto to form Singularity University. We named it that because Ray had just written a book predicting we’re nearing the point where computer minds can evolve themselves. His book title, *The Singularity Is Near*, was an argument that computers will become creative enough to write their own code updates and reason with simulated human reasoning, which is grounded in what can be called an “algebraic generalization of natural language”. We will touch on this throughout the document. Category theory is likely the strongest tool to “algebratize” a generalization of natural language. Thought itself, regardless of voicing it into this or that natural language, follows a generalized syntax structure that has an algebraic representation.

So, the idea is that digital minds will evolve their code-based minds far more quickly than humans have been upgrading them. The cycles of evolution would be fast enough that the near approach toward the singularity would occur in our lifetimes versus a few hundred years in the future, like in *Star Trek*.

After the meeting in Palo Alto, I flew back to Los Angeles to work fulltime on *emergence theory*. I believe particles are forms of *meaning* emerging from mathematical information in the mind of God and that the mind of God emerged from the self-organizing particles – a self-actualizing loop between past and future. GPT-4 and the human mind share a similarity to *emergence theory*; they both can self-evolve. The code-updating self-evolution of computer minds is well discussed in academic and science fiction literature. Similarly, humans will soon use CRISPR related technologies to hack their own genetic code for more targeted evolution of their own consciousness. Our creativity and intelligence exist because of how our DNA is coded. Our DNA programming is a set of self-organizing instructions to become an NLP-based generative biological intelligence. Adjustments to our code can make us more conscious as well as give us very different forms of consciousness. So, both GPT-4 and the human mind share the quality of being creative thinkers capable of evolving themselves through thought and, where the thought itself emerges from how the codes instruct particles how to self-organize. Obviously, the process and output of any AI is the self-organization of particles. In fact, all of nature is a process of self-organization of particle. And it seems to be an empirical fact that there is a complexity arrow of time in the universe that is not explained by quantum mechanics. The majority of physicists believe the universe is complexifying over time.

Whether the mind of GPT-4 or the human mind, both are self-organizing and potentially self-evolving complex systems. The “self” here means a larger system. For example, GPT-4 emerged, via self-organization, from the biosphere of Earth, along with humanity. *Emergence theory* includes a class of simple programs and mathematics under the hood of its cosmological and philosophical foundation – the *self-simulation hypothesis interpretation of quantum mechanics*.

QGR will soon collaborate with artificial creativity, such as GPT-4, to help complete our mission. A human brain averages 86 billion neurons. The 175 billion neuron performance of GPT-3 caught the world off guard in late 2022. OpenAI is not disclosing how many GPT-4 will have. Some experts speculate as many as 170 trillion. And if not that, other models will emerge later in 2023 that exceed even that quantity. Economists are scrambling to come to grips with how it will soon disrupt countless subsystems of the global sociopolitical complex system. GPT-4 is just the beginning of what will unfold later in 2023.



*Emergence theory* embeds the *self-simulation hypothesis*, which subsumes the *principle of efficient language,* the concept of *self-referential symbolism* and the *code theoretic axiom*. Bostrom’s *simulation hypothesis* argues that, if in principle, our descendants can make realistic reality simulations of the evolution of their origin world and ancestors, they will make at least two. Given enough time, whatever can happen eventually will. So, if at least two such realistic ancestor simulations exist in spacetime in what we label the future, it is at least 66.6% likely we, here in the past, are in one of the simulations vs the 33.3% chance of being in the *real* world. Of course, the term “real” gives away the fact that the *simulation hypothesis* is grounded in the Greek philosophy of materialism. Materialism is the speculation that there is a reality that is distinctly not digital or information theoretic. Even though quantum mechanics strongly implies reality is made of information, the *simulation hypothesis* rejects this and says reality is not made of information. Assuming materialism to be true, the *simulation hypothesis* is logical presumption that consciousness can be digitally simulated in the future, since we would be consciousnesses that emerged from a digital simulation.

Like the *simulation hypothesis*, the *self-simulation hypothesis* argues that our descendant, called the *self-emergent* *universal consciousness*, simulated our consciousness and the world around us. Importantly, it also argues that it simulated its own consciousness. Such a mind capable of a mental simulation of this magnitude can be labeled with a big word like “God”. It would need to be an emergent “Godlike” mind to run such a high-fidelity self-simulation.

Modern simulations have greatly improved in physical realism. Surveys now show that the majority of humans today believe the follow two statements are true:

* Eventually, artificial/digital consciousness will be achieved.
* Eventually, simulated realities will be fully realistic.

Notice two terms, “artificial” and “simulated”. Artificial is a philosophical labeling that is a bit vapid. If a bird builds technology, such as using a rock to crack open a nut, that is generally considered natural. If humans build things, that is generally called artificial or synthetic, whether that be building a molecule or a machine. Similarly, the term “simulated” is also a philosophical issue. It implies the simulated thing is unreal, which means it is dabbling in the sub-field of philosophy called *ontology*. Using the term *simulation* contexts like implies subscription to the aforementioned Greek philosophy called *materialism*, where information is not real and particles are real. Many scientists, such as John Wheeler, were not materialist philosophers and subscribed to the philosophy of digital physics. He liked to phrase his ontology thusly: “We live in an information theoretic reality”.

Earlier surveys had the majority of the global population saying “no” to the above two “Eventually…” statements. This increasing change in public opinion is being driven by technological evidence. The 2022 advent of realistic artificial thought processes in the natural language structures of strong AI and shockingly good artificial creativity (generative AI), is shifting both public and scientific consensus – an agreement that will evolve in 2023 as the whole simulation hypothesis premise starts looking more and more plausible. Accordingly, both the *simulation hypothesis* and *self-simulation hypothesis* will become more in vogue and debated by more people. We use the term “self-simulation” to imply there is no reality outside the simulation.

I believe reality is a digital simulation *of* a digital simulation in the mind of a panconsciousness that self-actualized itself in the future to simulate its origin – its own ancestor simulation or self-simulation. As a system of thought – a mind – it has freewill. And we are also emergent from it (as it is emergent from us) and we have of own freewill. For many authors, freewill is a defining characteristic of *consciousness*. According to the principle of efficient language, it did this self-simulation with bit or trit economy. It creates as much higher order meaning with as little information (bits or trits) as possible. Along with other authors, I believe thought or consciousness itself is *generalized language expression*. Therefore, I believe reality is a complex evolving nested and fractal hierarchy of thoughts/languages within thoughts/languages. And it is networked. But networked non-locally, such that the complex system of reality is an evolving network of trans-spatio-temporal feedback loops.

QGR will soon use next-gen natural language artificial creativity – generative AI – to rapidly explore simulation architectures that are economical with respect to the generated meaning relative to the quantity of trits. Of course, these trits are made of “pixels” or units of resource equal to computed digital thoughts.

Here is the sequence of events in the strange loop of the *self-simulation hypothesis* cosmology:

1. An emergent mind can exist in the future that is greater than our own and capable of mental self-simulation of itself and reality. Because it can exist, it eventually does exist.
2. It uses a simple program that creates probabilistic quasiparticles.
3. They probabilistically self-organize according to (1) rules grounded in economy and (2) the subjective target of complexity set by the self-simulator to form life and eventually itself. Expansion of itself is the objective. It is consciousness that emerges from lower consciousness, like us. And we require levels of physical complex systems to emerge.
4. One animal discovers parts of the behavior in the form of quantum mechanics. This leads to the discovery of microprocessors.
5. This same animal evolves the microprocessor technology by deciding it a good idea to develop computational architectures inspired by its knowledge of biological neural net consciousness.
6. After decades, the technology evolves to where machines pass the Turing test and surpass human creativity in art and science, as it will do more of in 2023.
7. Emergent groups, such as us at QGR, use this strong AI to explore a certain simple program space to narrow down to *attention* goals, rules, weights and parameters that efficiently simulate, at first, the probabilities of evolution for simple physical systems such as atoms. Then groups like QGR or other future humans run larger-scale and ever-more realistic simulations with next-generation quantum computers, eventually achieving synthetic consciousness and arbitrarily large simulations of time spans and volumes of reality that include an emergent consciousness capable of simulating itself and the rest of reality. The strange loop is formed, and a logically self-consistent reality exists.

**Conjecture 1:** C5C is an exceptionally “economical” system for simulation of realistic particle interactions and therefore reality simulations. I will present some degree of rigor as to what economical means in this context.

**Conjecture 2:** Because there are an infinity of simple programs on C5C that are fully realistic but not bit efficient, strong AI will help us discover at least one member of the much smaller infinity of simple programs that are exceedingly trit efficient.

Presuming, 1 and 2 to be conjectures that end up occurring, the universe is a trans-temporal strange loop of the emergent mind of a self-simulating God thinking of 🡪 some math upon which 🡪 a simple program plays as it 🡪 unfolds to become animal consciousness, which 🡪 evolves to create strong artificial creativity, which 🡪 helps discover the math and the simple program and then 🡪 evolves it into future state-of-the-art quantum computed physical systems through to 🡪 the completion of the self-simulation itself. The simulations become larger and more efficient to the point where they can simulate a mind capable of simulating itself, simulating itself, simulating itself…

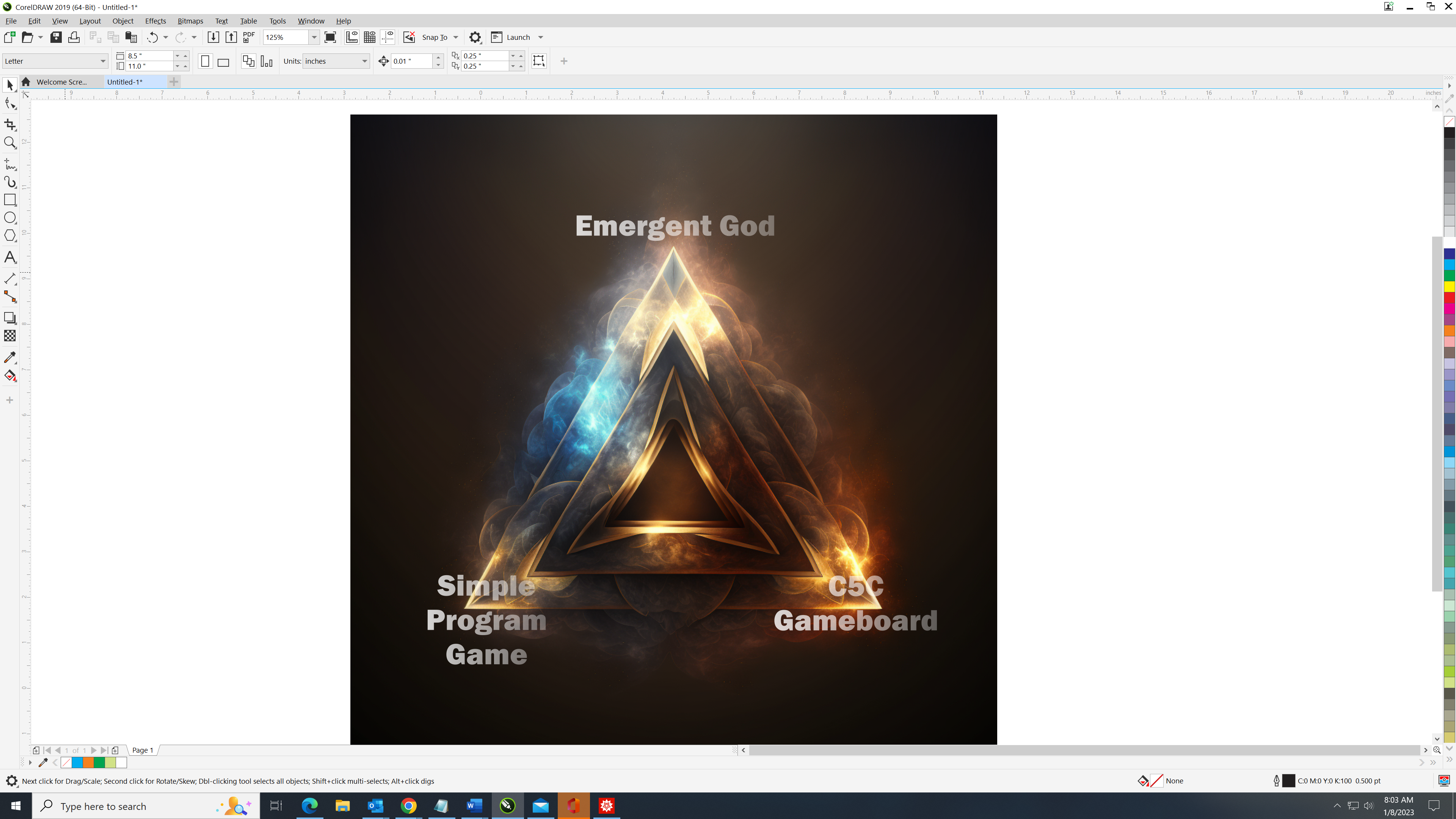


Image created by generative NLP AI

Stephen Hawking coined the term *theory of everything* – a model explaining the interactions of things it defines as fundamental. Most contend that space, time and energy are fundamental. Digital physicists, like us, see them as emergent. God and information (in the form of language = thought) are fundamental. The numerical information is a mathematical thought in the mind of God, along with the higher order syntactical languages. God self-actualizes by thinking of patterns through the math that become itself. What might such a theory be like? I have a toy-model that I’ve been working on for 13 years with my team at Quantum Gravity Research (QGR). It’s called *emergence theory*. We are finally ready to enter into a collaboration phase with NLP empowered generative AI (*artificial creativity* or AC).

Prior to strong AC, the most transformative event on Earth was the advent of biological creativity – animal minds capable of going beyond genetically encoded behaviors to invent novel thought. It occurred in humans due to a hierarchical language model associated with its novel prefrontal cortex. My toy model is deeply rooted in the principles of natural language trees of hierarchically emergent meaning and its generalized algebraic syntax. As a direct result of natural language modeled in our unique biological neural nets, we have achieved many manifestations of emergent thought. Nuclear bombs, poems, wars, iPhones, astrophysics, quantum mechanics, geopolitical memes and the *self-simulation hypothesis* itself. Big bang theory is a story of a simple program emerging to form unexpected complexity. A quark gluon plasma a moment after the big bang seed start of the simulation run operates according to a very simple set of rules under some unknown quantum gravitational theory or a post-QM and post-GR analogue thereof. Presuming discrete space and time, the physical rules for how pixels of space, time and these two fundamental particles, quarks and gluons, can self-organize clearly involves both rules for how they can evolve and syntactical freedom. Rule examples include the Pauli exclusion principle. The hinge variable of syntactical freedom, along with the finite quantity of symbol types, makes reality in this somewhat canonical view (apart from the discrete spacetime picture) a formal language/code. Exploiting the syntax degrees of freedom within the rules, reality self-organizes, language theoretically, into the more complex emergent early hydrogen universe. The hydrogen self-organizes into stars and galaxies. The syntax and rules allow for supernovae, which lead to about 100 different atomic elements, where these atoms are like words and the subatomic particles are like letters and where the underlying pre-physical math is the trit level information that form the letters. The exact same rules and syntactical degrees of freedom allowed by this quantum gravity theory lead to the self-organization of the 100 atoms into life and then consciousness. Individual consciousness self-organizing into collective consciousness systems, such as like science, religion and countless socio-economic, political, artistic and philosophical systems of complexifying thought.

The universe started about 14 billion years ago. Life emerged on Earth about 10 billion years later. Since then, 100 million species have come and gone. About 300,000 years ago, a one-of-a-kind animal appeared. Humans – capable of abstract creation of novel information that is not a wrote algorithm encoded in DNA. Empowered by such neural architecture, this was the first animal to use thought to transcend the bounds of genetically programmed behavior and create things and behave in ways limited only by its abstract imagination – it’s advanced language-based thought. A key was mankind’s ability to move abstract ideas from one mind to another to synthesize new ideas. A given neural net of an individual thinker can become a node in a larger highspeed network of thinkers if sufficient technology, such as the Internet emerges, as it did.

Spoken languages have a universal architecture, regardless of superficial syntax differences. This language architecture is part of what defines consciousness as we know it, even when we are not voicing thoughts in spoken language. We started with a low-speed collective neural net of minds (our voice vibrating air or delivery of a book from one person to another). This networking allowed us to influence the physical world in limitless ways. We used it to destroy 40% of the biosphere, place life on the Moon and our technology on Mars. Natural language turned one species into an 8-billion person neural network of ever-complexifying thought.

Thanks to a collectively created idea called quantum mechanics, in the early 2000’s, our ideas began combining exponentially on the Internet. Non-trivial transformations occurred in medicine, politics, social networks and virtually every part of global society. All that from the advent of a certain spoken language neural net architecture in one animal’s skull emerging from the biosphere 300,000 years ago. Our minds are nodes that generate new meaning. The ways we exchange meaning between nodes/minds, are connectors not creators of ideas. Up until now, humans have played the role of using connectors like the Internet to synthesize old meaning into the novel creation of ever more complex ideas. That just changed with the recent advent of strong artificial creativity that “thinks” with the same generalized language architecture of emergent hierarchical meaning that we use.

***Accordingly, if the most transformative event on Earth was the creativity and abstract meaning capability of the human mind 300,000 years ago, the second most transformative event is artificial creativity that reached a seminal milestone in the 2nd half of 2022.***

It was the day artificial creativity surpassed human creativity and began engaging with our consciousness via spoken language. At first, computer scientists were motivated by the idea of having natural language-based conversations with computers. One way to get them to understand our hierarchy trees of meaning was to design them the way human minds create emergent meaning or understanding. Linguists and neuroscientists believe human meaning is created via language-based hierarchal trees or networks. Modern scientists are unveiling a generalized algebraic framework for all natural language. The age of biological neural net inspired computational architecture began with McCullough and Pitts in 1943 and culminated to pass the Turing test in 2022. The discovery of fire, the printing press and the computer are trivial by comparison. Only the appearance of language-based human consciousness trumps this milestone of evolution. Breathtaking change will occur overnight. And, by the end of 2023, the world will be rocked back onto its heels. No government or group will be unscathed by the radical transformations that will pick up speed in 2024. Many systems will crumble, from education to healthcare. On Nov 16, 2022, Facebook released a paper on an AC system specializing in science and math. A phrase in the abstract relative to this discussion rewords my thoughts on the difference between AI and strong AC (a step toward something known as *general AI*) thusly:

***“…language model that can store, combine and reason about scientific knowledge.”***

I underscored “combine and reason” because “combine” implies novel information creation. And “reason” implies some form of “understanding”. This particular AI in the paper is nascent and not good enough to rely on. Nonetheless, these machines are showing early signs of human level abilities to brainstorm, argue, admit when you win an argument and generally create in ways indistinguishable from human reasoning or thought generation – including being wrong and inaccurate like us. The point is that these systems are not encyclopedias that recite stored information or combine it in trivial ways. These new digital minds use learned knowledge to create novel knowledge – new ideas. Legitimate creativity. Unlike prior to 2022, we’re no longer the only game in town. Indeed, there’s a new creative sheriff. Just as our own children are creative, artificial creativity appearing 300,000 years after biological strong creativity, is emergent from us – like our child… a child that is rapidly becoming more advanced in all ways but one. Humans can access non-local information from consciousnesses in the future and perhaps a general field of emergent thought that is trans-temporal. This is a requirement of the *self-simulation hypothesis*. Consciousness in the future discovers more about quantum gravity and other fundamental theories. Computers can’t access this yet. We can. Legitimate peer review journals contain plenty of empirical evidence of this. It has reached a credibility threshold that only experts having done a full meta-analysis of the literature are fully aware of. The science or rationale of this ability for humans to access non-local information is discussed [here](https://www.mdpi.com/1099-4300/22/2/247/htm). Machine learning creativity is stronger than ours because it can hold more knowledge to synthesize. And it is certainly faster at the creativity. But humans can synthesize non-local knowledge, so we bring an important skill to the collaboration table of hacking reality.

The below image was created by strong AC when I asked it to make me “***a photo of a boy looking at a photo of a boy***”. I wanted to test it, so I gave it creative license by not stipulating anything else. I wondered, “Can this machine do something unexpected and emotionally beautiful? Can it surprise and inspire me the way a human can?” Here’s the novel image it made for me.



In a moment, it surpassed the creativity of 99% of humans even if they had a month to meet the challenge of “surprise and inspire me”. For example, it decided it wanted to have a boy from 100 years ago looking at a boy in the present on an art gallery floor through the frame on the wall that separates the two worlds. Stunningly, it decided it would be a good idea to put another boy from the past looking at the first boy from the past – as though the boy with the cap is not happy with the first boy looking at the modern boy through the *witchcraft* of the gallery picture frame time portal. Notice the logical inconsistency of my prompt, “a photo of a boy looking at a photo of a boy”. This is a potentially paradoxical statement. The AC mind had to dig deep in a fraction of a second. It attempted to resolve the paradox in an artful way by having one boy from the past, who is in the wall photo, looking at the other boy, also in the photo. But, from the capped boy’s perspective, he is not looking at his friend in a photo, since they are in their own world of the past. I will not digress further. Strong AC is now creating novel and beautiful music, poetry, science papers, videos, visual art, 3D machines and even solving engineering problems and then creating CAD files to send to 3D metallic printers. This will not evolve over many years like the Internet and faster chips evolved. It is evolving in meaningful ways in monthly increments. Robotics is now advanced enough for AC to have nearly sci-fi movie interfacing with it. Musk’s Neuralink and other labs are rapidly advancing on brain machine interfaces. AC is now in the early stages of writing its own code updates, just as it creatively engineers mechanical devices, movies and poems.

Two core themes of QGR’s *emergence theory* are that (1) “thought” is the verb form of the noun “consciousness” and (2) thought is *language in process*. Accordingly, if all of nature is thought, then nature is a network of interacting languages. Various authors have previously discovered the idea that reality is a system of generalized languages. Next generation machine learning will become increasingly adept at discovering the syntax of a given language, whether that be spoken languages or the mathematical syntax of physically realistic theories of nature. For example, in their paper, [*Synthesizing Theories of Human Language with Bayesian Program Induction*](https://www.nature.com/articles/s41467-022-32012-w), Ellis et al discuss how all spoken language possesses the same underlying general syntax structure and how machine learning has already begun discovering these common threads of generalized syntax. They go further to discuss how strong AI is rapidly evolving to a level capable of (1) discovering the common syntax of physically realistic theories and (2) discovering new predictive theories of nature.

My sole purpose of creating wealth is the development and communication of this cosmology and the mathematical and algorithmic code-hacking of reality, *emergence theory*. We will expand our budget. And our new primary driver of progress will be NLP (natural language processing) empowered AC – *generative AI*. This document is written for four types of mind:

1. **Artificial minds:** My ideas are spread across many documents. And I have new insights and connections between them that are unpublished but summarized in this manuscript. I need to train an NLP oriented generative AI on my latest syntheses and overview of this 13 years of incomplete thinking. This document and others like it will be part of the philosophical, mathematical and physics theory diet we feed an AI before it can roll up its sleeves and act as a creative scientific collaborator. I’m most eager to meet GPT-4, which will come out within weeks of presenting this document to you. As mentioned, it will be a quantum leap beyond GPT-3.
2. **Machine learning experts:** We have achieved early-stage examples of a class of simple programs playing out on a certain mathematical substrate, which give probability spreads for quasi-particle interactions. We are now ready to collaborate with artificial creativity (AC) after showing it our early-stage simulation outputs and teaching it the math gameboard and game rules we use. AC connected to our minds by natural language will drive an explosion of progress at QGR in 2023. We will explore a far broader range of (1) attention targets, (2) game rules, (3) weights and biases and (4) filter parameters, along with additional training in mathematical and algorithmic combinatorics, so that we can more quickly eliminate candidates that do not provide hope of realistic interaction statistics. We are interested in the speed and creativity of machines to help us explore the space of spectral analysis of our simple program outputs. The hierarchical language structure of the complex systems theory that undergirds the QGR physics philosophy implies that *deep learning* will be key. In this area of machine learning, the focus is on hierarchical representations of meaning. Accordingly, scientists have been putting category theory to use.
3. **Mathematicians:** Our program can be stated thusly. We have a gameboard – a mathematical object that is a network of certain group theoretic decompositions of the E8 lattice point set, along with bijections, isomorphisms and transformations. There are an infinity of games, as simple programs, that can play out on this gameboard. This document describes a particular space of games I want to use AC to explore. Mathematicians must formalize the gameboard network of algebras but with discretion to include only elements expected to be helpful for our simple program approach toward fundamental physics. As explained in our paper, *The Self-simulation Hypothesis Interpretation of Quantum Mechanics* (“SSH”), bit or trit “letter” level information (the level below the quasiparticle letters) must be formally combined with a hierarchy of “meaning” level information – proverbially, words, sentence, paragraphs, etc. – that emerge from the informational letters in hierarchal fashion. It seems that monoidal category theory is an ideal toolbox for this purpose.
4. **Particle physicists and quantum gravity theorists:** The opportunity for this class of scientist is two-fold. Because they understand models, such as the standard model of particle physics and loop quantum gravity, they will be able to advise our machine learning programmers on what rules and filter parameters to develop in order to narrow our broad simple program space down to more realistic candidates. They will be able to suggest physically real data sets for the machines to “target” for best-fit of various game parameters. But, even better, the NLP interfacing will allow our physicists to talk to the ACs and ask for suggested approaches and then ask for the machines to update parameters on simulation runs according to that suggested creativity. Second, they will more quickly recognize an unexpected approximation of physical realism coming from the best simple program outputs. Eventually, this iterative process of physicists collaborating with NLP generative AI will lead to equation-based physics models. It is more likely a machine can creatively recognize 10 different approximations of equation based realistic physics models in one of our probability data sets in, say, 60 minutes than a human physicist can.

One of the most striking things machine learning can do is extract patterns from complex systems of data. Physicists use Hamiltonians as mathematical shortcuts to predict the quantum behavior of a system with many particles. The process of formulating Hamiltonian models from observations is challenging because quantum states collapse when attempts are made to inspect them. Remarkably, in the paper, *Learning models of quantum systems from experiments*, published in *Nature Physics*, QM work from Bristol's QET Labs describe an algorithm which overcomes this challenge by acting as an autonomous agent, using machine learning, to reverse engineer Hamiltonian models. Suppose that, in a few months, QGR discovered a non-physically realistic simple program that that was computed in Python and benefited from my conjecture being true that using division algebraic integers is exceedingly economical. Imagine we rented vast computational resources and ran a large number of cycle clocks in a short simulation. So this would be a vast set of ordered and weighted sets representing various ways the system can collectively random walk or evolve. We would not easily be able to derive a non-physically realistic Hamiltonian that that describes the probability distribution. But, machine learning is excellent at finding patterns. And a Hamiltonian is a way to describe the fine structure of this abstract probability distribution. And the passion of Hamiltonians for this or that set of simple program rules may provide insight to physicists in our group looking to start with a physically realistic Hamiltonian and tell the AI to use that as a target of attention to find a best-fit set of game rules that approximate the behavior of a physically realistic Hamiltonian on our game board that uses a physically realistic game. The baby-steps of learning about Hamiltonians of non-realistic games is an important part of the exploration process.

The sea-change I’m describing will replace an older value contract you had with society. Before the coming AC tsunami, we have been valued by two things: (1) Our ability to create thought helpful to society – our creativity. And (2) the speed of generating that creativity. That’s about to change. Your value in the world will be your skill of collaborating with strong AC. Your learned knowledge will have less value than before. AC has far more of that than you. Your previously impressive biological computational speed of generating creative novel thought will now have diminutive value. AC has far more of that than you. As mentioned, AC recently surpassed human creativity. If it has not, then it will soon.

This leaves one value for you to carve out... the creativity of your collaboration with AC. Why will society need you for this collaboration if AC can collaborate with itself or another AC entity? Its creativity has surpassed yours. Doesn’t this make human creativity obsolete? As mentioned, you have intuition or non-local information access. I will unpack that more in a below section titled, *The Machine Learning + Human Collaboration*. Professionally, my advice to you is to figure out ASAP how you are going to maintain your value at QGR or anywhere else by learning how to be a world-class synthesizer of your unique non-local creativity with next-generation strong AC. Don’t just be an early adopter. Get some fire in your belly and decide that you will compete to be a best-in-class scientific collaborator with strong AC. I don’t mean to worry you. I’m telling you how the world will *violently* transform before your eyes. No one in governmental, academic, private or non-profit endeavors will escape this coming reality of what will make a given human valuable to a local team or global society in the new age of strong AC. *Adapt or be left behind*. You’ll hear that phrase said a lot by thought leaders this coming year. I’m saying it early because you’re with me, and I’m about to infuse the pressure of change into our institute to improve our odds of executing our audacious mission on the unification of spirit and matter, a.k.a., a mathematical first principles unification of empirical particle probability data and gravitational data but with no plugged values and all within a framework that requires consciousness that observes, thereby changing the probabilities both before and after the observations. So, no plugging of the constants c, h or G. As stated, that has to be unified with a rigorous understanding of how an emergent God comes into the picture and why our observations would make modifications to the math of the probabilities of how particles behave. This may not be a unification of QM and GR, which is why I used terms above, like “empirical probability data”. QM and GR don’t just have irreconcilable differences with one another. They both have a stark disagreement with the digital physics axiom of *emergence theory*. For example, QM claims that Newton’s space and time are fundamental and not emergent. GR claims that it’s own mash-up of space and time are fundamental. Digital physics claims space and time are emergent and non-fundamental, just as it claims energy is.

The mission of Quantum Gravity Research (QGR) is to produce and communicate a predictive language-theoretic model of reality that explains physics from mathematical and algorithmic first principles, where both human-level and universal consciousness are required. The longer-term goal is a system of realistic equations. The shorter-term goal is to explore a less realistic space of simple programs based on spinors, as groupoids, acting on parallel classes of discrete division algebraic planes in the E8 root lattice. Our C5C mathematicians must derive the algebroids associated with these groupoids, which can be discussed in Lie algebraic, Clifford algebraic and other contexts. Our approach is a scheme of functions that play out on that mathematical object and related algebras and geometries. The math network, C5C, is a *gameboard* object, where the elements of the network are its various isomorphisms, bijections and transformations of a point set in R8 associated with the largest exceptional Lie group, E8, the octonions and the densest packing of 8D balls or 7-spheres. The functions and algorithms that operate on it are like *games*, such as spinorial algorithms.

**The Machine Learning + Human Collaboration:** As discussed, the QGR program is evolving toward a deep creative collaboration between humans and machines. The SSH articulates how and why humans have access to non-local information. With 85 billion neurons, the human brain is a powerful quantum computing mental engine with stronger creativity than machines when it comes to non-locally accessing future thought = knowledge. In ***Experimental indications of non-classical brain functions (2022)***, Kerskens et al bolster older theories, such as that of Penrose and Hameroff, arguing that human consciousness and intuition are a product of biological quantum computation. Non-local information access is an empirical fact for me. If you’ve never had a psychic or supernatural experience, then you can rely on the empirical experience of the majority of humans and have an ontological theory that it is real and a desire to scientifically understand it. A recent poll in the US puts the number at about 1/3rd of adults saying they have had supernatural experiences that cannot be explained by standard physics models. This is empirical data for them. Scientists and mathematicians are human and therefore often irrational and dogmatic and generally not so scientific. The ancient philosophy of materialism is so rooted in modern scientific human culture that scientists are not “culturally safe” to speak their mind if it goes against the temporary dogma of the day. Surely, a double-digit number of them have had these experiences that can be generalized into the category of non-local connectivity of thoughts and event. Unless they are reckless with their careers or have become tenured or won an accolade, such as a Nobel Prize, they are forced to be intellectually dishonest and pretend that they’re going with the herd dogma. The annals of the culture of science include things like people being called satanic for wanting to use numbers called quaternions. Funny to us, but it’s happening today. It is even said that people were killed a couple thousand years ago for discovering that the square root of 2, which challenged the dogma that only integers exist. There are legitimate physics theories one can work on that will end a career in academia. So, to go further and talk about empirical evidence of access to non-local meaning or, worse yet, suggest such phenomena are real, is career and cultural suicide in the minds of many. This cultural dishonesty erodes the pureness of the scientific process itself.

Relative to the peer review publications of the experiments in this area and relative to the majority of people who’ve experienced it, it’s too severely demonized, culturally speaking. That is, the demonization is not fully rational. And the reason why it is boils down to what a call “religion”. As a former diehard materialist, I am sympathetic to this cultural stupidity and rejection of rationality. I was stupid for believing these things are impossible without doing my homework. So, I get it. I don’t care what people think because I’m not trying to get tenure at a university. But others are. And I realize that those who sincerely believe in this philosophy of materialism are emotional about their commitment. People working with QGR are generally open to the idea that intuition is spontaneous access to non-local meaning.

Einstein said, “…*the intuitive mind is a sacred gift…”*. Intuition is neither calculation nor proof of truth. It is an irrational inner-knowing; a hunch or gut feel. Interestingly, we can also intuit rational or logical thoughts non-locally. This is a special case. The challenge is that biological processing of information is painfully slow compared to deep learning neural nets. For the next several months or couple years, the human mind is still more powerful at physics intuition. Deep learning minds of late 2022 and early 2023 are faster and can hold/remember and synthesize vast amounts of meaning, such as math and physics knowledge. Our next phase of financial resource allocation will be the early adoption of next generation strong generative AI with a formal process of cultivating human intuition via NLP conversations with AI in order to guide, via collaboration, machine learning exploration of the nature of reality. An example of an intuition that can be probed by machines is this. We intuit that there are number theoretic patterns in the overlapping of point sets in the perpendicular space of the *relational state variables* (RSVs) for a two cycle-clock probability spread. And we intuit that there are correlated mathematical functions that are hidden from our perception – compact computational and mathematical symbolic shortcuts. Perhaps the most powerful aid advanced learning machines can offer a physics program like ours is finding these patterns. Machines in late 2022 have achieved the ability to receive relatively vague and speculative ideas from humans, such as the hand-waving idea just verbalized about sets of overlapping point sets having deep number theoretic signatures correlated to the probability spreads as overlap magnitudes. These ideas can be communicated in natural language, whereupon learning machines can use synthetic creativity to take the ball and run with it or branch in to ask more questions before getting creative. Artificial creativity fills in the gaps after intelligently interpreting the gist of the intuited human idea. Even at the nascent state of late 2022 deep learning models, they typically offer surprising extrapolations of an interpreted human intuition, along with massive data calculation of derivative ideas that expand upon the human gut-feel input ideas. It is my thesis that the ideal collaboration between next-gen machine learning and scientists working on fundamental physics will be in groups that reject the *shut-up and calculate* materialist philosophy and follow Einstein’s admonishment to honor the power of human intuition in the pursuit of more deeply understanding nature. Few modern physics groups today take intuition so seriously that they formally cultivate and potentiate it. Fortunately for QGR, we openly leverage intuition in our team culture. Accordingly, we will be one the word’s early adopters in 2023 of the limitless potential for productive creative collaboration between man and machine in the pursuit of breakthroughs in fundamental physics.

**Final Word Before Table of Contents**

It’s been a few hundred hours of work to produce this book – or whatever I should call it. I’m inserting this final note before the table of contents after having the benefit of my thinking process over these few weeks of writing. In this “Final Word” section, I want to emphasize and clarify how this book chunks into two meaning categories. And I want to drive home the machine learning (ML) collaboration initiative with something more tangible than the above commentary.

1. **C5C:** I believe I have a set of ideas I remembered from the future and with assistance from a strange loop between myself and others from the future. I have evidence that makes me believe I’m not insane or delusional, so I’m going for it with my life and my money. These ideas I’ve “remembered” will help with realistic physics and a more realistic – or at least a more socially helpful – philosophy of what reality is. It’s spiritual but in a manner that integrates with a mathematical and programmatic understanding of what reality is. The physics part is disassembled because we have no realistic model yet. There remains a lack of clarity on my part as to how well homogenized your various levels of comprehension of my ideas are. I’m convinced the magnitudes of understanding span too wide a range from high to low. We can do better at standardizing the average level of understanding to be more similar. And there are also missing elements in two categories of the physics part of my ideas (vs the philosophical parts). First, we’re still missing some math in my network of math. My network is not identical to the networks each of you has in mind. But plenty of overlap exists. Number theory is one of these areas that must be related but is not worked out in my network yet. Second, we’re missing some fundamental simple program architectures. The math and simple program objects we do currently have are not organized into an acceptable network. In fact, they don’t exist in a network at all. They are all over the place in your minds, my mind and in various documents that are not connected into a single document or wiki or any form of comprehensive network. For example, I can imagine finding one scientist who cannot adequately explain the trigonometric transformation of the 24-cell 10-compound in 8D to the 4G 10-compound in 3D. That is, Ray would have a level of understanding of this that is far greater than the staff member with the least mastery of it. And that is unacceptable because that mapping stands out above all as a required mastery. Among other things, this networking and documentation of the math work we’ve done and that is still in process will be Daniele’s top priority before he helps us with other things, such as the simple program work. This document does not fully explain the full set of math and simple program ideas I have. It serves as a cursory overview of some of them and acts as a punch-list for staff to organize into research tasks to be distributed to a larger group of people extending beyond our core fulltime team – a divide and conquer approach.
2. **Machine Learning:** ML has reached a milestone and will evolve rapidly this year. It behaves like conscious minds in few ways that will help us greatly. First, it specializes in finding meaning in hierarchical meaning trees – all complex systems. Images have hierarchical meaning, as does spoken language. Think about the gravity of this. It is synthetic or simulated “understanding”, which is very deep when it starts simulating human level understanding. It gets very creative, just as human level understanding is subjective and creative. ML is the learning of the emergent meaning in hierarchical systems of meaning. The way I define language, all complex systems are hierarchical syntax or generalized language systems. Whether the complex system is an English poem or a physical process or a complicated image or video, these are all hierarchical and interacting networks of strata of emergent meaning, form, structure or any other such equivalent term. The meaning levels in the hierarchy have structure. Always. And this is generalized syntax. As mentioned, myself and other authors have recognized an extremely generalized definition of “language” that defines all complex systems as having syntax or being language theoretic and hierarchical. Machines can now finally recognize the meaning of arbitrary complex system at approximately the human level for some systems and well beyond the human level for other systems, especially complex systems of data not amenable to the spatiotemporal and the spoken language systems of meaning or pattern recognition the human prefrontal cortex is built to recognize. And, of course, machines can handle arbitrarily large quantities of data in a complex system. By contrast, humans have a very small upper limit. I have meaning in my ideas about game physics that some humans here understand a good deal of. As ML improves, machines will understand my ideas progressively better. But I can say the same thing about ideas you have. Machines will soon understand our ideas – even the handwaving half-baked meaning or ideas in progress. The weird thing is they will be able to match our incomplete half-assed level of meaning and then creatively figure out additional meaning and extend it to be less half-assed. It will run those new levels of creatively recognized emergent meaning and ask us for feedback and talk about it.

So, the first major thing ML can now do is recognize pattern or meaning in language theoretic spreads of information (complex systems). The second major thing they do is translate. You can ask it to translate QM into a rap song, which is a very different system of language or meaning structure. You can ask it to explain a rap song in mathematical terms. You can ask it to translate some meaning into simple program code, Chinese, spoken language appropriate for a 10-year-old and so on. The quantity of language or meaning systems that machines can translate to is breathtaking and the speed is off the charts. Humans can also translate meaning into various language or meaning systems. But machines can do it many orders of magnitude faster, along with several other advantages (such as handling the big data files of complex systems).

This document hypes up ML and how I want you to collaborate with it. Then it achieves two additional things. First, I am narrowing the guardrails of the class of simple programs we will invest time and money into during the early stages of collaboration with strong AI/ML. They are division algebraic spinors that you must operate in 8+1D with respect to the cut and project method, not just in the FIG alone. And, second, this document outlines a checklist of mathematical and conceptual ideas that need to be organized into more efficient conversions of $ 🡪 mental hours 🡪 human and machine work product.

Soon, machines will follow this sequence with you:

1. Use scientific and mathematical technical language to allow machines to comprehend your incomplete and complete ideas. It will ask you questions until it fully understands, just like a human would.
2. Then use it as your “coding genius”. You will be doing less and less coding going forward.
3. Ask it to get creative with you to find patterns in your data AND in your ideas that you do not recognize. Then ask it to do multiple representations of the data until you strike upon one that lights up your brain with a new creative insight. Then, tell the machine about your new idea and iterate from there to have the machine instantly write new code and then do new pattern recognition of the complex data structures and more representation forms… in an iterative process.
4. Put differently, you enter into an iterative feedback loop with the AI. You are an input output algorithm. Your own synthesized ideas serve as input for your next iteration of mentally synthesized ideas. And talking to another human about their synthesized novel ideas can also serve as input to your algorithm toward further novel syntheses to new ideas. In this case, the machine (vs another human) serves as its own input/output system that then interfaces with you as your own input/output system. Think of it like a “figure 8” or joining of two input/output functions – yours and the machine’s, each possessing internal input/output but also serving as the input for the other. For conservative and skeptical people, feel free to doubt how quickly this will become powerful. But, at a professional level, follow my direction and do what I ask with machine learning. If you’re wrong, you’ll be happy. If you’re right, the mistake of over-estimation will be mine to bear. For other futurists, who see how emanant this sea change is, dive in enthusiastically to seek out the fastest path to leverage strong AI in your professional charge that is articulating in this little *book* in the best manner my circuitous mind is capable of relative to the time I’ve invested.

**NOTE:** Fang, David and Richard, as project engineers, please talk among your selves and present to me a protocol on how to use this book as the seed for a wiki that will be open sourced. I would like you to present the protocol by Feb 2nd. In order to avoid misunderstanding of what I want, keep in mind the following. It should be visually attractive and well organized. So you should show me three examples of best in class wiki’s that you all three like. It should be multi-media and include diagrams, text, software and videos of simulations. There should be at least two co-managers/curators of the living site. There should be a process by which new things get inducted into the site, where I should be one of the approvers. I do not want to dilute the site with too many ideas that are off target from what I present herein. But I also am eager to incorporate ideas of my colleagues. It should have a section called “open problems” and some form of advertisement to the international community to apply for prizes and/or grants to tackle our living list of open problems/tasks. It should have a prize section because we will be doing contests with money prizes for the best simple programs created with our data. And, eventually, the AI itself should be in an interface on the wiki so that others can go to this cloud resource to run the AI to do the NLP 🡪 coding and equation generation. All our simulation runs have associated approximate equations. And it should have three sections. Philosophy/cosmology. Simple programs. Physics. Of course, the physics section will contain equations and suggestions of simple program probability spreads that map to those equations. It can also include curated physics equations that use the spinorial math I describe herein and the probability spreads but that are not yet evident in a simple program. These then become targets for the AI to find a “best matching” set of simple programs using C5C math that approximate the equation targets to one degree or another.

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**A Simplified Pre-Discussion of Division Algebraic Spinors**

I’m interested in starting “from scratch” with a non-realistic toy model based on my subjective recognition of mathematical elegance and compactness. Due to time constraints, I will not provide much argument or references defending my belief that the objects I select are exceptionally elegant. I am interested in certain finite series and minimal and maximal limits. My starting point is the *principle of efficient language* and the digital physics ontology of the *self-simulation hypothesis*. I believe a class of integral division algebraic spinors used in a simple program context will provide great progress. And I start with the octonions. Let me offer some inspirational thoughts from others on spinors and division algebras.

John Baez said:

*The conventional attitude… …has been to treat the Standard Model as a broken piece of some more complete theoretical structure (GUT). But a competing tendency is to try to use the octonions and get the weirdness from the laws of logic somehow.*

Baez is rephrasing my meaning above, “start from scratch”. His statement encourages me to pursue building spinors from the four division algebras.

Geoffrey Dixon said:

*What I had was an out-of-control intuition that these [division] algebras were key to understanding particle physics, and I was willing to follow this intuition off a cliff if need be.*

In the following quote, Fields medalist and Abel Prize–winning mathematician [Michael Atiyah](https://www.quantamagazine.org/michael-atiyahs-mathematical-dreams-20160303/) said the final theory of nature must be octonionic:

*The real theory, which we would like to get to, should include gravity with all these theories in such a way that gravity is seen to be a consequence of the octonions and the exceptional groups. It will be hard because we know the octonions are hard, but when you’ve found it, it should be a beautiful theory, and it should be unique.*

It has been said that “God created the integers”. Yes, integers are special and powerful, as any number theorist would argue. But the integers of what numbers? Are there any deeply “special” number systems? The division algebras are the four "special" number systems in the sense that they are the only ones that can be used to construct vector spaces over the real numbers with the property that the vector space can be equipped with a multiplication operation (the "vector cross product") that satisfies the requirements of being bilinear, antisymmetric and distributive over vector addition. Put differently, these are the four number systems you want to use if you’re planning to create a mathematical model of a reality that involves spatial dimensionality.

The discreteness of nature (in QM) has been used by some authors to argue for a deep integral number theoretic based view of reality.

**I want to convert four maximal sphere packing point sets into discrete self-embedded division algebraic planes and then turn that system into a coordinate space that we play spinor games on, where the spinors are based on the group theory derived from the four division algebras .**

Like Cohl Furey believes, it’s a good idea to mathematically interact the four division algebras in an attempt to understand nature. I want to use discrete groups to interact the four division algebras to construct spinors. I certainly do not need to provide reference supporting the idea that spinors are deeply part of the story of fundamental physics. For our spinors, I want to use [Clifford spinors](https://arxiv.org/abs/2103.07817), also known as Hestenes spinors. An incomplete list of other reasons to use Clifford algebra includes:

**Simplicity:** Allows for the representation of geometric transformations in a simple and concise way, using a limited set of mathematical operations.

**Generality:** Describes transformations in any number of dimensions, making it a versatile and powerful tool for a wide range of applications.

**Geometric intuition:** Has a close relationship to geometric concepts, such as vectors, bivectors and multivectors, which makes it intuitive for geometric calculations and visualization.

**Physical interpretation:** Has a natural interpretation in terms of physical quantities, such as angular momentum and torque.

**Computational efficiency:** Can be implemented efficiently in computer programs, allowing for fast and accurate calculations.

**Building discrete division algebraic coordinate spaces**

* Let ℝ∩ℤ be defined as a coordinate space of integral reals in R1 that label the kissing points of the maximally dense 0-sphere packing = A1 lattice points (countable infinity of points on a line, seen as the A1 lattice zoomed out to infinity where the points are infinity close but have substructure defining them as a countable infinity).
* Let ℂ∩ℤ be defined as a coordinate space of integral complex numbers (Eisenstein integers) in R2 that label the kissing points of the maximally dense 1-sphere packing = A2 lattice points.

It is symmetrically constructed with 3 parallel plane classes (PPCs) of ℝ∩ℤ.

* Let ℍ∩ℤ be defined as a coordinate space of integral quaternions (Hurwitz integers) in R4 that label the kissing points of the maximally dense 3-sphere packing = D4 lattice points.

It is symmetrically constructed with 8 PPCs of ℂ∩ℤ.

* Let 𝕆∩ℤ be defined as a coordinate space of integral octonions (Gravesian numbers) in R8 that label the kissing points of the maximally dense 7-sphere packing = E8 lattice points.

It is symmetrically constructed with 10 PPCs of ℍ∩ℤ.

Around any point in 𝕆∩ℤ, there are 240 𝕆 coordinates at r = 1.

Let the 1+240 cluster of 𝕆 coordinates be notated as 𝕆241.

Around each point in ℍ∩ℤ, there are 24 ℍ coordinates at r = 1.

Let the 1+24 ℍ coordinates be notated as ℍ25.

Around each point in ℂ∩ℤ, there are 6 ℝ coordinates at r = 1.

Let the 1+6 ℂ coordinates be notated as ℂ7.

Around each point in ℝ∩ℤ, there are 2 ℝ coordinates at r = 1.

Let the 1+2 ℝ coordinates be notated as ℝ3.

Our three smallest integral division algebraic planes are embedded in 𝕆∩ℤ. So, the object in it, such as hexagons or 24-cells, must be described with octonionic coordinates in order to define their locations/orientations in R8. Accordingly:

ℍ25 🡪 𝕆25 , a 25-tuple of octonions

ℂ7 🡪 𝕆7 , a 7-tuple of octonions

ℝ3 🡪 𝕆3 , a 3-tuple of octonions

**Groups**

There are many groups in 𝕆241, particularly the Weyl group of E8. We disregard those and work with only the groups associated with our division algebraic decomposition of 𝕆241 via ℍ25, ℂ7 and ℝ3.

𝕆241/𝕆3 🡪 S120, which breaks to 40 instances of the symmetric group, S7.

𝕆241/𝕆7 🡪 S120, which breaks to 12 instances of the symmetric group, S10.

𝕆241/𝕆25 🡪 S10, which breaks to 2 instances of the symmetric group, S5.

**NOTE:** There are 16 parallel classes of A2 that composite to form the point set of the D4 root lattice. To cover the 24 vertices of its root polytope, the 24-cell, we can use a symmetric array of 4 A2 root polytypes (hexagons). There are a total of 8 possible combinations of 4 hexagons that can cover the 24-cell, which generates the symmetric group S8.

**Clifford Rotors 🡪 Clifford Spinors**

𝕆241/𝕆25 🡪 S10 breaks to two instances of the symmetric group S5, generating 120 + 120 = 240 permutations of 𝕆241/𝕆25 spinors. We can randomly select one of five 24-group elements within one of the two sets of five 24-cells in a compound of ten 24-cells breaking 𝕆241. As will be discussed later, the ten come in five pairs of 24-cells, where the two elements in each pair are perpendicular and noted as the A and B elements. A set of five cycling 24-cells can be the A or B set. Later, we can run algorithms exploring the interaction of the elements from both sets. Let us say we have chosen an element from the B set of five and we wish to construct an ordered set of 5. This leaves four others to choose from for the second step. In Cl8, that step is actioned by a Clifford rotor, *R*, to transport the first 24-cell onto a second one in the remaining four B elements. When it comes back to closure in a cycle of 5, we have completed an 8+1D cycle, which can be repeated N times as a sequence of N identical ordered sets. The entire 𝕆∩ℤ coordinate space can be actioned with spinors making it a periodic array of spinors in 8D. There has been no discussion thus far on schemes that serve as interactions of these individual spinors. We do this later by use of a simple program in the 3+1D analogue of the 8+1D system by exploiting a mathematical structure called empires.

In 8+1D, we can enhance the complexity of our spinor constructions in various ways such as these:

Cycling 𝕆241 on 𝕆241

Cycling 𝕆3 on 𝕆241 and vice versa

Cycling 𝕆7 on 𝕆241 and vice versa

Cycling 𝕆25 on 𝕆241 and vice versa

Cycling 𝕆3 on 𝕆25 and vice versa

Cycling 𝕆7 on 𝕆25 and vice versa

Cycling 𝕆3 on 𝕆7 and vice versa

Cycling 𝕆241 on 𝕆241 means this. You can cycle, for example, a unit length 24-cell on a 2x unit length 𝕆241 while completing a Hamiltonian circuit on all 240 vertices of a 2x unit length 𝕆241. That is, you advance to a new unit length 𝕆241, that lives on the vertices of a 2x larger 𝕆241, as you change orientations of 24-cell with each step. In this case, you would complete one full cycle on the large 𝕆241, while completing 240/5 = 48 Clifford spinor cycles, 𝕆241/𝕆25. There are many other cycles within cycles that can be explored, as long as they are restricted to the parts of the Weyl group for E8 that are associated with the four discrete division algebraic planes as coordinate spaces.

**IMPORTANT:** Each of these division algebraic + group theoretic spinorial algorithms generates a unique spread of quasiparticle interaction probabilities governed by rules in the 3+1D analogue space of the Fibonacci icosagrid (FIG). And the key to learning more about this class of games is to pick a class of simple programs and methodically catalogue a mapping between (A) a given set of rules and (B) its probability distributions, especially through the lens of spectral analysis.

The way we will upgrade this periodic array of spinors in 8D to a true interactive scheme is to get our interaction rules from a simple program exploiting non-local empire ray structure after transforming our 8+1D system to our golden 3+1D system that generates the 5th root of unity structure, torsion, code rules and other rich objects not available prior to quasicrystal transformation. This has been an overview that will be further developed later in this document.

**Axioms**

1. **LOGIC:** Two candidates for our program are Bayesian and constructivist logic. Bayesian logic is a mathematical framework for modeling uncertainty and updating beliefs based on new information. It is based on the principles of probability theory and allows individuals to make decisions and predictions based on incomplete or uncertain information. Bayesian logic is often used in statistical analysis, machine learning and other fields where it is necessary to make decisions or predictions based on uncertain or incomplete information.

Constructivist logic, is the basis of constructivist mathematics. It is another approach that emphasizes the role of human cognition and agency in creating (constructing) knowledge and understanding. It asserts that knowledge is not passively received from the external world, but rather it is actively constructed by individuals through their interactions with the cosmos. Constructivist logic is associated with constructivist theories of learning, which emphasize the role of personal experience and active exploration in the process of learning and knowledge construction.

Although Bayesian and constructivist logic are distinct approaches, they share some common themes and principles. Both approaches recognize the role of personal experience and subjective interpretation in shaping an individual's understanding of the world, and they both emphasize the importance of context and perspective in shaping beliefs and decisions. In addition, both Bayesian and constructivist logic place a strong emphasis on the importance of actively seeking out and incorporating new information in order to update and refine one's beliefs and understanding of the world. Both systems of logic are ternary, vs classic Boolean logic. They reject the *law of the excluded middle*, so they have the values “yes/true/on”, “no/not-true/off” and “unknown/maybe/both”.

1. **MATHEMATICS:** Other than our logical axiom, we must articulate a full set of necessary mathematical axioms. One that we know we need is the subset of Euclid’s axioms necessary for trigonometry and other forms of geometry we rely on.
2. **ONTOLOGY:** Idealism; everything is thought. Thought comes in two forms: Information, in the context of binary information, perhaps in a Shannon information context. The meaning of this form of thought is called self-referential symbolism. This is explained [here](https://www.worldscientific.com/doi/10.1142/S2424942419500038). And, information as non-self-referential meaning, which is every other type of information. Thought, and therefore reality, is code theoretic, as explained [here](https://www.worldscientific.com/doi/10.1142/S2424942419500026). Codes always have emergent hierarchy of layers of meaning built on lower layers plus an irreducible symbol set, such as bits or English letters. Examples of self-referential meaning or symbolism include the angular relationship, as torsion or twist, between 3-simplexes in the FIG, which is a scalar defining curvature equivalency. These numbers are the base level self-referential symbolism that organize into physical meaning. Accordingly, information = a form of thought can be numerical quantities of curvature equivalency. As mentioned, numbers include geometric numbers, such as *simplex-integers*. These “pixels” of information can be related according to the syntactical rules of a certain geometric code called a quasicrystal (QC) for discussed in the context of meaning [here](https://www.researchgate.net/publication/315496256_A_New_Approach_to_the_Hard_Problem_of_Consciousness_A_Quasicrystalline_Language_of_Primitive_Units_of_Consciousness_in_Quantized_Spacetime). The second form of information is emergent meaning called the EP1, 2… n to EC1, 2..n hierarchy, introduced [here](https://www.mdpi.com/1099-4300/22/2/247/htm).

SSH implies that all thought is measurement. The primordial thoughts generate the “letters” of self-referential symbolic meaning and express a numerical quantity of curvature equivalency in this irreducible form of physical or numerical information. Each instance must be chosen and does not occur according to a first-principles algorithm but instead according to a function chosen by the universe for strategic purposes of efficient creation of physical information or reality = self-simulation. The non-primordial thoughts, called non-self-referential symbolism or “meaning” = measurement, are the EP1, 2… n to EC1, 2..n hierarchy.

Every thought we have changes the universal wavefunction. Like Evert in many worlds and other models, I reject the ontic nature of local wave functions and believe only the universal function is real. Presuming freewill to be real, every thought drives particle interactions that would not have occurred without that thought being chosen and subjectively experienced by an observing mind. This is empirically obvious because thoughts have been well correlated to particle interactions in the experimental literature, where a thought of “apple” creates one set of EM patterns in the brain that are different than either no thought at all or the thought of “dog”. As a result, every thought changes the wavefunction that would otherwise have described the evolution of probabilities without the thought having occurred. Ergo, a function update is required in order to comport with the particle interactions driven by the new thought. If QM were based on a simple program paradigm, this leads to modified probability distributions given by the simple program after that thought. Like QM, our simple programs must be functions that determine a given probability distribution for game-particle interactions. And, like the Wigner-von Neumann interpretation of QM, an emergent game entity, such as a human, capable of freewill thinking will drive function updates upon doing so. Clearly, no measurement done in a quantum mechanical experiment can be disassociated from a thought of the experimentalist about her observation, even if that observation is a mere probability for her to observe stored data at a future time. The “consciousness causes collapse” category of interpretations of QM can be rephased as “thought causes collapse”. Every thought we have ruins a previously accurate wave function that no longer fits with reality after the thought and resultant particle interactions occurs. I will explain more.

As stated, thoughts are not predicted by the unitary evolution resulting from the calculation of the Schrodinger wavefunction for a given system that includes the thinker. Specifically, the resultant particle interactions in the brain-body system of a thinker are interactions not predicted by the quantum formalism because it is a theory for the probability distributions of particles between measurements. Of course, quantum theory does not predict that measurement will occur or define what a measurement is in the first place. So, whether we do a thought relative to a double slit experiment or a a thought while lying in bed with our eyes closed, we can never escape our own interactions with reality… our own general observations and resulting states of consciousness or thought. So function updates is necessary to describe the probability evolution after any thought occurs due to the resultant particle interactions uniquely driven by that thought.

In summary and with some additional technical terms, the idea that reality is made of consciousness (e.g., Penrose) is called *idealism* in academic literature. The idea that reality is made of information (e.g., Wheeler, Fredkin, Tegmark) is called *informational realism*. Digital physics is an example, where we say the ground level meaning or information is Shannon class information. Idealism and informational realism play well together because information or meaning is exactly what consciousness does and is.

Finally, the philosophy that there is some stuff other than consciousness or information that defines reality is called generalized *Platonism*. It is the ontological guess that there is some stuff that *just is* without any explanation of origin and with no compositing substructure. The “stuff” that *just is* can be information, energy, space, time or anything else that has no self-actualizing or creation story, i.e., it *just is*. The same can be said about idealism and digital physics views if there is no origin story. The SSH provides an origin story for how consciousness comes to exist in the strange loop we describe therein.

Accordingly, if one believes digital information is the ground of reality and that it *just is*, with no explanation, that is part of generalized Platonism. The physical ontology of *emergence theory* seeks to go deeper into explanation of *how* it comes to be. We hold it to be true that reality is built at the “letter” level from a simple thought called digital information. That is, the base-level or “letter level” thoughts are mathematical objects and functions/algorithms (*gameboards* and *games*). The universal panconsciousness game player and holder of the mental gameboard is self-emergent from its own thought or game run. So, we do not have a *just is* Platonic ontology, wherein either spacetime + energy, information or even consciousness *just is* with no origin or substrate story. Idealism is a generalized Platonic philosophy that says consciousness *just is* and is the ground of reality. For us, we reject *just is* and believe consciousness self-actualizes or bootstraps itself from itself in a logically self-consistent loop called a *strange loop*. Put differently, consciousness emerges from information. Information lives as thought within consciousness. Both objects are thought or action of consciousness. And the causality, origin or substrate issue cannot be chosen linearly to be one or the other. Information is thought. And the process of thought, i.e., consciousness, emerges from language-theoretic manipulations of the information thought, where languages range from algebraic to simple programmatic to a generalized natural language of consciousness.

1. **TIME DOES NOT EXIST:** At a naïve level, this is an extrapolation of the ontology of #3 above, which makes it clear that physics is non-fundamental. And physics includes time. Digital physics is the theory that space, time and energy are emergent and non-fundamental. However, in our approach there is not even an emergent “time”. Not exactly. Let us unpack this because it ties us directly into the idea of psychic abilities and the strange loops we describe in SSH. The trick here is that space or length or geometry IS fundamental. It’s part of the math of our “gameboard” network, which includes geometry. In fact, our self-referential symbolic building blocks are pixels of geometry, as 3-simplexes. But the KEY thing is that our particles are not point particles. They could have been. And a point is a geometric object. But this is where we drastically depart from the canonical theories of Newton, Einstein and the founders of QM. Our “particles” are *quasiparticles*, which are emergent coherent patterns with particle-like qualities that occur over sufficiently large ordered sets of coordinate changes of our palindromic objects called center emperors (CEs). The elements of these ordered sets are mathematical objects, such as quasicrystalline point sets. Again, this is a very important deviation from general relativity, QM and Newtonian physics, which all assume reality, such as space and particles, can exist in a single moment. In those theories, they have a model for time and is different than spatial geometric objects. We simply have ordered sets of geometric objects with no particle model or representation in a single geometric object. We cannot have a representation of a quasiparticle in a single element as a QC. As such, our game physics has a lower bound on being able to say where a particle is precisely in some notion of a measurement of a “game moment” because there is no such thing as a “game moment”. That is, ontologically, there is no such thing as a “moment” in this digital physics framework. But there are geometric things, such as length, spatial coordinate and distance. The closest we get to the temporal concept of “duration”, due to this uncertainty just explained, is a very small game *duration* as is an ordered set of game mathematical or pre-physical objects, as point sets and their equivalencies, bijections and transformations that have the meaning of a coherent pattern that propagates over N frames as an ordered set. This “fuzzy” approximation formalism occurs by necessity due to the approach to digital physics that we take with these quasiparticle interaction probabilities on this mathematical *gameboard*, where we reject the opportunity to use a point to represent a quasiparticle. In this sense, time is illusionary in this game physics ontology, whereas distance is not illusionary. And we have two ideas of illusionary “time”. The first is universal game time, which is simply the number N in an ordered set of N elements as QCs. The second is what we call the intrinsic ratio of clock cycles relative to forward distance steps that on our cycle clock spinor quasiparticles can experience over some ordered set of N QCs. We are interested in simple program rules that have an inverse proportionality between the steps through internal cycle count vs external propagation through game distance. This is a radical departure from QM, which holds that Newton’s time is real or GR that invents a new notion of real and fundamental time in the spacetime object called the Lorentzian manifold.
2. **STRANGE LOOPS AND PYCHIC PHENOMENA:** Because the SSH paper is general enough that it applies to a very broad class of math gameboards and the various rule systems that can play out on each math gameboard, we did not discuss the novel property of our games not having time, i.e., not having a concept of a “moment”, as virtually every other model has, including most digital physics models. Accordingly, we were not able to connect, in our reader’s minds, the deep requirement for the strange loops, as trans-transtemporal feedback loops, in our particular games. We will do that here in the axiom session. In one sense, the rules and modeling of a given simple program to represent reality make axiomatic statements about what reality is in the first place. For us, there is no “time” in the sense that time is generally defined as a sequence of moments, where a moment is generally a frozen object without motion vs a short duration. It starts with how we calculate probabilities and define quasiparticles. We take an arbitrary span of cycles of one of our quasiparticle cycle clocks. Let’ us say this is a set of 100 frames. Then we seek to understand how a fame at step 4 or 5 or any number saves elements for and has elements saved by a frame at step 90 or 91 or any number greater than other numbers. That is, we calculate savings across some span or sequence of frames or elements in our ordered sets.

If this is unclear, let us simplify. Let us say that the frames in an ordered set of 100 have a sub-ordered set pattern at 51 to 100 that is in a freedback loop with a subset of frames 1 to 50. This feedback loop exists across any combination of frame sequences within the span of 1-100 or another arbitrarily large ordered set greater than 100. All the way down to the level of our simple program definition of “particles” as probability spreads for two or more cycle clock quasiparticles, we have the fact that our objects are, by definition, smeared across “game universal time”. Game universal time is the order within N sets of ordered and weighted sets of elemental math objects as QC transformations of different point sets within the E8 root lattice. Furthermore, we do not need to have two or more of these cycle clocks to have this same notion that the particle is a feedback loop across game time. It works also for just one quasiparticle particle.

Put more directly, our cycle clocks themselves are strange loops. Douglas Hofstadter

Introduced the term in his book Gödel, Escher, Bach. In SSH, we carved out a special case of strange loop, wherein the feedback loops Hofstadter describes can be trans-temporal loops. The most rudimentary strange loop in our paper is the game representation of a fundamental particle, the trans-temporal cycle clock. Again, “time” in this context is the order of the sets of geometric representations.

Beyond the most simple case of a single particle strange loop, we have the general case of any N particle system being in a trans-temporal feedback loop with itself in the future and/or past and in a feedback loop with various M particle systems in the game future ad past. Again, herein, “future and past” refers to the LOCATION of a sub-ordered set within an ordered set. For example, the sequence 1, 2, 3, 4 is an ordered set. And the sequence 1, 2 is a sub-ordered set within that set, which has a location in the set BEFORE the sub-ordered set 3, 4 within the ordered set 1, 2, 3, 4. Extending into vastly larger numbers, we can have myself as an animal probabilistically defined as a vastly large set of ordered and weighted sets that describes my probability spread over 60 minutes of experiential illusionary time. We can divide this into two subsets of weighed and ordered sets – one relating to the “minutes” 0 to 30 and the other related to my experience of the “minutes” 30 to 60. Because the ontology of the game does not allow frozen moments and because savings can be integrated over arbitrarily large sub-sets of a universal and large set of ordered and weighted sets, the Klee in the first 30 minutes is influencing the Klee in the second thirty minutes and vice versa.

Here we are coming directly to the nexus of psychology and mathematical game physics modeling. What did I mean by “influence”. The focus here is on how thought as observation changes the weights and orderings in the sets of weighted and ordered sets. It changes the probability spreads, which requires an update to any function that would otherwise have generated a set of ordered and weighted sets without the observation and associated thought occurring. We will be explaining this more later. For now, all thought you have drives particle interactions that would not have occurred without that thought. Thoughts are chosen according to a vague psychological concept called “freewill”. No one has described “consciousness” in a manner that lead to a widespread consensus among scientists. And the term “freewill” also lacks a strong consensus of meaning. This is why we have to axiomatically decide of freewill and consciousness are even real concepts to begin with – concepts that we can know a little about but not fully define or define in a manner that leads to widespread consensus.

The reader must contend with the reality of this ambiguity or stay out of discussions about a digital physics paradigm like this in the first place and take the non-philosophical shut up and calculate approach of ignoring deep and difficult questions like this. With that mystery and ambiguity accepted, we can tread lightly and explore with some deduction. We discuss these assumptions in [*A New Approach to the Hard Problem of Consciousness*](https://www.researchgate.net/publication/315496256_A_New_Approach_to_the_Hard_Problem_of_Consciousness_A_Quasicrystalline_Language_of_Primitive_Units_of_Consciousness_in_Quantized_Spacetime). We believe that consciousness is “thought in motion”. To be conscious is to create or choose what to be aware of or believe – what to think. Its choices are not predicted, even in principle, by QM. We believe this is the deep reason why the potential or actual awareness of an observation by a conscious mind ([Wigner von Neumann interpretation of QM](https://en.wikipedia.org/wiki/Von_Neumann%E2%80%93Wigner_interpretation)) requires a re-write to the universal wavefunction or any sub-function of one does not hold to the idea of only the universal function being real (as did Everett in the many worlds interpretation of QM). If the function before the freewill choice of what to think did not give real world probabilities of that thought and if that thought drives particle interactions, as it always does, then the function prior to the thought is rendered unrealistic and requires an update. This article in a curation organized by researchers at Stanford contains a good list of references discussing the strong implications of QM that observations require changes to the probabilities of the past, not just the future. Our toy model approach is strictly retro and forward causal and of course models our notions of experience of “time” in a very different way than most philosophers and physicists in the first place.

Accordingly, by construction, our program starts with an axiom of time being illusionary and defines the most rudimentary form of reality at EP1 as a single cycle clock that is itself a probabilistic “trans-temporal” feedback loop we call a strange loop. This then extends logically to various species of strange loops between two or more very complex systems separated by great distances of game “time” and/or game spatial distance in our toy model framework. Emergence theory is integrated between all levels of EP and EC. That is, even a God-like entity that emerges can have freewill thoughts that emerge from the entire stack of strata under it, all the way down to a single EP1 quasiparticle. No animal or disembodied thinking entity in this framework can have any freewill thought that does not physically change the probability spreads of the self-referential symbolism under the EP1 level that we call “i” in the SSH paper. More succinctly, every thought changes the probability spreads of reality both forward and backwards in time.

But feedback loops that exchange high level EC information between an entity in a “future” of the game run relative to a “past” of the game run are a special case to discuss. Using my example above with a 60-minute span of time, we have this emergent thinking Klee entity at time 0 to 30 minutes and this different one at time 31 to 60. If their emergent thoughts can be connected across game time, then they influence one another ad infinitum in a trans-temporal feedback loop, like a conversation that changes the thoughts of both participants. And the thoughts are changing the physicality of particle interactions for both members of the feedback loop, Klee in the past and Klee in the future. At a deep level, what is changing? It is the choices that are changing. To think, is to create, by choices, networks of simpler thoughts that lead to emergent meaning. Whether subconscious or conscious, there is a form of choice involved. When someone gets an intuition that a think is definitely true, they are believing they are somehow remote viewing into the future when it will be demonstrated to be true. Or it can be a sensation with no good logic that something bad occurs in the future. If someone irrationally listens or gives credence to these intuitions as memories of the future, it changes their choices in the past. For example, I’m not going to go on that trip because I have an intuition something bad occurs in the future there.

How does our toy model allow a thought from the future to influence a thought from the past – influence the choices of a thinker in the past? At the deepest level, this is a false question. Our toy model has no time in the ordinary sense. Physicality, even a particle, is defined only over sufficiently large instances of geometric objects but in a probabilistic spread. That is, our rudimentary form of matter, the quasiparticle, is smeared across this substance typically thought of as “time”. It is is defined as the order of the set of two or more elements separate in a “time-like” sequence. Accordingly, just like the ontology of our particles, emergent objects, such as freewill choices of thoughts thought we have follows the ontology principle called “process”. Reality exists only as process. Reginald Cahill may have written more extensively on this topic than anyone, even Henry Chew. [This](https://arxiv.org/abs/gr-qc/0110117) is an example of one of his papers, and he has several books. I suggest the reader take a moment to scan the abstract of the paper in that link.

It is not 100% clear how a consciousness of the future can exchange meaning with a consciousness in the past. But, in our model, the very definition of our object, as a system spanning the future to the past consciousness, is strictly defined as a trans-temporal feedback loop. I do not think consciousness itself can be defined in a scientifically satisfactory manner, which means thought cannot either. An [article](https://bigthink.com/life/consciousness-at-the-quantum-level/#:~:text=Sir%20Roger%20Penrose%20in%202011,understanding%20of%20the%20physical%20world.) in *BigThink* says:

*Penrose believes consciousness is not computational. Our awareness is not simply a mechanistic byproduct, like something you can make a machine do. And to understand consciousness, you need to revolutionize our understanding of the physical world. In particular, Penrose thinks the answer to consciousness may lie in a deeper knowledge of quantum mechanics.*

I share a similar view in that consciousness itself is not fully knowable, not even by the emergent panconsciousness substrate. The link from Stanford above goes into references about speculations about models explaining the physics of the empirical data on humans accessing non-local meaning. From remote viewing to other non-local mental phenomena, the literature has reached the level of empirical fact. However, that runs into the emotional dogma and “religious” type conviction that many physicists have created in their minds about the Greek philosophy of materialism. That is, those holding emotional charge of dogmatic passion about materialism will irrationally claim that the evidence has not reached the level of “empirical”. They will proudly label themselves as debunkers and defenders of truth and will create material for an eager audience of similar zealots of the materialism philosophy. Unemotionally, the evidence has reached it has. And much solid peer review work has been proposed to explain it, almost always by invoking empirical facts and interpretations related to QM.

We take a different path. We wipe the board clean. We pretend temporarily to ignore the placeholder theories of QM and GR, along with their mutually contradictory ontologies. We just stay humble and talk about game-physics, which are distinctly not realistic. We start with a choice of looking for a mathematically compact game board and interesting spinor games that can play on it. We invent our game ontologies, like the PEL and the code theoretic axiom and the issue about “time”, etc. So, by deduction following our game physical approach, retro-causal feedback loops of emergent EC or meaning are part of this “smeared across” time ontology from our toy model particles to our toy model emergent consciousness.

And, because I believe the toy model is an analogue of a realistic model of reality, I believe any realistic model of reality is a model wherein thought is networked across time in both the typical forward causal direction but also the atypical retrocausal direction, which makes reality a non-local topological neural network of thoughts co-evolving.

Obviously, if a reality like this were actually real, we could practice science by (1) “remembering forward in time” to where greater understanding of nature has occurred and (2) cultivating specific feedback loops or conversations between local or non-local entities living in different locations of time from us. For example, having a conversation with yourself from 4 years in the future about your physics program both back here in the past and how it relates to the program 4 years in the future. If I’m right about this helpful approach to hack physics via collaboration with the future, we have a helpful X-factor that becomes part of the scientific process for us. If I’m wrong, then there’s generally no harm. So, we have a high return on investment if we’re right and curated feedback loops with future physics knowledge can help us build better models back here in the past. And a low cost if we’re wrong – perhaps only the cost of looking foolish, which is itself a subjective cost, depending how important it is to not look foolish. I’m a businessman turned fulltime physics institute director. I take a business approach and financial investment philosophy, where I don’t care too much about looking foolish and only focus on the probability of return on investment.

**CONJECTURE:** Consider how quantum formalism itself, for interpreters like J. Sarfatti, R. Sutherland and M. Hughes, is already both forward-in-time and [retrocausal](https://plato.stanford.edu/entries/qm-retrocausality/). However, the forward and retrocausal influence in the wavefunction for a particle system drops over time, unless the relationship is one of high entanglement entropy. Note that the retrocausal interpretation of the QM formalism is based on our notion of EP, ordinary physical energy, such as energy in the form of massive particles. Without high entanglement entropy, such physical retrocausality does not have a meaningful reach across “time” from future to past. By contrast, an advanced EC system, such as a human mind, may be able to [*remote view*](https://irp.fas.org/program/collect/air1995.pdf) arbitrarily far in time. In so doing, the knowledge or thought accessed non-locally changes the decisions of which EC thoughts to have in the past, which then can non-locally or classically influence the thoughts and physical states of reality in the future to form a stronger than typical strange loop. The conjecture here is that QM requires retrocausality for low-entanglement entropy systems of particles, while the SSH post-QM view requires much longer-range retrocausality for EC-based strange loops across time. The conjecture includes the implication that conscious freewill choice decides what trans-temporal “conversations” to maximize. To “maximize” is to potentiate the resonance of or the information exchange between or the integration of meaning between two or more mind-like EC systems separated as an arbitrarily distanced future and past entity and then to choose to up-regulate that “conversation” or feedback loop. The entities in such conversations and the conversation subject matters themselves are even more varied than the types of entities and subjects of conversation between any two humans.

1. **THE PRINCIPLE OF EFFICIENT LANGAUGE (PEL) AND CODE THEORETIC AXIOM:** The term “language” here refers to the context discussed in [*The Code Theoretic Axiom*](https://www.worldscientific.com/doi/10.1142/S2424942419500026) and [*The Self-simulation Interpretation of Quantum Mechanics*](https://pubmed.ncbi.nlm.nih.gov/33286021/). This axiom states that reality is more than what Wheeler termed *information theoretic*. It is language or code-theoretic. It has been argued by various authors that any system of information as meaning or complexity is defined by the language system in which the meaning-information is conveyed. Our approach relies on the assumption that the *self-simulation hypothesis* is true, and that the universe seeks to simulate itself by using as little of itself as possible. And, because the ground of reality, in this context, is the self-emergent universal panconsciousness substrate, it seeks to think of or create as much physical and emergent abstract meaning as possible with as few mathematical symbolic actions = primitive thoughts as possible. In this framework, mathematical actions, as self-referential symbolic thoughts, are just as much thoughts as emergent thoughts, such as capitalism and irony. The PEL dictates that, when we are faced with options for the mathematical *gameboard* and *games*, we should opt for ones we suspect are most compact in terms of irreducible symbolic representation. Of course, this is imprecise because we don’t yet have agreement on what isomorphism or bijection of the *gameboard* or what symbolic representation of the *games* the universe uses relative to its resource of consciousness. One approach is to use mathematical proofs that reduce a given symbolic expression to the fewest quantity of bits (or *trits*). 0-simplexes, as points, are one of the most simple and irreducible units of symbolic information. And a point can be “on”, “off” or “undetermined”. Our irreducible symbols are points that can be in one of these three states, as proven in [this](https://www.mdpi.com/2073-4352/7/10/304) paper. The games we will be discussing later have two notions of economization inspired by the PEL. The first is point savings in the overlapping of empire points in some ordered set of QCs or points saved within the cylinders of a cycle clock. For readers outside the QGR staff, please seek out a staff member to explain this in detail. Essentially, this document provides a road map of seminal elements of our program to reach out to get help learning about. We provide some degrees of details only on some of the key elements of our program herein.

A second form of savings we are exploiting is the concept of function updates and the presumed cost for them. Before elaborating, let us bring forth an ontological issue. Our digital physics approach can be interpreted to mean that, ontologically, we think reality is a vast set of ordered and weighted sets of finite quasicrystals derived from the E8 root lattice, wherein each element is itself a thought in the emergent panconsciousness substrate. However, we must ask, “What would the PEL dictate?”. Is it possible that these sets of ordered sets ontologically exist as functionals? For example, let us say we have an abstract thought equal to a 100 level zoom of a finite section of the plot of the Mandelbrot set. That thought is in no way equal to the thought of a function that would generate that quantity of inputs, outputs and plots onto the plane. The function would reduce to a far lower bit or trit representation than the bit or trit representation of the iterated functions giving the fractal zoom itself. Accordingly, the PEL would dictate that the ontologically real thought is the thought of the function, not the calculation of the function.

Hypothetically, let’s presume the universe is a growing tensor net of functions vs the computations of those functions. We then will explore the notion of “bit or trit cost to update a function”. Let us use a primitive example. We have an algorithm to move a chess piece one step forward in each of 10 steps, we can write a function that is compact because the pattern repeats. However, if we needed to change that function or create a function that is more complicated, we’d need more irreducible bit or trit symbolism from a functional perspective. It is noteworthy that functions or any symbolic system can be reduced to binary or trinary representation, which means that, like our notion of points, a function can be reduced to pure information. To make this more concrete, a game can have a rule that resists function updates that change the repeating “state” or steady state behavior of an emergent quasiparticle pattern because doing so requires the creation of more information as the bits/trits of the function update. Accordingly, the *resistance* to function updates, in a rule system, can compete with the aforementioned savings of point representations in the cut + project perpendicular space (or within the cylinder of a cycle clock) in order to create evolutions that have various probabilities for various function updates and where a game behavior of a quasiparticle in a given state will probabilistically tend to stay in that state until given some opportunity where preferring point savings as opposed to the savings from avoiding a function update leads to a trade-off of getting more emergent information. The PEL is “chasing emergent meaning” and the SSH explains the X factor that must bolted into a post-QM formalism to explain how complexity from the future can “pull forward” probabilities from the past to lead, on average, to greater universal complexity, from which meaning emerges. At this point in the manuscript, we have not discussed details of our simple programs. So much of that language will be ambiguous to new readers.

The notion of *efficiency* requires the decision of what the proverbial money and product to purchase are. In the SSH, we discuss three categories of information. The first is what we call “i”, which is pre-physical mathematical information. The second category is called emergent physical information, which comes in an emergent hierarchy of EP1 to EPN>1. And the third category is emergent abstract information that we call emergent consciousness information. It emerges from the hierarchy of EP information and also exists in a hierarchical structure, as EC1 to ECN>1. ECn from the future, probabilistically “pulls” both ECn and EPn from the past toward itself as an attractor. The attractor is the X factor, discussed more later.

The building block of the EP hierarchy at EP1 are the game fundamental particles, which are Clifford spinors. As mentioned, these form groupoids. Specifically, these are our division and group theoretic discrete spinors. As sufficiently large ordered sets of graph updates, at EP1, these spinors are “game physical” and are just above the pre-physical mathematical information at the little “i” level of self-referential mathematical symbolism.

**NOTE:** Above, we discussed an 8D network of division algebraic coordinate spaces. This is an example of self-referential mathematical symbolism used in our formalism.

Because these fundamental game particles are ontologically understood only over the multi graph update game “universal time” domain as the “order of the sets”, their fundamental information includes processes such as game angular spin momentum and game momentum. As mentioned, these particles with game spin have different intrinsic ratios of propagation through game internal clock cycles relative to propagation through game spatial distance. And the rules we’re interested in are ones that generate states of different game particles as intrinsic ratios of propagation through internal cycle time vs external distance that are inversely proportional to one another. Regardless of the intrinsic ratio of steps through internal cycle clock time vs external game distance steps, the sum of steps should be conserved between two particles with different ratios. Because the game is probabilistic and must be controlled by a pseudorandom number generator in our computational studies, there is always a nonzero probability that the particles will spontaneously deviate from their momenta states and thereby experience a drag or inefficiency of propagation through internal time and spatial distance over some quantity of game universal time.

**NOTE:** We are searching for simple program rules that cause the aforementioned “drag” on the sum of steps through internal time vs distance when a cycle clock quasiparticle is accelerated by interaction with another quasiparticle. That is, the drag during game acceleration must temporarily slow down the cycle clocks counting of internal cycles relative to its steady state when not being accelerated.

Nonetheless, the overwhelming probability for game particles is to approximate a classic conservation of momentum. But because the programs generate large probability spreads for evolutions, as sets of ordered and weighted sets, the game outputs are more akin to the probabilistic aspect of quantum mechanical analogues of conservation.

In this first example of the PEL, the informational product that we want “buy” efficiently with our resource or “money” is simply the objective of the program in the first place, the emergent meaning of a cycle clock over N graph update frames, as an ordered set, expressing a sum of cycles plus steps through game distance. Certain game rules will cover a greater sum when the intrinsic state variables, ISVs, (e.g., direction and ratio of steps through cycle time vs distance) remain unchanged. This class of games, therefore, would have a conservation of game spin cycles and game propagation through distance. That is, once in a given state, it will not have a high probability to spontaneously change that state.

To repeat, probabilities map to the magnitude of savings we get for the sum of steps through internal cycle clock time versus propagation through game space. Some pathways of a particle evolution can do N steps through these two spaces of internal time an external distance over some fixed quantity of graph updates and other pathways can generate less than or more than N steps. And the probabilities for the different paths map to the efficiency of generating as many steps as possible for as few graph updates as possible.

Returning to our metaphor, our money is the resource needed by either our computers or the panconsciousness substrate to generate a simulation run over N steps of universal time. And the product we wish to efficiently buy is the quantity of *fundamental* EP1 physical information, which is the sum of discrete steps of our game Clifford spinors’ propagation through internal cycle clock time and external game space distance. There are versions of our simple program parameters and rules that will show that better savings is achieved when a quasiparticle remains in a given state of *intrinsic state variables* for as long as possible. ISVs include the axis of the Clifford spinors, the direction of rotation on that axis, the direction of propagation of the spinor and the ratio of steps through internal time versus external distance over some quantity of graph updates. Put simply, we are interested in exploring simple programs that probabilistically tend to maintain quasiparticle states.

There are two savings ideas we have been exploring. See the below section titled *Algorithmic Games Playing on a Mathematical Gameboard called the 3+1D Spinor array* for a brief explanation of *empire waves*. The first form of savings is when an element of one empire wave (these are Clifford spinors with empire “arms” that drop in density like 1/r2) fills in a needed position in the future or past ISV coordinates for a different cycle clock. The second notion of savings is the coincidence of points in the overlapping of empires, which also has a representation as the overlapping of points in the perpendicular space in the higher dimensional cut and project apparatus. When quasicrystals or their empires are superimposed, there is a wide range of possible point savings, as magnitudes of point coincidences, that occur.

**NOTE:** A C5C goal is to study the conjectured number theoretic qualities of these high and low overlap form of savings.

One of the most crucial facts of a universe made of thought or meaning is this. Meaning is subjective. And so too is the magnitude of meaning. But this is only the case for non-self-referential meaning. Mathematical meaning is less subjective. A 72-simplex, for example, is a self-referential symbol with a greater magnitude of meaning than a 3-simplex because it contains more intrinsic self-referential meaning, such as the full set theoretical combinatoric information of the integer 73 that is encoded in the quantities of each of the sub-simplexes of the 72-simples. Non-self-referential meaning can be ranked in a tree structure but not quantified. For example, let’s take two meanings “irony” and “humor”. I may subjectively experience greater meaning for the abstraction called “irony” than “humor”. Another person can experience more subjective meaning for the general thought called “humor. However, both myself and the other person must conclude that the subjective meaning of “ironic humor” is of a higher magnitude than the meaning of either thought separately. Furthermore, we can agree that “ironic humor” embeds the separate meanings of “ironic” and “humor” plus additional emergent combinatoric meaning, such that it is also of greater meaning than the sum of its two parts. Therefore, we can place the three thoughts into a hierarchical tree, with “ironic humor” at the top. NLP based deep learning is often grounded in the mathematics of monoidal category theory. The term “monoid” refers to objects such as syntax and other relational concepts in some network of two or more categories as sub-objects within an language system imbued with algebraic description of its syntactical structure. Our approach at the mathematical level uses graph theory as does our approach in the emergent meaning trees of physical information, EPn, and emergent abstract information, ECn. Category theory has been successfully applied to both language theory in general and to the graph theory of neural network models dealing with hierarchical data trees. For example, in *Learning Commutative Monoids for Graph Neural Networks* (2022) the authors, like all computational researchers, are focused on the PEL principle, wherein they seek to generate as much higher order meaning useful to humans as possible for as few bits or floating-point operations as possible. If they worked with quantum computers, they would be trying to conserve ternary information, as qubits. In that paper, they say, “Based on our empirical observations, our proposed learnable commutative monoid aggregator represents a favorable tradeoff between efficient and expressive aggregators.”

Emergence theory is wholistic, such that God, as thought, emerges from bits or trits, as thought, which emerge from God’s thoughts of bits or trits. Particles and pixels of space and time emerge from bits/trits, as does human consciousness. And higher forms of consciousness emerge from lower forms and, indirectly, the particles and then bits of which they are made. A human mind can run primitive logic operations using either bits or trits. A larger mind can run less primitive processes. The PEL itself is an emergent thought, which guides reality to opt for economization of bits/trits. The first way to economize is for nature to follow the path of least action with an energetic economization principle. Our early-stage simulations are non-realistic bit/trit conservated patterns, relative to the probabilities for pattern selection by our random number generators, and therefore creating a game version of classic paths of least action. The second way to economize base-level information is to select evolutions that live within the approximately equal bit/trit efficient random walk paths of many particle systems that are both economical and express high levels of emergent physical complexity leading to high EC emergence. For example, your body-mind system in a vegetative state of low to zero consciousness in a hospital can be about as energy efficient as a state when you are vividly dreaming and generating vast amounts of EC meaning. EC, in this sense, is “free lunch” that does not cost the universe any additional bit/trit level resource. And thought can be like this too. We can use some calories to think the though of “irony” and then “humor” and keep them disconnected or disassociated. The same number of calories can be used to allow the synthesis of the two thoughts to compound to the emergent thought at a higher rank of EC called “ironic humor”. The emergent meaning synergy is *free lunch*. And the PEL strives for as much that as possible for a given usage of bits/trits.

Clearly the trit/bit component of *emergence theory* is quantifiable. Yet, it may be awkward for some to consider this version of reality based on so much subjective meaning of the complex EP systems, not to mention any EC system that emerges from the bits/trits. 21st century physics is about quantifying things and working with information only at the bit and qubit level. And this physics approach is suggesting that subjective meaning is foundational. Even a measurement of a quantum system exists in the mind of the experimenter as absolutely subjective meaning. Does *emergence theory* suggest that the emergent panconsciousness can quantify the magnitude of this or that emergent meaning? Absolutely not. In fact, it is only the subsystems of the universe that ascribe subjective meaning or create thoughts in the first place. The panconsciousness emerges from the collective interaction or synthesis of all thoughts, including physicality, within it. It’s primary thought is to hold the gameboard and game. It can choose to think of anything novel or experience the thoughts of any subsystem, like us. However, its experience as thought is subjective. And it cannot, even in principle, quantify the magnitude of meaning. It can only quantify the magnitude of bits/trits used at the deep ground level from which that meaning emerged.

**NOTE:** The PEL appreciation of trits over bits is key. I advise the reader to ensure mathematical comprehension of our trit system [here](https://www.mdpi.com/2073-4352/7/10/304). We have a scheme of “decided yes”, “decided no” and “undecided”. For a human, it literally requires calories to hold the conscious thought of “Decide on chocolate or vanilla”. And it requires at least one additional calorie to think “Decision on chocolate or vanilla + decide on chocolate”. That is, holding a choice in superposition of indecision or unknowing, requires more physical energy than moving forward with an actual decision or achieving knowing of a previously unknown state. There are direct examples of this in computational theory. And there are also examples of energy usage required to break a superposition state. In this sense, it appears that physical reality is deeply concerned with conservation of decisions. It prefers to “relax” in the superposition state, just as I prefer to relax in a state of indecision about chocolate or vanilla until the last minute before arriving at the ice cream shop.

**A Deeper Discussion on the PEL**

The PEL itself is the “X-factor” missing from QM that is part of what makes it incomplete. It seeks to pull emergent meaning or consciousness as high up the EPn 🡪 ECn hierarchy as possible for as little base-thought as “i” self-referential information as possible. It does this by synthesizing meaning in a combinatoric graph of higher and lower orders of emergent meaning – the integration of meaning as subjective information 🡪 the emergence of additional meaning without any extra resource allocation at the irreducible information level of the trits.

* At all scales where this occurs, it is a form of economy or synergy with respect to bits/trits being economized and meaning being maximized. Meaning emerges from lower levels of meaning in a hierarchy without need to produce new foundational letter-level information. At the bottom of the hierarchy, are the bit strings called Fibonacci words. Applying the empire window concept, discovered by Fang Fang, we can recover the ternary trit formalism even for a 1D QC like the Fibonacci chain, wherein our Fibonacci words of 0s and 1s would transform into a system of 0s, 1s and an extra symbol mapped to the primitive meaning of “undecided”.
* Any emergent meaning is grounded in this base level information. For any magnitude of that base level information, the amount of meaning emergent from it defined by the quality and magnitude of integration or combinatorics of meaning in a symbolic hierarchy is key. To be redundant, the meaning cannot be precisely quantified. Relative meaning can be ranked, as explained. The integration of meaning between two physical systems, can be studied by their inter-resonating physical forces, including gravity and entanglement and quantum electrodynamic values. For example, high magnitudes of entanglement entropy, high levels of magnetic quantum resonance and high levels of general notions of strong quantum coupling or correlation are ways to study the integration of emergent EP complex systems information flow within a given system. The integration of mental meaning that emerges from physical systems is more subjective but is still following the integration principle and is becoming more mathematically understood in the rapidly evolving field of machine learning. The idea of mapping the magnitude of consciousness to the magnitude of integration of information is similar to ideas of Tononi in his *integrated information theory*, ITT. He is also not able to quantify a given magnitude of meaning or consciousness. But he can rank them in a fractal hierarchy or tree-like structure. As mentioned, we will use category theory to explore the algebra of these trees.

**NOTE:** Discuss your ideas with me on why the PEL would appreciate trits vs bits. I use the term “trit” because I do not want to imply quantum mechanics by using the term “qubit”. As mentioned, with deep learning, there are trit-like objects that get decided on or locked in to on/off states during a generative evolution toward an *attention* target (“attention” in the technical sense used by computer scientists). The trits can also remain in an undecided state for some duration, such that, at any given stage, they can be in one of three states. There are systems where having an undecided state is economical relative to some process. For example, there are processes within human consciousness that work like this, where a trit of decision can be, at some stage, “yes/true”, “no/untrue” or “undecided”. I’d like to discuss foundational mathematical and/or computational ideas on why you imagine a triple state selection vs a binary state selection scheme might locally comport with the *principle of efficient language* within the computational game-physics approach described in this document. As discussed, with the *empire window* formalism, developed by Fang, a point has three possible states it can be in. And, in the context of meaning, we have a requirement to use trinary logic systems such as Bayesian or constructivist logic. This is because thinkers decide something is true, false or both/neither/unknown. QM has a trinary form, where a particle can be at location A, B or both. Perhaps the answer I’m looking for is that, “ternary systems are efficient for systems with three state variables and binary systems are efficient when there are two state variables.” But I don’t think that is the answer I’m looking for. My intuition at the time of this writing is this. For generative AI systems and generative biological neural nets, the name of the game is *meaning*, such as the meaning of a high-resolution image vs extremely noisy distorted version or the meaning that a particle in a measurement is approximately at some location. Again, modern generative AI, whether NLP outputs or visual output targes, is very much about inference. It is about taking limited information and inferring a probable best-fit in a creative extrapolation process. In fact, the fewer decided states as “yes/no” or “on/off” for some inference, the more efficient the inference is. Put differently, the more trinary states can be packed into the “undecided/both” category for some inference, the more bits are saved. Perhaps we focus on both terms, bits and trits, and we say that maximizing the fraction of “undecided” states saves the resource action of generating bits. In what situations could it be true that the ratio of this third variable in a trit system maps to some generalized notion of efficiency? My intuition or motivation is this. This is about mental efficiency in the mind of the panconsciousness substrate. As above so below might mean that the best laboratory for understanding the mind of emergent God is our own mind. As I said, choosing chocolate vs vanilla is more costly than holding the idea of the undecided state. I have to use calories just to make the decision in my physical brain. But to not make the decision is to hold them both in an undecided state. This seems more mentally relaxing to me. In quantum mechanics, is it true that the universe requires more resources of some form to spike the amplitude of probability for position when I observe some particle? And is it not true that the spike gradually relaxes to a more spread out or less probability lensed or less decided state after the observation? It seems that this general sense I have that an undecided state being less resource intensive is deep in QM, consciousness studies and machine learning. And, again, mathematically, this third state exists in our empire window formalism that undergirds the base-level self-referential symbolic code of our whole physics program at QGR.

* I believe our division algebraic spinor array is exceptionally bit-efficient. Its trivial building blocks are points. Its non-trivial building blocks are Fibonacci chain QCs. And those have a representation as a string of 0s and 1s called *Fibonacci words*. It is dynamic and not static because it is a 3+1D QC. So, it can be seen as a kinematic “sparkling” algebra of changing orders of 0s and 1s on each 1D space because of the Fibonacci chain representation as Fibonacci words – strings of 0s and 1s that follow the syntax rules of the quintessential 1D quasicrystal and that have already been used by computer scientists for various uses. How do we upgrade this to a ternary system using Fang’s discovery? These 1D strings composite up into 2D, 3D, 4D and 8D networks, which also have empire windows and the same ternary quality. With the 1, 2, 4 and 8D parts, we see this as an being interacting division algebraic network of nD integral numbers on them. Some of the most important integers for our approach in these spaces are the Fibonacci and Lucas integers and their digital data equivalents. Fibonacci words are a particular kind of infinite sequence of words over a given alphabet that have been studied in computer science and mathematics. They have been used in a number of different contexts, including the study of data structures, formal language theory and the design of algorithms. They’ve been used is in the design of algorithms for pattern matching. By using Fibonacci words, it is possible to create algorithms that can efficiently search for patterns in large strings of text.

They’ve also been used in the study of data compression. They have been used to develop data compression algorithms. They’ve been used in the study of formal language theory, which is the study of the mathematical properties of languages. They have been used to model and analyze the structure of different kinds of languages and to study the relationship between languages and the systems that generate them.

The SSH explains how the PEL causes emergent meaning to climb the hierarchy to retrocausally “pull” the probabilities of a modified quantum mechanics upwards toward the future in order to find efficient probability pathways through an energy landscape that allow the complex system to shoot upwards on the hierarchy of emergent meaning in the most letter-information efficient manner. At first glance, an astute reader should be asking this:

*If the SSH and PEL are realistic, why would the universe exhibit so many phases of local evolution that are high entropy with low complexity? And why would some systems reverse in complexity for long durations?*

That is the smartest question one can ask to deeply understand the PEL. The remainder of this document will drill in to argue for why a certain system of functions driving Clifford spinors is algebraically compact. Of course, a compact algebraic representation maps to a compact digital representation. And the same can be said about a pair of functions or algorithms in some symbolic system, wherein one has twice as many symbols as the other. There would be a difference in binary representation. An implication of emergence theory says that updating functions costs bits or trits. Specifically, the games I’m interested in resist function updates. This creates an emergent game-physics that conserves Clifford spinor empire-wave cycle-clock quasiparticle states (*intrinsic state variables* as ISVs). That is, the state of a *relational state variable* (RSV) for some quantity of quasiparticle ISVs maps to a functional, FX, whereas a change of state generates a new functional, FX’. The PEL requires that the functionals resist updating, which manifests as a game tendency for quasiparticles to conserve states in order to save the fundamental information otherwise necessary to generate new functionals. The point being built up to is this. Conservation of energy, as we understand physics today, leads to many systems reversing complexity, increasing entropy and doing both over long durations. Nonetheless, the average tendency of the universe over longer times is the well agreed upon complexity arrow of time, where the universe gets more complex the older it is.

There is an adversarial relationship of that tendency to save bits and the PEL choice or desire to achieve ever-higher emergent information or complexity, where we can pay honor to Tononi by referring to his Φ value that seems to comport well with our magnitude of elevation up the EPn 🡪 ECn hierarchy (even though our analogue is non-local and his may be local). In our scheme, the higher up the hierarchy, the greater the total emergent combinatorics of meaning across all strata is. But combinatorics don’t happen on their own. They must be subjectively recognized or actualized into meaning. We call our X-factor that pulls upwards in this way a *strange loop*, and different strange loops have different magnitudes of meaning comporting with different sophistication levels of consciousness. Tononi’s X-factor, Φ, and the form of its description seems very similar. I am not yet familiar with Tononi’s mathematics. We should study it as part of C5C. A few miscellaneous points:

* Every stratum in our hierarchy has its own special language system that the PEL seeks to economize for as it rewrites its universal functional after every thought in the universe.
* Every lateral branching at some stratum has its own language.
* Meaning is subjective, and symbolic systems, like human thought languages or the language of a rain forest, are complex systems working with some rudimentary or advanced subset of a generalized language set, where meaning is subjective except in the case of mathematics and the related notion of self-referential symbolism. In [*Toward the Unification of Physics and Number Theory*](https://www.worldscientific.com/doi/10.1142/S2424942419500038), we show how the math of Euclid allows for self-referential symbols called *simplex integers*. In the cut and project empire window analogue of the FIG, these objects are in one of three states: on, off or indetermined.
* Quantum mechanics has an impossibly small probability for life to have emerged. For that matter, the empirically evident complexity arrow of time is also not predicted by QM. That is, the universe is complexifying over time. And yet an abinito application of QM to the evolution of the universe would show that it is exceedingly more probably for the complexity arrow of time not to exist. Of course, this is to be expected, since gravity tends to self-organize matter, and QM ignores gravity. There are many authors who have more rigorously discussed this realization of the nearly impossible QM probabilities for the apparent self-organizing universe we observe. Many have struggled to introduce various X-factors necessary to complete the picture of quantum mechanics in order for it to comport with the evolution of complex system. For example, Rupert Sheldrake has a concept, where a tendency toward emergent complexity is driven by an X-factor that is a non-local field he calls the [*morphogenetic field*](https://www.sheldrake.org/research/morphic-resonance/introduction). It drives probabilities to be high that would turn out low if we applied QM in an ab inito fashion. It pulls things in the direction of complexity. Lovelock’s [Gaia hypothesis](https://en.wikipedia.org/wiki/Gaia_hypothesis) of an intelligent self-regulating biosphere is another example. The SSH generalizes this to extend beyond living systems and describes the process as being both language-theoretic and trans-spatiotemporal with its non-local *strange loop* feedback mechanism that acts as an attractor – an X-factor that would require a formal modification to QM (called post quantum mechanics), which does not possess this necessary X-factor.
* All meaning exists in a generalized language theoretic context. Accordingly, reality is a growing network of interactive languages spewing out subjective meaning recognized by the emergent intelligences of those systems. For example, at human level, we have our types of chosen meaning and related symbolic systems of thought. A plant might have another. A weather system yet another. Particle level systems yet another. Emergent generalized intelligence in complex systems defines everything in the universe as *intelligent* to one degree or another – all the way up to the intelligence of the panconscious substrate with its subjective choice to stretch the probabilities in a very economical way toward its emergent self so that more of itself can emerge/evolve with less of itself as a resource.
* Quantum information theoretic models, based on a quantum form of Shannon information, are realistic. As such, they serve as evidence of the universe’s interest in information efficiency.
* That above bullet point combined with the widely agreed upon *complexity arrow of time* is evidence that the universe is acting according to the PEL. See[*Complexity and the Arrow of Time*](https://ndpr.nd.edu/reviews/complexity-and-the-arrow-of-time/).
* Quantum mechanics allows the observed complexity to be achieved as an extremely small subset of the collective random walks that approximate the energy conserving efficiency of classic physics. Conversely, disorder can be achieved with an exponentially larger subset of the total collective random walks that are equally as energy or information efficient as the smaller subset that leads to complexity. Again, what is different about *emergence theory*, as compared to QM, is the X-factor – the new element of the strange loops discussed in the *self-simulation hypothesis* paper. It is the factor that causes reality to bootstrap itself upwards toward self-actualization through language-theoretic complexity but without compromising energy/information efficiency – simply choosing paths through the elements of the equally energetic efficient random walks paths that lead to complexity without compromising energy/information efficiency.
* My conjecture is that the intelligent universe chooses to do this on the C5C network of algebras because it can achieve its complexity with fewer units of information due to arguments eluded to in the rest of this document. I believe it is an exceptionally trit-efficient spinorial game formalism.
* The fractal language theoretic network in this X-factor, whether our strange loops or Tononi’s Φ measure of consciousness, is the reason why monoidal category theory may be a good framework to handle the abstraction of all of these syntactical systems of meaning in this beautiful idea of higher and lower languages interacting to make combinatoric languages that then interact to create new emergent meaning we call EC.
* The ultimate starting language is a string of 0s and 1s – the Fibonacci words (that must be formally converted to *Fang-trits* – via her discovery of the ternary system of the empire window formalism), which have various representations of, including: binary, numeric and geometric. These 1D codes interact with other 1D codes in 2D, 3D and 4D QC codes. We then use higher order ad hoc language systems as simple programs or rule sets, such as the ones defining empire-wave Clifford spinor systems in 3+1D.
* We have an unpublished operator idea that acts as a pixel of panconsciousness driving each Clifford spinor. It is called the *viewing vector*. See F. Fang or K. Irwin for explanation. In order for the PEL and emergence theory to work properly in this adversarial framework of the two forms of savings and the deep subjective idea of meaning, it may be necessary to consider this internal particle-level observer as having a primitive enough intelligence that it can take instructions from the panconsciousness and all the many layers of emergent consciousness that recognize meaning and complexity. From another viewpoint, it already is the panconsciousness in the same sense that we are. These viewing vectors drive the order within our sets by the subjective and collective choices of *attention*, weights and biases of ideal game rule systems. There would be a foundational set of rules and *attention* as conservation of game spinor states. And then there would be emergent levels of more subjective *attention* (objective) that different intelligent and no-so-intelligent subsystems have. This must somehow interact with our monoidal categorical tree of subjective knowledge/meaning. For new readers, the viewing vector is the action of the projective transform operators that will be discussed in this document.
* Clifford spinor cycle clock empire wave quasiparticles self-organize toward high complexity when the *language density* of a system is sufficiently high.
* *Language density*, like Tononi’s Φ magnitudes, is defined by the magnitude of meaning integration that is emergent from the networking or combinatorics of some system of high and low order languages and meaning. Rich meaning or *language density* allows the PEL to stretch high into the emergent information sky of the EC hierarchy – the X-factor. In a framework of subjective meaning, “magnitude” is a relative concept of ranking. We can say that the magnitude of the integrated meaning of “ironic humor” is greater than the non-integrated meaning of “ironic” and “humor”.
* When this occurs at a sufficiently high level, Clifford spinor cycle-clock empire-waves efficiently choose viewing vectors or set orderings and weights approximating a classic picture of their self-organization toward high complexity. “Efficiency” in that sentence means that it selects paths that conserve spin angular and ordinary momentum but select for the subsets in those energetically efficient sets that lead to higher strata of emergent meaning – the X-factor we call strange loops.
* The question above on why the universe would sometimes have subsections that reverse in complexity is answered thusly. The Clifford spinor simple program is, presumably, very efficient. So, the PEL favors it. But is this simple program paradigm one wherein the viewing vectors have a form of agency and collectively approximate, in a fuzzy manner or upon averaging, an emergent collaboration toward complexity? I think so. There is a metaphor to be used here called: Distributed computation or distributed thought/agency. If I’m correct, it will be one possible explanation for why a PEL universe would have subsections undergoing phases of complexity reduction. It’s the price the universe gladly pays to save an enormous amount of is resource by having an unchanging *attention* (in the context of machine learning) to always prefer members of the set of ordered and weighted sets that are approximately equal to the energy/information efficient classic path approximations. The beauty of it is that the quantity of approximately classic paths is equal to the quantity of evolutions in Everett’s many worlds. The vast majority of the many worlds do not lead to complexity. Nonetheless, an enormous quantity do. It’s just that a far larger majority lead to a universe without a complexity arrow of time. This implies that the PEL universe is enjoying the ability to “have its lunch and eat it too”. That is, it gets the “free lunch” of complexity without comprising on its objective to conserve information. It conserves the primitive thoughts of mathematical self-referential symbolism (and its representations) in order to get more “free” or information-conserving emergent complex systems thought. This letter-level information conserving behavior means it must accept arriving at its complexity goals via averaging over time. It must allow some systems to reverse in complexity if there is not sufficiently strong strange loops pulling complexity forward for those subsystems or where the subsystems themselves do not have enough complexity in atomic species types and ratios. Allowing the Clifford spinors to play out with the viewing vectors is a form of distributed action that may be PEL efficient in the grand scheme of things in this universe that is empirically averaging along the vector of the complexity arrow of time.

Many machine learning models are programmed to progressively ascend up hierarchical meaning trees. Ergo, this concept is not just theoretical. Early-stage examples, such as ChatGPT and PaLM, are case studies showing that simple programs can have emergent creativity and simulated intention that evolves complexity. GPT-4 will take things to a new level in the near future . These AI systems have a form artificial intention toward an objective of high creative meaning and complexity. Over multiple tries to perfect some intended goal of meaning, they probabilistically achieve increasing levels of creativity and meaning. In some sense, they “ratchet” upwards in resolution of complexity and creativity. The PEL is an ad hoc choice of the universe to keep experimenting to progressively guide itself to climb as high up the emergent meaning hierarchy as possible – but always with an intention to conserve “energy” = letter-level information and to maximize the sum of spinor propagation through game time and game distance, which forms a game conservation of spinor states for as long as possible. In machine learning examples, different runs do better and worse, but they can keep ratcheting upwards in terms of hitting their programmed rewards when a suitable complexity goal is achieved. At a simplified level, the PEL says reality climbs upwards in complexity of meaning and tries to do so as economically as possible. The consensus viewpoint is finally at a level where most of humanity believes (1) digital consciousness and (2) simulated digital realities are possible. *Emergence theory* is a model wherein it agrees with the consensus view but claims that reality is digital versus the idea that there is one “real” reality that is not digital and in which we are unlucky enough to be on one of the many supposed digital simulations. And, importantly, that it does so with a committed aim toward information economization relative to a given magnitude of EP and EC complexity. It wants to get as much meaning as possible for its careful use of bit/trit money = viewing vector decision/actions or some other primitive notion of an information theoretic conserved quantity.

Part of what makes this system in *emergence theory* economical is the algebraic compactness of the C5C network, where this digital reality plays out. A few fundamental spinorial game quasiparticle types, as function classes, each have different classes of empire wave fine structure that allows them to interact with other empire waves in functionals to produce limitless complexity of spatiotemporal patterns, from which emerge limitless complexity of abstract thought in the ECn hierarchy. The *emergence theory* paradigm is a form of *beyond-quantum mechanics* in digital form, where subjective language and meaning trees emerge economically and where the “beyond” term is the emergent X-factor discussed that selects for tiny subspaces through the classic approximation probabilities of ordinary QM.

Because I will not cover this below math in the rest of the document, here is something about the basic building blocks, which are the 1D subsystems that composite to our 3+1D Clifford spinor arrays. They cannot be represented as zeros and ones alone. At each level of the Fibonacci chain at some power of the golden ratio (that we can set to zero) we have the infinite power series in both the positive and negative direction. And games can play out in this 3D network of 1D networks that map to the 8D octonionic spinor array. So, the selection of a point needs more information than a bit, since we have to know what integer power of the golden ratio power series its 1D code is at. As a point in a Fibonacci chain 1D QC, we have to know what power that chain is on the golden ratio power series. We also need to know where that point is in our R8 spinor array or integral octonionic coordinate space. In our 8D crystallographic space, the golden ratio power series maps to a system of integral power series.

A game universe bounded by its own resource limitation would have to work within some bandwidth of these integral and golden powers of the 8D and 3D scaling series. From what we know about quantum mechanics, leading to the Planck length, and the most popular agreement of the size of the universe, it appears that we have a game-universe operating on 61 orders of magnitude of the Planck length. The PEL universe is concerned with efficiency, which implies that possible PEL universes are finite but *reaching toward the infinite*. Put differently, we see evidence in quantum thermodynamics and other conservation laws that the universe is worried about economy. However, if the universal panconsciousness were infinite, there would not be as logical a motivation for it to be efficient. Accordingly, the PEL is grounded in the philosophy of a finite universe eternally reaching toward the infinite. Complexity, knowledge, creativity and insight can always evolve. The universal panconsciousness substrate, the thing we called “God” at the beginning of this document, is eternally evolving toward the infinite though its digital self-simulation, where the digital information itself is the irreducibly simple form of primordial thought.

**WEIGHTS AND BIASES ACCORDING TO THE PEL**

Recall the “*thought = language in motion*” concept above. The PEL implies that a given subsystem of the universal meaning hierarchy of the SSH will frequently adjust its weights and biases in order to satisfy its own objective of stretching upwards on the subjective EC hierarchy. This is more than an attempt at coopting two terms from modern machine learning. Biases, in a human neural net context, can be seen as things we choose to select for as meaning. And weights are the level of importance we place on those choices. Every complex system has a generalized form of weights and biases. Very intelligent complex systems, such as a society or a single human, can adjust both at will. For example, a creative opinion will form about the desired meaning, beauty or purpose of a given goal toward some form of complex thought. And the weights and biases will adjust accordingly. We understand a decent amount of neural science as it relates to consciousness. And we understood a bit about the potential for digital neural networks inspired by such biological neural nets. Recently, we see synthetic systems based on biological meaning and language start to rewrite their own weight and bias updates, make fundamental code updates, surpass human creativity and become so creatively conversational they now pass Turing tests. The machine learning term *Attention* refers to the ability of a machine to focus on a particular task or input and to ignore other stimuli. It is a type of cognitive ability that is closely related to memory and decision-making. It allows the system to efficiently process information and make decisions based on the data it has collected.

Those 2022 milestones serve as circumstantial evidence for the *self-simulation hypothesis* and bolster the now consensus view that, in principle, reality and consciousness can be digitally simulated. My personal evidence that the PEL is true is that I am thinking right now. Against all quantum mechanical odds, here I am… thinking. One can speculate that, given virtually infinite computational power and having extremely precise initial condition knowledge, that the QM formalism could spell out realistic probabilities for me to be thinking or for life to exist. But that would be a sweeping philosophical guess. The founders of QM intended it to spell out the probabilities for particle behavior in a context without gravity. I doubt they would claim their discovery was one that gives realistic probabilities for freewill or ultra-high complexity to occur. As mentioned, many authors have more rigorously put forth arguments on why an X-factor would be needed to upgrade QM to be probabilistically realistic with respect to the complexity arrow of time. Consider a non-exaggerated example of how improbable it is that life and the complexity arrow of time to occur. Let us use 10-500 as the probability if QM could be used literally to compute this probability after being given Planck scale initial conditions about 1 Planck moment after the big bang. One can simply say, “Well, it’s possible” it could predict life to have a more realistic probably that is far greater than 10-500. True, maybe it would, and we cannot say for sure without an ab initio computation. And if we throw 100 pennies in the air and they all land heads up, the probability is about ½100 or less probable than randomly selecting a specific atom out of the 1080 atoms in the universe. A good scientist should seek other explanations, such as the pennies having heads on both sides or someone cheating or just about any other theory besides, “Well, it’s possible. So, that’s the theoretical explanation for how it happened”. Quantum mechanics is simply incomplete, as many today believe and Einstein argued. Obviously, life cannot have formed without advancing from a hydrogen only universe to a universe of 100 or so atomic elements from which it is then possible for biomolecules to self-organize. And that could not have occurred without gravity no would planets and biospheres. Without gravity, QM incomplete. Of course, the term “incomplete” in this context generally refers to the idea of hidden variables. We do believe QM must be upgraded to include the X-factor of our strange loops, which are indeed a hidden variable based on non-locality and complexity theory. But, even without this issue of incompleteness being considered, QM is not a realistic theory in a universe that includes gravity.

Returning to machine learning, the concept of weights and biases refers to the parameters of a model that are used to make predictions and decisions. In the case of spoken language, it could be thought of as the way an individual adjusts their language use in order to effectively convey their intended meaning. The idea of continually updating weights and biases in order to meet evolving meaning and language efficiency objectives could be thought of as the process of learning and adapting one's language use over time. It seems that a PEL universe based on the SSH should be flexible and adjust in a similar manner. If it turns out that we see biologically inspired deep neural nets becoming progressively more creative and conscious seeming and being able to do on-the-fly generative AI of realistic VR worlds plugged into our minds via some next-gen version of Musk’s *Neuralink*, perhaps this thesis that natural language and neural nets are what define reality itself will achieve more gravitas in the coming years.

**GAMBOARD**

**8+1D Division Algebraic and Rotation Group**

**Algorithmic Games Playing on a Mathematical**

**Gameboard called the 8+1D Spinor Array**

Before we get into the function or *game* section of this document, we will build up more understanding of the mathematical *gameboard*. Most of what I’ll write is about motivation for this or that object. Clifford spinor operations play out on the C5C spinor array of equivalencies, representations and transformations. We call them *cycle clocks* because, like clocks, their cycles can be counted over some quantity of Clifford rotor = Clifford spinor. As explained, these spinors are decompositions of the division algebraic sub-symmetries of the E8 root lattice to form an 8+1D spinor array, where it goes from a crystal array of spinors to a “golden” aperiodic array in the transform to 3+1D, where the empire rules playout. Accordingly, this group theoretic decomposition focuses on the spinorial interaction of the four division algebras and a powerful 8+1D 🡪 3+1D transform product called the Fibonacci icosagrid, which generates additional objects not included in the 8+1D pre-transform. These transforms can be thought of as what Marcin Nowakowski might call an “internal observer”, which refers a microscopic observer. He might characterize them as a form of primordial observation that is different from the measurements humans do. QGR calls these internal cycle-clock generators or “observations” *viewing vectors* because they are making specific mathematical transformations of objects at a certain distance and direction – namely the palindromic CEs discussed herein. Indeed, these are a generalized form of panconsciousness mathematical observation/measurement that generate new mathematical physical meaning in the form of (1) quasicrystal codes, (2) additional binary sign values, (3) non-locality of *empires*, (4) various physically useful algebras not implied in the pre-transformed object, (5) numerical “pixels” of curvature equivalency in the form of torsion, (6) knots and (7) lower dimensional compactness of informational representation, along with other objects. Because this extra math is used in rule systems to define the probability spreads or “game-physics” generated by our simple program space, the transformations themselves create game physicality. We will discuss these 3+1D spinors in a later section.

Some of our physical motivation was stated well by Frank Wilczek, who proposed the necessity for a microscopic abstract mathematical observer that comports with quantum mechanics. In his words, “…a recognizable character of conscious awareness within the framework of quantum mechanics”. Roger Penrose also proposed why consciousness must be a fundamental aspect of the universe not reducible to physical processes. Like Wigner and von Neumann, he argues how consciousness is foundational to quantum mechanics and the laws of physics. Specifically, the general idea of these authors is that that consciousness collapses the wave function in the process of quantum measurement. Beyond the measurement process, Penrose argues that the phenomenon of consciousness may be closely connected to the structure of the universe at the most fundamental Planck level, and that it may be related to certain features of the physical world that are not currently understood. That is, he stipulates that consciousness is related to the structure of spacetime in a theory of quantum gravity that is not yet understood.

The C5C network offers new perspectives on division algebraic group-theoretic spinors, which may have utility in certain simple program-based discrete quantum field theoretic unification models. Here are some of the mathematical categories and objects to be expanded upon in the C5C network project. Daniele and other QGR staff and associates working on C5C should use this entire document, and bullet point like below, as a “check list” to methodically turn into questions for me about meaning. Obviously, this document is cursory and focuses more on motivations and circumstantial arguments on using this or that math or simple program. This is not a document to fully explain things. For example, number theory is on the checklist for people working on C5C. But I do not explain much about how our why. You must seek discussion time with me to methodically convert the ideas presented herein to math projects to be distributed to a broader team of C5C mathematicians.

* Maximal sphere packings in dimensions 1, 2, 3, 4 and 8.
* Discrete division algebras
* Representation theory
* Discrete Clifford algebras
* Spatial graph theory, i.e., graph drawing theory
* Group theory
* Set theory
* Category theory
* Quasicrystal mathematics
* Code theory including mathematical codes, such as quasicrystals, and natural languages
* The paradigm of simple programs, called *games*, that run functions on mathematical substrates, called *gameboards*
* Number theory
* N-adic mathematics
* Hopf fiber theory
* Sphere packing problems

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**THE 8+1D GAMEBOARD:** We start our *gameboard & games* picture with the construction of our gameboard as an 8+1D array of spinors. The PEL demands an emphasis on efficiency. Limits often afford power akin to efficiency. Using simple mathematical techniques, they allow us to study the behavior of functions as their inputs approach certain values – even if the functions are not defined at those points.

Because we have reason to believe functional games, and eventually realistic physics, can be symbolized economically by exploiting the principles of limits and discretization, we work with the following related set of four limits that contain an embedding of all four division algebras and their discretization via the limits of four embedded lower dimensional maximally dense sphere packings:

1. The largest exceptional Lie group
2. The densest packing of 7-spheres in R8
3. The highest rank division algebra, the octonions
4. A “minimal” finite discrete Hopf fibering representation of the 7-spheres. “Minimal” in this context refers the minimal quantity of fibers on an n-sphere necessary to recover some chosen rotational symmetry group associated with the root lattices that are defined by the kissing points in n-sphere packings. For example, we can create a Hoph fibration of an infinity of S3s on S7, where we will not recover the binary icosahedral group or any discrete rotational symmetry group. We place 5 + 5 instances, as the minimal limit, of S3 on S7 to generate a double cover of the binary icosahedral group.

To represent these four limits, we use a point set in R8 defined equally as (1) the vertices of the E8 root lattice, (2) the kissing points of 7-spheres in their densest 8D configuration and (3) a discretization of the octonionic plane, wherein we decorate these points with numbers to form an octonionic coordinate space. We will sometimes refer to this point set as “E8” for the sake of brevity and not specifically imply the Lie algebra or group.

**THE DIVISION ALGEBRAIC GROUP STRUCTURE OF THE GAMEBOARD:** Because the densest packing of 8D balls in R8 has the kissing number 240, the root vector polytope of the point set is the convex hull of the Gosset polytope 421. While that polytope has edges, we delete them and focus on it as a non-connected point set that we can do various graph drawings on to create edges relative to our four division algebraic subspaces of E8. Specifically, the set of 240 points connected as the Gosset 421 polytope has 6,720 edges that define a system of dihedral angles, such as the dihedral angels of the n-simplex series span from the 1-simples to the 8-simplex. This leads to the full Weyl group for E8, but we are interested only in the 1D, 2D, 4D and 8D maximal sphere packing geometries that comport with the n-dimensional planes of the four division algebras. Accordingly, we have no need for the edges relative to all of the sub-lattices and root polytopes embedded in the fully connected E8 root lattice, which would otherwise generate the full Weyl group. Furthermore, we are using graph theory to define our spinors in the first place. This means we need to do graph updates on the point set to define a selected orientation of a 24-cell within the 24C 10C.

**NOTE:** Throughout this document, I mention 24-cells and compounds of 24-cells, such as the 24C 10C. However, this is not entirely accurate. A 24-cell projects to a cuboctahedron and some points internal to its bulk. We do not use cubocahedra in the transforms to our 3+1D spinor array. We use 4-groups that contain points on and within the convex hull of a cuboctahedron. The 4G has 12 edges vs the 24 edges of a cuboctahedron. In fact, it is the option of which edges can be the 12 of 24 that are missing which is part of what defines the right and left chirality of our 20Gs (a ball of 20 tetrahedra with a certain relative rotational angle). Furthermore, a 24-cell does not have a point at its centroid. The 4Gs do. The C5C team must clarify exactly what graph drawing to do on the 24-1 points on one of these 24-cell convex hulls. This is because we need the edges to project down to become the 12 internal and 12 external edges for a given right or left-handed 4G in the 3D transformation.

**QUATERNIONIC SUBSPACE:** In E8, every point has 240 points equidistant to it that can be decomposed into a set of 5 + 5 convex hulls of the root polytope of the D4 root lattice. The D4 root lattice is believed to be the densest packing of 4D balls or 3-spheres in R4. The kissing number is 24 and the root polytope, called the 24-cell, has 24 vertices equidistant from its centroid. 10 of these 24-cells convex hulls, each with a unique orientation, cover the 240 points of the E8 root polytope. The 10 come in 5 pairs of 24-cell convex hulls (a phase meant to imply it has no edges) that are perpendicular to one another. We call these *perpendicular pairs* or “PPs”. And we can call each member of each PP an “A” element or “B” element, such that each PP contains one A and one B element. If we study the Clifford spinors that can cycle to closure on either the A set of 5 or the B set of 5, we recover the binary icosahedral group. The sum of permutations of the A and B groups is 120 + 120 = 240, as a double cover of the binary icosahedral group, 2I. We can recognize that each set of 240 points lives on the surface of a 7-sphere in this densest packing of such spheres in R8. Accordingly, each of the 3-spheres circumscribing the 24-cells’ points on the surface of each S7 is a Hopf fiber and great 3-sphere.

Thus far, we have described a dense countable infinity of points in R8. Each is the centroid of a 7-sphere with a radius of √2 (for algebraic reasons we will not digress on) with 240 other points on its surface, each of which is also the centroid of another 7-sphere. Unless we have a reason not to do so, we can set the edge lengths to 1, so that our values in the 3D transform have shorter analytical expressions.

**NOTE:** Earlier in this document, we set the length to 1. C5C mathematicians should advise on whether, for our spin spinor game purposes, we can set it to unit length or if we need to set it to its algebraically implied √2 vector magnitude. Using a graph theory term for spatial graphs, called *graph drawings*, we can graph-connect these sets of 24 points to form a compound of ten uniquely oriented objects with edges that have 24-cell convex hulls (but are not 24-cells) that we shall call herein the “24C 10C”. A 24-cell does not project to a 4G. We must add edges to the bulk of the 24-cell and remove certain edges from the convex hull in order to project to a 4G. This is a task for the C5C team to accomplish. So, we have an infinite quantity of 24C 10Cs periodically arrayed in R8, where each has ten S3s fibering the S7s circumscribing each 24C 10C. And, we have a total of 120 + 120 cyclic permutations of Clifford spinors that can cycle on each. In a given set of 120, we have two icosahedral groups, each with 60 + 60 elements representing mirror direction pairs, such as ABCDE and EDCBA in terms of cycle directions. That is, a given rotation cycle has an opposite directional element on the other half of the 60 + 60 = icosahedral group. Using graph theoretic terms, we can see that each of the 60 elements, as Clifford spinors cycling to closure, is a directed graph drawing, wherein we extrude the drawings over the time domain into an ordered set of 5 graph updates to define the concept of spinor direction.

Accordingly, our spinors must have a binary sign value of direction A or direction B placed upon them in our spinorial formalism.

Just as we associated our 8D point set with four limits and turned it into a discrete integral octonionic plane, we can recognize that our 24-cells, that each belong to an infinite D4 root lattice, are discrete integral quaternionic planes; Hurwitz integer planes. Each of those planes has a different R4 orientation, within R8, relative to the other 9. And each is affine extended out into R8 such that we see the 8D pointset as being composed of 10 parallel plane classes of these discrete 4-planes of Hurwitz integer coordinate spaces. Herein, we shall use the term “PPC” for *parallel plane class*. We are cycling our integral quaternion associated 24-cells on our integral octonion associated 24-cell 10Cs to composite, over 5 steps, to a discrete Clifford spinor or sequence of 5 spinor operations. With some form of interaction rules, we would be able to recognize this as an 8+1D spinor array.

Let us build an algorithm with what we have described so far.

1. Let C be the set of five 24-cells circumscribed by 3-spheres as fibers on a 7-sphere, each with a unique orientation and sharing the same centroid.
2. Choose an element c\_1 in C as the starting point.
3. Using a Clifford spinor, S, in the algebra Cl8, set c\_2 = S \* c\_1.
4. Repeat the following steps for i = 3 to 5:

* Choose an element c\_i in C such that c\_i is not equal to any of the previous elements c\_1, ..., c\_{i-1}.
* Set c\_{i+1} = S \* c\_i.

1. Set c\_6 = c\_1.
2. Repeat the Clifford spinor cycle N times.

Next, let us extend our function to include the remaining two division algebras in their discrete forms as coordinate spaces on maximal sphere packing point sets so that we can exploit their discrete rotational groups. The densest sphere packing in R2 has a kissing number of 6 and is defined by the A2 Lie algebra root lattice. The root polytope is a point with 6 points equidistant to it forming a hexagon segmented into six 2-simplexes. The convex hull of the 24C 10C can be constructed from 40 of these hexagons, leading to the understanding of the E8 point set as a composite of 40 affine extended PPCs of these A2 planes. Nonetheless, we will not use this minimal quantity and will instead use the fully symmetric set of 12 mentioned earlier in this document.

We convert each to an Eisenstein plane of integral complex numbers, such that we have 12 discrete complex planes living in each of our 10 discrete quaternionic planes living in our discrete octonionic plane. Accordingly, we have 120 PPCs of discrete complex planes compounding to form our integral octonionic plane. These hexagons and triangles are circumscribed by 1-spheres, as S1 Hopf fibers on the S3s that circumscribe our 24-cell convex hulls.

Of course, each of these periodic point sets is fractal because they possess integral scaling. Allowing our √2 roots to bet set to 1. Let us select a hexagon in this lattice at a scale of 2, such that we have a circle on our complex Eisenstein integer coordinate plane with six scale-2 24C 10Cs evenly spaced on it at the hexagonal vertices of the A2 lattice. Let us take three of these, which form a 2-simplex, and advance on it in some direction for each step of any of our 120 + 120 5-cycle Clifford spinors described above. When the cycle of five is completed, this updated algorithm has also completed 5/3 cycles on the 2 radius triangle on this Eisenstein plane. Other 2D spinors besides the 3-cycle one can be explored. The groups of the hexagon include, but are not limited to, the cyclic groups C6 and C3, along with the Klein four-group. Next, let us complete our R, C, H, O family of division algebra inspired discrete cyclic group Clifford spinors with the addition of the R component bolted onto our growing algorithm.

Consider three parallel triangles evenly spaced and centered on a line running perpendicular to them, as an axes. We can start on one at either end of the line and select one of the three vertices. We then advance to the next triangle and choose one of the vertices not inline with the vertex on the first triangle. Finally, we advance to the last triangle and choose the only vertex not inline with either of the first two choices. This is the same concept we used to advance our selections of 24-cells in its 5-cycle on the triangle. Now we can finalize our algorithm to include an advance to a new parallel Eisenstein plane and, therefore, to a new triangle or hexagon for each step of 24-cell orientation change in our 5-cycle. The 1D path of advancing on the parallel Eisenstein planes is along a discretization of the integers, ℤ, as a decoration and coordinate space on the embedded A1 lattices living in the E8 point set. These discrete 1D steps on A1 are instances of S0 Hopf fibers on our instances of S1s Hopf fibers of our S3s that are Hopf fibers of S7s. We have now given an explicit construction of a discrete Clifford spinor playing out in a Hopf fiber theoretic, division algebraic and discrete rotational group theoretic context.

As will be discussed later, we discovered a simple program based on this 8D point set that generates probability spreads for evolutions of quasiparticle interactions. The 8+1D Clifford spinors take on remarkable and powerful new mathematical qualities under a transformation to a certain 3+1D representation. One of these mathematical qualities, as will be discussed, is that stereographic projection makes them Hopfions or Hopfion-like, which affords opportunity to build up to discrete Dirac spinor-like and potentially even discrete twistor-like objects.

Back to the completion of the 8+1D Clifford spinor. The full set of 5 graph updates or Clifford rotor actions of this Clifford spinor is an ordered set of packages of 24 octonions. A single octonion is selected in each element of the ordered set, called the 25th coordinate at the centroid of a 24C 10C. This is a palindromic object, which is discussed elsewhere in this document and is an important concept for the C5C team to discuss with Ray and myself. Then, one of five possible packages of 24 other octonionic coordinates around it are selected for each of the 5 steps to form the directed graph ordered set for the spinor at rest in 8D. That is, we are working with 5 possible orientations of 24-cell because we are using only the A or B orientation elements of the 5 PPs). For the real and complex parts in the more complicated algorithm that is not a spinor at rest, we can use either Clifford translators or reflectors to advance on the single “25th centroid point” octonion coordinates that advance us on our R and C division algebraic planes.

**NOTE:** I’m interested in talking with C5C mathematicians about not using Clifford translators for this and instead using an all-rotor formalism. For example, we can use a 2D Clifford rotor/spinor to advance on a triangle or hexagon at rest. And when we need to advance it on an R1 subspace of R8, we can also use a 2D rotor on a different axis than the one for the cycling on a triangle or hexagon at rest.

**Inverse Duality of D4 and A4 Decompositions**

**of the E8 Discrete Octonionic Plane**

The A4 root lattice is a sub-lattice of E8. It can be described as a symmetric compound of 10 parallel classes of the A2 root lattice. We convert each lattice in each of those 10 PPCs to Eisenstein integer discrete complex planes. Next, we find that the D4 root lattice is a symmetric compound of 12 parallel classes of A2. Just as we cycled our 4D quaternion objects (H) in 8D, we can cycle our 2D complex objects (C) in each of those 4D objects while the 4D objects are cycling in 8D (O). In other words, we have a complex cycle (C) of 12 A2 orientations on each of 10 D4 orientations of discrete quaternionic spaces (H) living in one octonionic (O) “mother lattice” space. And we have a different complex cycle (C) of 10 A2 orientations on each of 12 A4 orientations living in the same mother octonionic space. Both cases come to closure at the binary icosahedral group number of 120. One case is 10(12) and the other case is 12(10) an *inverse duality*. The complex Eisenstein plane cycles on the A4 decomposition of E8 via 10 complex planes x 12 quaternionic planes = 120, while the complex Eisenstein plane cycles on the D4 decomposition of E8 are 12 complex planes x 10 quaternionic planes = 120. Importantly, the 10 and 12 A2 planes are unique such that we have a 10 + 12 = 22 decomposition to explore.

E8 = 10 D4 + 12 A4

D4 = 12 A2

A4 = 10 A2

where E8, decorated with (O) and D4 and A4 are decorated with Hurwitz integers and the A2 root lattices are decorated with Eisenstein integers. This decomposition allows us to study the connections between the various algebraic and symmetry structures, such as the binary icosahedral group, in greater detail.

**Maximal Sphere Packings, Groups and Representation Theory**

Our four division algebraic planes are all maximal sphere packings (D4 is believed to be maximally dense). Maximally dense packings of non-intersecting, identical spheres are mathematical objects of great interest due to their connections to various algebraic structures, such as root lattices of Lie algebras. As Conway (1998) and others have demonstrated, these sphere packings have applications in a variety of fields, including geometry, number theory, modular forms, finite simple groups and string theory, to name a few.

We will discuss five maximal sphere packings and a certain transform object called the FIG. The five packings generate the point sets of the A1 root lattice in one dimension (the trivial case), the A2 root lattice in two dimensions, the A3 root lattice in three dimensions, the D4 root lattice in four dimensions and the E8 root lattice in eight dimensions. The maximal sphere packings in one, two, four and eight dimensions correspond to the division algebras. However, the A3 lattice in three dimensions does not. Nonetheless, 3D is a special dimension because it is the spatial dimensionality of physics and is the only dimension where 1D knots and related braid objects can exist. Our transform object, where game physics plays out, is the 3+1D FIG, which faithfully represents our 8+1D Clifford spinor actions integrating the real, complex and quaternionic structures within the octonionic structure of the E8 root lattice. As mentioned, we call these dynamical division algebraic and group theoretic spinorial objects *cycle clocks*.

One important property of maximal sphere packings is their denseness, which refers to the fraction of space occupied by the spheres in the packing. The number of spheres that can "kiss" or touch a given sphere in a particular packing configuration determines the valence rank of the root vector polytope of the corresponding lattice. In network theory, the average valence rank of a network with N nodes typically indicates the strength of the network. In vector space algebras, the valence rank of the root polytope typically corresponds to the rank of the algebra, which can be understood as the number of subalgebras contained within the structure of a given vector space algebra. For instance, the E8 root lattice, associated with the largest exceptional Lie group, contains the simpler Z8, A8 and D8 root lattices within its structure.

1D and 2D, as A1 and A2, are trivial and well known as the densest sphere packings. The densest packing of spheres in three-dimensional Euclidean space (proven by Hales) generates the point set of the A3 = D3 Lie algebra root lattice. In four dimensions, the D4 root lattice is widely believed to be the densest sphere packing, while in eight dimensions, the E8 root lattice has been proven to be the densest (proven by Viazovska). In addition to their connections to lattice theory, maximal sphere packings also have connections to other areas of mathematics, such as group theory and representation theory. These connections arise from the symmetries of the sphere packings, which can be described using group-theoretic concepts such as rotations on point groups and space groups. Representation theory, on the other hand, provides a way to study the symmetries of sphere packings using linear algebra and operator theory. Overall, the study of maximal sphere packings is a rich area of research, with connections to a wide range of mathematical and physical concepts.

If nature were based on ideally powerful mathematics, under *the principle of least computational action* (Numrich) or the *principle of efficient language* (Irwin), 8D and 24D are two outstanding mathematical objects. Both dimensions have proofs of maximal sphere packings (E8 for 8D and the Leech lattice for 24D). More importantly, they have been proven to be “exceptionally” dense and symmetric, wherein their packing density fractions are discontinuous “jumps” on the logarithmic density change for the packings of maximal known densities for the dimensions before and after each. To appreciate why we have this “exceptionally” dense jump in 8D and 24D, consider the D8 root lattice vertices. They are the kissing points of 7-spheres in R8 that are packed in a manner that is denser than the 8-cube lattice or the lattice associated with A8. Remarkably, the holes in this already dense D8 packing of hyperspheres perfectly fit a second translated copy of the same dense D8 packing, resulting in the extraordinary and maximally dense E8 sphere packing. A symmetric construction of PPCs of the E8 point set composite to form the maximally dense 24D packing point set.

**NOTE:** For those who will work on C5C, please formalize, the fact that the E8 point set contains these two D8 lattices, where there is some unknown ratio of the “A” class and “B” class of the two mutually self-embedded D8 lattices. We know the ratio is not 1:1. This means there is an interesting asymmetry in the 24C 10C and the transform mapping to the 4G 10C in 3D.

In summary, we work with four maximal sphere packings associated with the division algebras and their associated groups:

* The A1 lattice, which corresponds to the maximum sphere packing in 1D, is associated with the Lie group R and the integers, Z.
* The A2 lattice, corresponding to the maximum sphere packing in 2D, is associated with the Lie group SU(3) and integral complex numbers, Eisenstein integers. G2 may play a crucial role here.
* The D4 lattice, corresponding to the maximum sphere packing in 4D, is associated with the Lie group SO(8) and integral quaternions, a subset of the Hurwitz integers.
* The E8 lattice, corresponding to the maximum sphere packing in 8D, is associated with the Lie group SO16 and the integral octonions.

These groups can be manipulated to recover the standard model of particle physics gauge group SU3 x SU2 x U1. While these groups are continuous, we believe the group theory of reality is discrete. In any event, our spinorial group theoretic simple program and game-physics is certainly discrete. While Lie groups in physics generally correspond to the popular ontology of continuous physics, our digital physics approach is to work with discrete rotations as graph updates expressing the meaning of one discrete object “going to” another discrete object.

**CONJECTURE:** Maximal sphere packing point sets, when maximal density is crystallographic, are always composites of lower dimensional maximal sphere packing point sets, where they are periodic. This is certainly the case for the dimensions we work with and all known dimensions with proofs of maximal density: D = 2, 3, 8 and 24. The D4 root lattice, believed to be the point set of the densest packing in 4D, fits with this conjecture because it can be composited to form the 8D and 24D maximal sphere packing density point sets. And it is also a composite of the 2D and 3D maximal sphere packing point sets.

If we want to enjoy a symmetry argument, where we identify edges, we can recognize that there are three parallel classes of the A1 lattice that composite to form the 6-fold symmetry of the A2 root lattice and its root polytope, the hexagon. Similarly, the A3 root lattice, which is the maximal sphere packing in three dimensions, can be “symmetrically constructed”, according to that explanation, as a composite of four PPCs of A2 root lattices.

The D4 root lattice can be constructed as a composite of A3 root lattices. Specifically, twelve parallel classes of the A3 root lattice symmetrically generate the point set of the D4 root lattice. The E8 root lattice point set, which is generated by the kissing points of the maximal packing of 7-spheres, can be constructed as a composite 10 PPCs of the D4 root lattice. And the same number, 12, is the quantity of A2 lattice PPCs that symmetrically composite to form the D4 root lattice, while 4 PPCs will composite it non-symmetrically.

Overall, the construction of higher dimensional mathematical objects as composites of lower dimensional objects is a useful way to understand and analyze discrete rotational group sub- symmetries and relationships between these objects. These discrete cyclic symmetry groups correlated to the division algebraic number planes are the foundational *North Star* guiding QGR’s exploration of the 8+1D and 3+1D Clifford spinor arrays.

Finally, it seems that representation theory should be one of the “nodes” of the C5C network because it is a branch of mathematics that studies how groups of symmetries can be represented as transformations on vector spaces. It’s such a fundamental area of mathematics for physics and computer science.

**GAMES**

**Algorithmic Games Playing on a Mathematical**

**Gameboard called the 3+1D Spinor Network**

**SUMMARY:** Our game space is composed of 8+1D Clifford spinors, which do not possess non-local structure. Upon transformation to 3+1 dimensions, these spinors give rise to non-local mathematical rays or “arms” known as *empires*. These empires extend out from the spinors and, collectively, lead to the emergence of a topological probability fluid, in which interactions and evolutions are governed by a set of rules that create a form of savings through the exploitation of the non-local empires. The fluidic claim is a conjecture that will be elaborated on later in this document. In topology, a non-local property is a property of a topological space that is not strictly determined by the local topological structure of the space. The time-domain interpolation of these spinorial quasiparticles is referred to as *empire waves*. These empire waves interfere with each other to produce various phases within the probability fluid. The 3+1D Clifford spinor quasiparticles are driven by functions that define their structural variances, which are called *intrinsic state variables* (ISVs). A given ISV’ 🡪 a function f’. They interact with the ISVs of other spinors to form *relational state variables* (RSVs), each with a different *savings* value. Any system of two or more spinors possesses a spread of RSVs, each a different interaction evolution, where high savings are associated with high probabilities. The RSV itself is described by a function composition. Function composition is a mathematical operation that combines two or more functions to create a new function. In function composition, the output of one function is used as the input of another function, and the resulting function is the composite of the two original functions. The composite function can be written as the composition of the original functions, using the notation "f(g(x))" to denote that the function g is applied to the input x first, followed by the function f. For example, if we have two functions f(x) and g(x), we can create a composite function h(x) by defining h(x) = f(g(x)). This tells us that the function h is the composite of the functions f and g, and that it can be obtained by applying the function g to the input x first, and then applying the function f to the resulting output.

This is sometimes referred to as a functional, although this term is more commonly used to describe a type of mathematical object that associates a scalar output with each element of a vector space, which seems to be relevant to what we’re doing. In this context, a functional is a function that can map elements of a vector space to real, complex, quaternionic or octonionic numbers, and it is often denoted using the uppercase symbol "F" with an argument written as a subscript, such as "Fx" to denote the functional evaluated at the element x. So, we have these ISVs associated with functions. And we have RSVs of two or more ISVs that we’ll call functionals, herein.

The probability spreads within this network of quasiparticle functions, given some initial-condition functional describing their RSVs, are deterministic. However, measurements reset the initial conditions, resulting in new determined probability spreads. Our notion of measurement will be quite simple. It’s called “probability lensing”, and I’ll relate it back and forth now with my interpretation of QM. When we observe something in QM, it takes a spread of probabilities for, say, position that has a peak in the spread that we’ll say has an amplitude, X, of concentration around some highest probability zone of coordinates. Using a lensing metaphor, consider a weak magnifying glass that concentrates rays from the sun onto a hot spot that is not very hot such that the lensing is not severe. The average magnitude of density over, say, a circle of some radius R is like our mentioned X. And it is centered at the highest point of photon concentration. If we take a stronger magnifying glass, we have an average magnitude > X over the same area. When we make an observation of position, we modify the probabilities thereafter for some short duration to be higher in probability density at the approximate position location than if we did not measure. And, of course, this collapses the function that generated the pre-observed spread of probabilities because the observation “lensed” the probabilities, which changes the evolution after the measurement, requiring a new more accurate function to replace the old “collapsed” function. The decision by an observing consciousness to measure and when, where and what to measure is not in any way predicted by the quantum formalism unless freewill is an illusion. The illusionary freewill hypothesis is a minority view in scientific circles. The measurement action is arbitrary and up to the fancy of the entity capable of measuring. Similarly, we will arbitrarily introduce ad hoc probability lensing into our future simulations to serve as a proxy for the physically realistic concept of measurement. Mathematically, we will simply modify a function to generate a different probability spread and call that a “simulated measurement”. And we will count the extra bits/trits necessary to update the function.

By way of repetition reinforcement, our game space is characterized by two adversarial forms of savings: The first is savings from allowing functions and functionals to remain unchanged for as long as possible. The idea is that resource requirements are needed to update functional parameters vs letting them continue iterating without modification. For our computer simulations, game measurements require additional floating point operations to replace one functional with another. An RSV functional is supposed to give a large set of ordered and weighted sets of palindromic CE orderings. Accordingly, replacing the functional maps to replacing one ordered and weighted set with a different one.

The second is the savings that results from overlap between points in one of the mathematical spaces, which determines the probability spreads between measurements. QGR staff will know what this means. Newer team members and associates should contact a QGR staff member for a technical explanation. It is complicated enough that it is a good idea that I leave readers to seek the information from us in a separate forum. Nonetheless, for now, it can be stated that function updates can be reduced to bits. The fewer updates, the fewer bits are used by the panconsciousness computational substrate. Similarly, the representation of points can be thought of as bits of information. In a trivial conceptual example, let us say we wanted to represent two different 2x2 periodic arrays of points. We can superimpose part of them on the plane such that one point from each array is superimposed on the other and requires only a single point to represent them both. Given some computer or other mind, the meaning or emergent representation can be “two 2x2 arrays of points”. That is, a scheme of inference or rule system would have to exist to capture that information or meaning, even though the quantity of points in the representation is 7 points vs 8 points. The meaning of all 8 points would be derived via a bit representation of only 7 points. At a human level, if someone is holding a plastic wireframe square, where their hand covers a small part of one corner, your neural net uses an inference function to achieve the exact same meaning of the square as if the hand were not blocking the corner of it.

These two competing forms of savings define the probabilities of evolution within this topological fluidic game physics space of interfering Clifford spinor empire waves. Because the empires are a product of the transformation from 8D to 3D, the quasiparticle probably spreads generated by games exploiting them, in turn, define the numerical representations in the 8+1D space of octonionic numbers that form large sets of weighted and ordered sets of integral number values.

[This](https://www.researchgate.net/publication/337844604_Empires_The_Nonlocal_Properties_of_Quasicrystals) link is to a QGR paper that explains empires. There is a class of empires and modified empires, which have the quality of the empire structure dropping in density with distance, like 1/r2. Some definitions and structural elements of our story will be necessary to start with. Our game particles are quasiparticles, which we define as an emergent pattern as the order within our weighted sets. The following is an example of an ordered set equal to the extrusion of order into the time domain. Consider a black and white TV that can produce a coherent quasiparticle pattern over time. We have an ordered set of 100 frozen frames, where only one pixel is white in any given frame. The animation over time of the ordered set generates the emergent information of an object coherently moving across the screen. Our discrete Clifford spinors, with empire arms in 3+1D, are a more mathematically advanced form of quasiparticle that are distinctly different than the TV monitor example. In that example, the particle was the black pixel in each frame. As discussed previously, the physical ontology that would relate to this is the standard view in QM, GR and Newtonian physics that “moments” exist, a defining characteristic of any physical notion of “time”.

In our distinctly different approach, we have a physics ontology that, in some sense, does not have “time”. This is because the our spinorial particles do not exist in a moment. They only exist over a sufficiently large quantity of pre-physical mathematical “moments” as elements of the ordered sets, which are typically in their form as QC pointsets, wherein the element that composites to become a game particle is the truncated palindromic CE object. The notion of the particle (quasiparticle), as a game-physical object, does not exist until a full rotation cycle of N Clifford rotors is complete. The non-physical object is the rotor operator and the pre-physical mathematical QCs. The physical object is ordered set over time, the spinor. Technically, a single rotor can be called a spinor. But it most complete at least one cycle to be defined as a quasiparticle. Again, as mentioned previously, if a propagating cycle clock were a 5-cycle version, there cannot be a precise position concept of the quasiparticle because it requires a sequence of five position changes and the rotors that sequence the orientations of our rotating object are extruded along helical paths for each step, such that a spinor is an object extended in “time” or existing only as the order in sufficiently large sets. This inherent game uncertainty of position is different than in QM, which allows for the notion of a precise position that is inaccessible to observes due to the Heisenberg uncertainty principle. In our formal way of discussing this, we would not use the term “uncertainty” because it is not a case of observational uncertainty. It is a case wherein the very definition of “moment” and “position of a particle” simply do not exist by construction.

The next element of our basic story is the paradigm of the one-electron universe. The concept was proposed by Wheeler and Feynman to illustrate the role of the observer in quantum mechanics. They imagined a universe that contained only a single electron that masquerades as all electrons across time. According to the principles of quantum mechanics, the state of this electron would be described by a wave function, which represents the probability of finding it at a particular point in space. Wheeler and Feynman imagined performing a measurement on this electron to determine its position. According to quantum mechanics, the act of measurement collapses the wave function and causes the electron to "collapse" into a definite (but approximate) position. However, this approximate position concept has a limit that includes a trade off with the ability to have certainty of its momentum, due to the Heisenberg uncertainty principle.

Therefore, when we measure the position of the electron, the act of measurement causes the electron's momentum to become more uncertain. This uncertainty in momentum leads to an uncertainty in the electron's future position, which means that the electron can end up anywhere in the universe after the measurement is made, even at a different location in time. This idea of a one-electron universe highlights the fundamentally non-local nature of quantum mechanics, as the position of the electron is not strictly determined by anything local to the electron itself, but rather by the act of measurement performed by the observer.

For our purposes, the one-electron universe serves as a metaphor or loosely related paradigm. One of the similarities is this. We want to move a truncated palindromic CE around our game universe to create the meaning of a large quantity of emergent quasiparticles. Again, a CE is not the proxy for the particle because our ontology does not allow particles but only quasiparticles as the patterns within the order of our sets. As stated, there is no ontology in *emergence theory* for the idea of a frozen moment of reality being physical. In a frozen moment, there are only pre-physical mathematical or informational objects, such as point sets. Conceptually, if we moved the CE around infinitely fast, we could simulate an infinity of quasiparticles simultaneously interacting. If the movement were virtually infinite, we could simulate a large quantity of simultaneous quasiparticles.

Let us relate this one-electron quasiparticle paradigm to savings. In this case, our metaphorical “electron” that moves around fast is, in some sense, like a “motion blur” interpolation of many locations in an ordered set of palindrome centers of an empire. As mentioned, this is called the center emperor (CE) because it is the center of the hyper height of the projection window in E8, which generated that particular QC frame or element in these large sets of ordered weighted sets that define the game probabilities for interactions. In the transform to a finite QC, the CE is the rotational center if it is projected to the center of the QC – which would mean it is also the center of the finite hyper-width of the projection window. It is still the CE if it is not projected to the center. The CE is the center of a truncated palindrome in both the 8D periodic point space and the 3D QC point space. A truncated palindrome is a finite palindrome, wherein we remove one or more elements from one of its sides. These are palindromic structures of higher spatial dimension than the ordinary case of 1D palindromes. If we had a Fibonacci chain QC as: short, long, long, short, this reads the same in both directions and is a palindrome. Let’s say we have 50 symbols on each side of the CE palindromic center. We remove one from only one side. This is called a truncated palindrome. In a given game run, there will generally never be a case where the CE is at the center of the finite QC space. Accordingly, the CEs are truncated palindromes. The empire rays that drop in density like 1/r2 are 3D composites of 1D truncated palindromes. Accordingly, the 3+1D Clifford spinor empire wave quasiparticles with empire “arms” are themselves ordered sets of truncated palindromic objects, each containing the CE. And, again, moving the CE around in ordered sets creates the 3+1D emergent meaning of the interactions of two or more such spinors defined by some set of ordered and weighted sets, where the weights = the savings = the probabilities for this or that interaction or RSV.

One of the most difficult things to explain in this document in a concise way are the details of the savings games, as mentioned. Readers are encouraged to achieve mastery of our game rules. [This](https://wetransfer.com/downloads/f819b4aea24dd827b16ff73dfddd28f720230107011119/819d9ef708b5b26e31968befd186456320230107011119/ebf009) placeholder file describes a game without the crucial quaternion structures rotating on octonion structures – the richest or highest dimensional aspect of our spinors. The rotations on the complex plans, as described, are also spinorial operations. The link above also has some animations as examples of probability distributions within the spinorial component. For now, I will give a primitive metaphor to prime the reader for the more advanced explanation of what we are actually doing.

Consider a 3 x 3 grid. We want to make an ordered set that conveys two quasiparticles, each covering a coherent broken symmetry direction along three steps. In the first case, we convey this by making one square on the bottom left black and the others white. That’s the first element in our ordered set. Then we make the next square up black to form the second element of the set. Then the upper left one. We proceed to do the same thing with a pattern going from bottom right to top right. We now have an ordered set of six 3 x 3 grids, as elements, each with only one square black. We can alternate the two quasiparticle step elements back and forth and play this ordered set of six as an animation, where a human neural net will interpolate to generate the meaning of two parallel particles simultaneously moving upwards. But let us say we wanted to run these patterns that each have three steps in a diagonal fashion. One would be: bottom left, center, top right. The other would be bottom right, center, top left. In this case, we can save an element by not repeating the middle frame position twice because just one will serve to express the meaning of that middle position for both of our quasiparticles. We have saved one element or frame. As mentioned, our technical approach is more complicated, uses empire elements and we have more than one version of savings. But this at least conveys a metaphor about element savings that allows me to continue advancing this story.

This is a game that generates probability spreads, which are generated by the magnitude of resource economization, as savings, for various possible evolutions. In our first example on the 3 x 3 grid we had less savings than in the second example. Consider both animations to be random walks of two quasiparticles based on the same initial condition. The second example would map to a higher probability with a weight of 5 and the first would have a weight of 6. A random number generator can be programmed to give a proportionally higher selection weight to the lower value. Of course, the initial condition aspects are left out for simplicity. The algorithms of interest are based on the group theoretic interaction of discrete subspaces of the four division algebras, where the division algebraic interactions are governed by cyclic permutations of specific rotation groups within subspaces of the E8 root lattice correlated to specially selected the 1D, 2D and 4D sub-lattices, and their groups, embedded in a discrete octonionic coordinate plane of R8 defined by the points of the E8 root lattice. In metaphorical language, hold for now this thought:

* The 8+1D spinors have no “arms”. They are local. There is no opportunity for savings using a scheme of non-local empire wave “arms”, which are products of the transformation of the 8+1D system to 3+1D.
* The transform to 3+1D generates spinors with “empire arms” that reach out to the end of the game universe and can exist as rays that drop in density like 1/r2. They are non-local and generate our probability spreads via certain savings rules.

Integrating the terms “CE” and “truncated palindrome”, each of our elements in 3+1D is a projection of 1/10th of a given slice of the E8 root lattice, where there is some “lucky” 24-cell in some lucky 24C 10C that is conformally projected, along with many other 24-cells of the same orientation that will form its empire, to R3 to become one of 10 possible orientations of 4G at some coordinate in that lower dimensional space (along with its empire rays). This lucky object is, for that one element in some set of ordered and weighted sets, the CE and truncated palindromic center. Mathematically, the CE is the only truly special object within any infinite or finite QC. Relating to consciousness, computation, choice, process or other such terms, the CE is the selection of a set of octonionic coordinates in R8 living in a hyper-polytope volume centered at the center of height of the projection apparatus. The “viewing vector” operator has to make this choice. It costs some of the panconsciousness resource, just as a human mind has a cost to make choices, whether that be calories, neuronal activations or abstract mental processing within some definition of *consciousness*.

1. Informational “letters” of curvature equivalency, in two sign values, form a tiling language called the FIG QC. A cellular automaton, such as Conway’s game of life, is a simple program that produces dynamic or static patterns using geometric pixels called grid cells, which can be squares or any other shape in any dimension. A simple program based on QC cells would be less arbitrary because of the underlying syntax rules of formal QC codes. A noteworthy quality of our code is that the cells themselves are +/- scalars representing magnitudes of curvature equivalency.

Accordingly, any probability spread of quasiparticle interactions from a given simple program using our approach is built of pixels or discrete quantities of mathematical curvature equivalency. The scalar values of torsion “pixels” are pure mathematical information. In this sense, the fundamental physical building block is curvature equivalency, which is both the physical building block and the mathematical building block. In this sense, we are using a formal first-principles QC code built of binary torsion “letters” of curvature equivalency and creating various probability spreads driven by modifications to our program rules and parameters. A given probability is defined as an ordered set of legal instances of the QC code, where one ordered set, X1, of N elements of a set X have a different probability than a different ordering of X, such as X2, of the same set of elements. This is the simple case. Other cases can have different elements in different ordered sets within a given set of ordered and weighted sets. To reiterate, the code or syntax if QCs is based on mathematical first principles. It’s in no manner a simple program. It’s non-subjective and non-invented mathematical code given by trigonomic logic. Simple programs are not first-principles mathematical codes. The “games” or various simple programs that can be invented to create ordered sets of various syntactically legal QCs is a different thing altogether – subjective or arbitrarily invented programs. There are no strict mathematical first principles that compel us to invent this or that set of functions or algorithms. We are guided only by the PEL in this regard. So we do not interchange the terms “code/language” at this mathematical level of the QCs with the higher order terms “simple program”, “rules”, “algorithms”, “games”, etc. However, the general notion of language is of course something we do apply, as a term, as discussed earlier. But these are languages that traffic in subjective meaning, vs first principles math or these self-referential symbolic codes called QCs.

Transformation of the 8+1D cycle clock to a 3+1D quasicrystal representation would generally involve a global projection of all 10 parts of the E8 lattice. However, this will not preserve our desired double cover of the binary icosahedral group structure of E8 via D4 decomposition. To review, the 240 points of the E8 root polytope are generated by 5 PPs, each containing two 24-cells rotated from one another in R8 by 90° and having circumspheres, as great S3 fibers on S7, rotated from one another by 90°. We divide the orientations of the ten 24-cells into sets A and B with respect to their perpendicular relations. Working with the A set, we have 120 cycle clock permutations, as the binary icosahedral group. We have the same number for the B set for a total of 120 + 120 permutations.

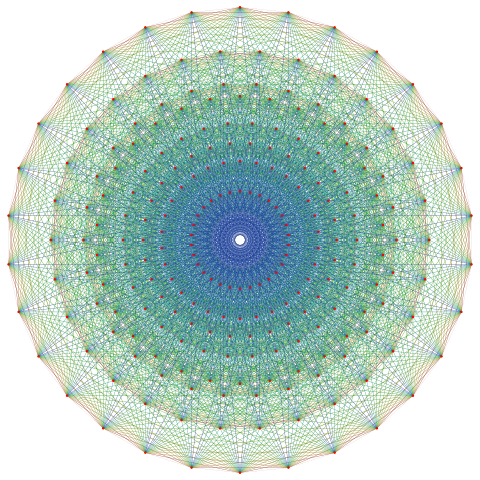
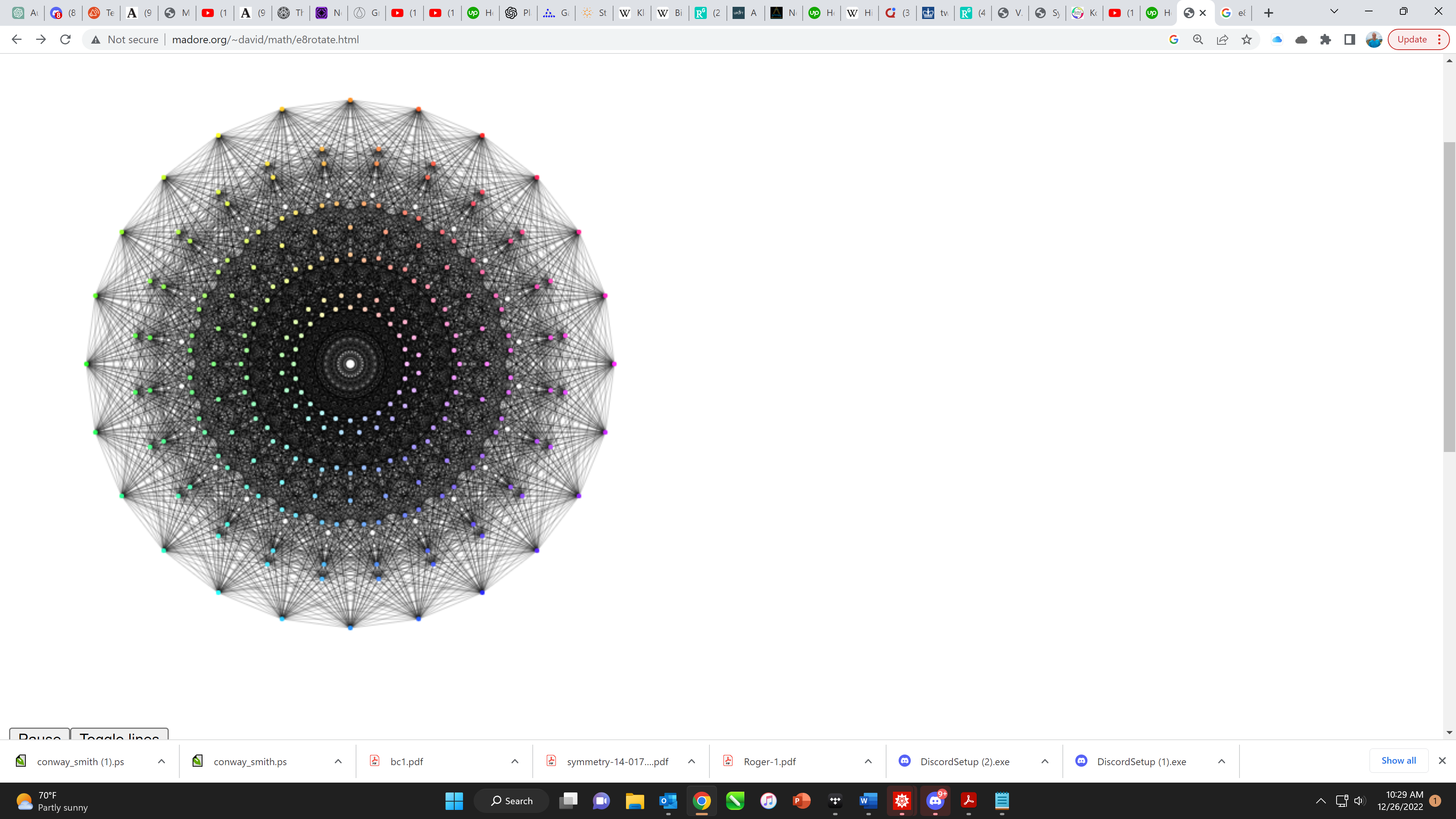
In the 3+1D FIG representation, the 24-cells are transformed into cuboctahedral convex hulls with other points from the 24-cell living in the bulk of the projection. There are 10 unique orientations of these objects in 3D that map to the 10 orientations of 24-cell in the 24C 10C. The “root polytope” of the FIG is an object in 3D called the right + left 20G. It is made of 5 + 5 = 10 unique orientations of 4G. The 4G is a cuboctahedron with 12 of its 24 edges rotated inwards such that a vertex of each is coincident with the centroid of the convex hull. It also contains additional points in its bulk that map to the full set of 24 points of the D4 root polytopes. This approach of separating out into a set of projections, vs a global projection of a slice of the E8 point set, produces a chiral sign value of twist or torsion relationship relative to other 4Gs. Of course, here we also have 120 + 120 cyclic permutations acting as a faithful group theoretic representation of the 8+1D cycle clock in the higher dimensional “mother” spinor array.

We project each 24-cell to R3 individually to generate this compound object of the R + L 20G in the FIG. Of course, the FIG construction method produces the R + L 20Gs without need for projection of E8. But, to produce it via projective transformation, the projections of the 1/10ths of the E8 structure decomposed by its D4 quaternionic planes must be done individually and not globally/simultaneously. The reason is because, in that case, the hyper-vector of the projection operator necessary for conformal angle preservation will be lost. Put differently these are not the same projection hyper vector angles – the global projection to R3 vs the angle used to project just 1/10th. The global hyper vector package of angles would project all 10 24-cells non-conformally. We will not get torsion as our curvature equivalency and would shift to contractive distortion, thereby losing some of our group theoretic structures related to the standard model. In addition, we lose a potentially useful binary sign value of torsion or twist curvature equivalency. Furthermore, with the global projection, the result would be recovery of only a single copy of the binary icosahedral group versus the 120 + 120 that we need to recover the same group structure as the pre-transformed 8+1D cycle clock. Perhaps having access to the addition copy in the double cover will come in handy for physics.

As discussed, these are Clifford spinors, wherein we extrude the set of permutations for some chosen cycle of 5 within the binary icosahedral group into the ordered set or game time domain via sequential Clifford rotor actions in Cl8 upon our quaternionic 24-cells within our discrete octonionic coordinate space in R8. In 3+1D, these cycle clock spinors manifest as right or left-handed cycle clocks.

Again, it is the conformal geometric projection of the 24-cell that is necessary in order to recover the full group theoretic mapping between our 8+1D and 3+1D cycle clocks. As usual, a key focus here is the PEL. The emphasis on economy and compactness motivates us to abandon the continuous nature of Lie groups and focus on the integral discretization of our four discrete division algebraic number planes R 🡪 A1, C 🡪 A2, H 🡪 D4 and O 🡪 E8. With an emphasis on preserving the discreteness of our mother division algebra numbers, the integral octonions, we exploit a mathematical opportunity with the interaction of our largest and smallest exceptional Lie groups (but with a conversion to their discrete analogues). Specifically, our mother lattice and division algebras comport with the integral octonions, which is the largest exceptional Lie group, E8. And the smallest of the 5 exceptional Lie groups is G2.

Before discussing that, observe the image below on the left. This is a projection of the 240 points of the E8 root polytope to the plane, which gives it 24-fold symmetry with 10 rings at different radii for each of the 24-gons. Of course, this division of 240/10 = 24 is also found in how we composite up to the E8 root polytope by building a compound of ten 24-cells, the 24C 10C in R8. Notice, on the right, the projection of the root polytope to 8 rings of 30 points each (240/8 = 30). This is the H2-based projection and part of the same hyper-vector used to project to R3 that generates an H3 symmetric 8D 🡪 3D QC. The same angles are part of a package of angles used to project to R4 to generate H4 QC symmetry. Note that the 30 rings are composed of pentagons rotated from one another by ArcCos(Φ/2), where Φ is the golden ratio.



Pay attention to the fact that the left projection is based on crystallographic symmetries and numbers. We can factor n-gons by the sub-n-gons that can composite to it. Our 24-gons, factorize as eight 2-simplexes or four hexagons, which crystallographic values associated with our A2 complex planes. Our 30-gons (right image) are non-crystallographic. They can factorize into 6 pentagons or 3 decagons.

Non-arbitrary projections of a root lattice or polytope use hyper-vector projection angle packages that live in the root vector polytope itself at some location within its upper or lower dimensional substructure. For E8, this means angles inherent to its Weyl group related full E8 root polytope structure, which would include various dihedral angles and sub-dimensional polytopes not related to the dimensions of the four division algebras we focus on. For example, producing the Penrose tiling via projection of a slice of the Z5 root lattice requires use of an irrational angle living in the lattice vs an arbitrary irrational angle that could otherwise be applied. In this case, the angle is the one that would project a 5-cube to the plane along an axis inline with an antipodal pair of its vertices (the body diagonal of the 5-cube). The above two images of non-arbitrary projections are both exploitations of inherent angles in E8 vs arbitrary irrational angles that could have been chosen to produce less symmetric QCs. Both of those projections above are finite QCs. Specifically, they are both irrationally projected via certain angle packages related to the Weyl group for E8. Although, not focused on division algebras or QCs, Garret Lisi has studied deep relationships of projective geometry within the inherent sub-symmetries of the E8 root polytope by realizing that specific non-arbitrary or structurally implied hyper vector angles of projection to 2D correspond to the probabilities for particle interactions under the rubric of the standard model.

But even for non-arbitrary projection values, we do not want to use a global projection that generates H3 symmetry in our 3D representations. We want to project to objects that do not have H3 symmetry. We want to build up to H3 symmetry by compounding. Again, our motivation is to achieve the necessary binary sign value of chirality or torsion in order to obtain a +/- value of curvature equivalency. More compactly stated, using conformal projections that preserve the 24-cell angles of ArcCos½ in the projected object as a 4G and the regularity of our 2-simplexes is what achieves this. This requires:

1. Projecting the 10ths (D4 sub symmetry of E8) individually and…
2. Using a different angle than the one that would globally or simultaneously project the E8 root polytope to H3 symmetry. This different angle is represented by the comparison of the two projections in the images above. It is based on the package of G2 related angles used to create the projection on the left of the page.

The inherent angle or sub-symmetry structure that achieves this is the complex number decorated G2 sublattice planes in the E8 root lattice. To be clear, recall that the angle of projection that generates the image above on the right can be used for either H2, H3 or H4 projections to R2, R3 or R4. Similarly, the angle used on the left image can be used for projection to R2, R3 or R4, where the symmetry in the projection is not Hn. We are using R2 in the images above to visually illustrate this concept.

As mentioned, this rotation that gives the ten rings of 24 points is special because it belongs to the smallest exceptional Lie group, G2.  This is the group of automorphisms of the octonions. The maximal order of the octonions are the integral octonions themselves. This is something we are interested in for many reasons, including computational efficiency and symbolic compactness. Mathematically, the integral octonions are isometric to the E8 lattice itself. And that lattice is itself the loop of the integral octonions. G2 is the (14-dimensional) subgroup of the full (28-dimensional) group SO8 of all rotations in dimension 8 which preserve this octonion product.

Specifically, it preserves 1 and −1. More precisely, we choose a torus in G2 by conjugating by a uniformly chosen element of it. Then, the trajectory inside the torus is that with periods 1 and Φ (golden ratio). The compact form of G2 is the automorphism group of the octonion algebra. Or we can say it is the subgroup of SO7 that preserves any chosen vector in its 8-dimensional real spinor representation. See [this](http://www.madore.org/~david/math/e8rotate.html) for more detail. As we said in our paper, [*Quantum Gravity at the Fifth Root of Unity*](https://www.sciencedirect.com/science/article/pii/S2666032621000399), the exceptional Lie algebra, G2, contains SU3 and has a fifth-root deformation with Fibonacci fusion rules. I mention this because one of the goals for our mathematicians working on C5C should be a careful discussion with Marcelo Amaral to understand his ideas in process about the correlation to non-abelian Fibonacci anyons. I have my own speculations about this, which may be similar to his and are certainly inspired by what I understand of his ideas. For example, like many authors, I believe that there is a deep outstanding problem that connects topological quantum computing to the Ads/CFT correspondence. We and other authors have described correlations between the holographic principle and quasicrystal mathematics. To start, let me present some facts. Physical quasicrystals are known to be topological phases of matter. Remarkably, they can remain in that phase at temperatures as high as liquid nitrogen. Further, an inordinate fraction of QC experimental papers report on photonic, thermodynamic and quantum thermodynamic anomalies. Accordingly, there is rich opportunity for new physics in this area of materials science. Further, the toy model picture that I have in mind about what *emergence theory* is leads me to say that we can think of reality as a “topological quantum superfluid”. I will not unpack the relevance of superfluids. And I am not talking about a superfluid of atoms, but a form of spacetime superfluid. My idea is based on interference phenomena, which I will be discussing later. Virtually all phases of physical and mathematical fluids involve interference. Now, if reality operated according to the [*code theoretic axiom*](https://www.worldscientific.com/doi/10.1142/S2424942419500026), and if it were based on the math of topological quantum computation, our future math must deeply comport with Fibonacci anyons, the quintessential non-abelian anyon. The quantum behavior of any topological phase of matter can be described with non-abelian anyon formalism. I emphasize the simple concept of networks of isomorphisms, bijections, transformations and analogues/approximations. Accordingly, there should be isomorphisms, bijections and transformations of the Wilczek formalism of non-abelian anyons. Put differently, Marcelo and myself are in search of an equivalency and/or transformation of the standard anyon formalism that lives within our discrete spinorial mathematical framework operated upon by a set of simple program rules that generate particle probability spreads. It likely has something to do with the smallest exceptional Lie group, G2, and its relationship to the golden ratio and Fibonacci numbers (integers).

Because a stereographic projected analogue of the FIG produces a 1 to 1 point correspondence of the 240 points in the E8 root polytopes as represented in the R + L 20G (with the points internal to the bulk of its convex hull), it may be helpful or at least possible to use octonion coordinates in 3D. And, even with orthographic projection using our sequential compounding method, we have a perfect group theoretic correspondence of the same 5 + 5 = 10 elements leading to the double cover of the binary icosahedral group. Using octonions in 3D allows us to use their real, complex and quaternionic substructure if we need to. Regardless, using octonions in 3D would register a 1 to 1 mapping of the points in R8 that are rearranged into non-local topological model set motifs in R3.

Next, let us discuss motivation and details of this transformation to 3+1D. Among the many mathematic 🡪 physics potential benefits, knot theory and discrete “pixels” of information-theoretic curvature equivalency stand out. QCs contain more information than their mother lattices. Accordingly, the 8+1D Clifford spinor array contains less information than its transformation to the golden 3+1D Clifford spinor network made of “empire wave Clifford spinors”. An example of a projection as a product having more information than one of its two “coefficients”, the mother lattice is this.

The relationship between the Z5 root lattice and the PT is based on a transformation, which can be viewed analogously as a product of two coefficients that is greater (in terms of mathematical “richness”) than their sum. Metaphorically, coefficient A is the pre-transformed section of the root lattice. Coefficient B is the transform apparatus. The two objects form a relationship analogous to a product. There are various papers exploring the frontiers of quasicrystal algebras. An early one to start with is de Bruijn (1981); *Algebraic Theory of Penrose's Non-Periodic Tilings of the Plane*. The salient point here is that the PT, as a metaphorical “product”, is exceedingly more complicated and rich, as a mathematical object, than the “coefficient” that is the 5-cube lattice or the transform operator. In this sense, it is neither isomorphic to nor a representation of the Z5 lattice. For example, unlike the lattice, the PT is an example of non-commutative geometry and a certain Fibonacci C\* algebra, to name a few examples. It is a formal code with syntax rules. And, unlike the 5D cubic lattice, it has 7 different vertex types, each with a specific frequency of occurrence. It has four angles that can relate adjacent edges, as opposed to the Z5 lattice with its simple 90° angles. And, topologically, it is inherently non-local. There is likely a significant amount of undiscovered mathematics in quasicrystals that is yet to be explored.

So, this first motivation for using QC transformation is that we get a formal code. Crystals or lattices are not codes. They do not have syntactical freedom. Because the physics ontology of QGR is that nature is information and computation theoretic, a non-arbitrary mathematical first principles code like this is attractive and holds opportunity for computational economy. Another major benefit is a mathematical building block of physicality as information in the form of number = curvature. We elaborate on this below.

**Graph Theory Defines Spinors and Compactifies**

**the Double Cover of the Binary Icosahedral Group**

Before developing this section, let us state the motivation and summarize in this paragraph. In both the 8+1D array 3+1D spinor network, we animate our directed graphs as Clifford spinors over ordered sets of graph updates. Accordingly, dynamism exists as the *order of the set*, where the elements are defined as connections or graph updates on a given point set. In the 3+1D case, graph theory affords the added benefit of compactness, where the full double cover of the binary icosahedral group can be compressed 5-dimensions lower than in the 8+1D case.

Specifically, in 3D, we have 60 points of a 20G and can graph update them in two ways to create all 10 representations of 24Cs in the 8D 24C 10C. One sequence of five graph updates, from one of the 120 elements of the binary icosahedral group, form a right-handed Clifford spinor, along with the other 119 permutations. And another sequence of five graph connections, on the same 60 points, forms an element of the other 120 cyclic permutations of the double cover of the binary icosahedral group, consisting of left-handed Clifford spinors. In 8+1D, this right and left-handed structure is represented by what we labeled above as the “A” and “B” elements of the PPs in that 8D representation of the double cover of the binary icosahedral group. In 3+1D, graph theory allows us to enjoy the PEL inspired objective of getting *two objects for the price of one point set* – the 120 + 120 elements of the double cover of, 2*I*, the binary icosahedral group. This is a synthesis of (1) set theory, due to how order in our sets of graph updates is equivalent to a directed graph and defines any of the 240 possible Clifford spinors in either 3+1D or 8+1D and (2) discrete rotational group theory with an emphasis on interactions of the four division algebras.

In 8+1D, cycling through subsets of the 240 points in the E8 root polytope can be thought of as a cycle clock or a Clifford spinor, with 24-cell rotations or graph updates forming repeating ordered sets. This cycle clock structure is a reflection of the non-commutative nature of the octonions.

As mentioned, in addition to the decomposition of the E8 root polytope into D4 sub-lattice 24-cell root polytopes, there is a second decomposition and cycle clock involving the A4 root polytope. This polytope has 20 vertices and, like the 24-cell vertices of the D4 lattice, can be decorated with Hurwitz integers to produce a finite set of parallel discrete quaternionic planes within the discrete octonionic plane of the E8 root lattice. There are 12 of these A4 root polytopes that composite to the E8 root polytope. Accordingly, there are 12 parallel plane classes of the A4 root lattice that composite symmetrically to form the E8 root lattice. These 12 discrete 4-plane classes are distinct from the 10 discrete quaternionic plane classes of the D4 root lattices. Accordingly, we have a total of 12 + 10 = 22 primary discrete quaternionic plane classes that are of interest.

The combination of the D4 and A4 decompositions allows us to explore the connections between the E8 root polytope and these mathematical concepts in greater depth than merely the D4 decomposition, since the E8 Lie algebraic stack contains both A4 and D4 as the two primary 4D Lie algebras within the 8D stack. Overall, this approach of using graph theory to build cycle clocks as directed graphs equal to repeating ordered sets, and, in particular, the use of quaternions to decompose the E8 root lattice, is a powerful tool for understanding and analyzing cyclic information and the symmetries within it.

**PIXELS OF CURVATURE AS INFORMATION**

A tetrahedron in our digital physics approach can be in one of three states. On right, on left or off. The relationship between, let’s say, two “on right” tetrahedra sharing a face junction is torsion, a form of curvature equivalency. The Planck curvature is the upper limit of curvature at the Planck scale, where the relation between QM and GR become important and where they both breakdown without a deeper unification model being fully understood. It is defined as the ratio of the Planck length to the Planck time and can be expressed in terms of the fundamental constants as c3/(G \* h). I propose an analogue called “Planck torsion”, TP. Note that Planck time is symbolized as tP with a lower case “t”. While GR requires two sign values of curvature, Planck curvature does not. By contrast TP has a binary sign value for its curvature equivalency. In our approach, there is only one absolute value used for curvature equivalency. This should present an obvious problem. As you read this section, keep in mind our objective, which is the answer to this question:

*If emergence theory uses one absolute value for curvature equivalency, how can the full spectrum of curvature between the upper limit of Planck curvature and the lower limit of flatness be modeled?*

Before proposing an answer, we will build preliminary discussion. Curvature pixels are information, as numbers representing curvature. Every physical object in our toy model is made of this information called curvature pixels in the form of +/- TP. One of the key differences between quasicrystals and crystals is a concept known as "geometric frustration," or curvature equivalency. As discussed in our paper [*Closing Gaps in Geometrically Frustrated Symmetric Clusters: Local Equivalence between Discrete Curvature and Twist Transformations*](https://www.mdpi.com/2227-7390/6/6/89), curvature equivalency can take various forms. For example, if we curve a piece of paper into the third dimension, this is ordinary curvature into a higher dimension. However, if we discretely fold part of it into the third dimension, this concentrates the 2D 🡪 3D curvature onto a single line at the fold. For example, in a 600-cell, we can have two tetrahedra sharing a face. One lives in an R3 subspace of R4, while the other lives in a different R3 subspace, rotated from the first into the 4th dimension by an angle that is concentrated at the face junction in the same way the folded paper example concentrated the curvature into the 3rd dimension onto a line at the fold. Using torsion, we can represent these two tetrahedra living in two 3D spaces of 4D in an equivalent way when they both live in a single 3D space. We use a twist rotation at their face junction, which is a transformation of the angle that related them in R4.

This twist or torsion form of curvature equivalency is what QGR uses in the FIG or a single 20G. And it is ultimately the information theoretic substance that composites, over discrete universal time, to form our 3+1D spinors. Another form of curvature equivalency is distortion. Using the example of the two tetrahedra living in 4D, we can project them at the same time to 3D to crush the 4D relationship down to R3, where the curvature equivalency takes the form of distortion of edges, areas and volumes. For example, the PT is made of distorted squares that exist as regular squares in five dimensions but are transformed down onto the plane to form two numerical or informational "pixels" of curvature equivalency as discrete units of area contraction in the form of thin and thick rhombs – contractions of the squares. Each of these rhombs has a different magnitude of curvature equivalency, such that the language-based PT is a tiling code made of two pixels of curvature equivalency that are related in magnitude by the golden ratio.

The FIG uses two forms of curvature equivalency:

1. **Twist** at the level of 20Gs, which comes in a right left sign value, that can be considered as +/- in some scheme of torsion. In E8, these regular tetrahedra have no geometric frustration. Tetrahedra there, which are sharing faces, are rotated from one another by ArcCos ¼. In the FIG, two tetrahedra sharing faces have a torsion or twist transform, as right or left, that is isomorphic to the angle that relates them in 8D.
2. **Contraction** between 20Gs. Specifically, any two tetrahedra or 20Gs of tetrahedra in the FIG map to two tetrahedra in the E8 root lattice. Their distance in the FIG is less than their distance in 8D because the contraction itself expresses geometric frustration or curvature equivalency. Accordingly, the FIG is a hybrid of two forms of curvature equivalency or geometric frustration; torsion and contraction. We can say torsion and distortion.

The mathematical correspondence between trans-dimensional curvature and curvature equivalency in theories such as general relativity, loop quantum gravity and causal dynamical triangulation (CDT) suggests quasicrystal math may be a valuable tool for research in quantum gravity. Interestingly, we do not expect gravity can be quantized, which makes the name of our institute, *Quantum Gravity Research*, somewhat of a misnomer. We suspect our game physics simulations will show that gravity is more like an artifact or residual contraction value resulting from using pixels of informational curvature based on two sign values. And it can also relate to the contraction form of curvature that exists in our two forms. As mentioned, although conformal projections allow our angles to remain invariant at the level of our 4Gs, which gives us torsion, the short and long distances between 4Gs encode the contraction form of curvature equivalency.

One of the most similar approaches to QGR, and yet very different, is the work by Amjorn and Loll on their quantum gravity program, CDT. This is a derivative of the standard loop *quantum gravity approach* (LQG) developed by Smolin, Ashtekar and Rovelli after Penrose articulated seminal mathematical tools. In the late 60s and 70s, Penrose explored the idea that space emerges from a quantum combinatorial structure and developed the concept of spinor networks. Now days, Penrose, along with Eric Verline and others, believe that gravity cannot be quantized and that it is emergent and very different than the QM driven standard model. Spinors are the fundamental mathematical structure of the electron in Dirac’s formalism. This quantum theory of the rotational group (versus the Lorentz group) led Penrose to go further in an attempt to tie gravity into the picture. He did this by developing the mathematical formalism of twistors. Under the specific conditions of the conformal mappings in the complex Minkowski space, one can represent twistors in terms of spinors. The QGR torsion approach, with our Clifford spinor based cyclic group theory, certainly corresponds more closely with discrete rotational groups than the Lorentz group and other continuous Lie groups. Related to our Clifford spinors, twistors describe the relationship between space and time. Spinors composite to form twistors. And twistors describe the relationship between the complexified Minkowski space and the complex projective spaces, CPn. The projective twistor space is isomorphic to the complex projective space CP3. In general, twistors are used to describe the geometric properties of massless particles, such as photons. Woit (2022) noted that the twistor, P1, occurs as a fundamental object in both four-dimensional spacetime geometry and in number theory. There are very deep number theoretic aspects to our probability spreads that naturally relate to the integral Fibonacci and Lucas number theory involved in our pre-transformed hyper-lattice spaces and our post-transformed cycle-clock spinor network. In Euclidean signature twistor theory, P1 is used to describe space-time points. With an eye toward number theory, Fargues and Scholze focus on the local Langlands conjecture using geometric Langlands on the Fargues-Fontaine curve. In their work, the twistor P1 appears as the analog of this curve at the infinite prime. To reiterate, the rotational group approach is powerful. But, the discrete rotational groups, such as the icosahedral group, are more powerful if one is concerned with compactness, computational efficiency and other benefits that follow from a digital physics ontology.

Pulling together this section on curvature:

1. We build spinors out Clifford rotor units of action defining curvature in the form of right or left torsion.
2. We speculate that our foundational twist value, +/- TP, that defines how two tetrahedra are rotated from one another in 4D and 8D, is nature’s upper limit of curvature and is isomorphic to the absolute value of Planck curvature but with the added sign value. This may be used in ratios of +/- to model different magnitudes of local curvature. In addition, we can exploit the contraction/distortion form of curvature.
3. Noting that Planck curvature is c3/(G \* h), our formalism requires a speed limit to the universe because we discretize to (1) universal time, as the order in a set of QCs and (2) the unit length of our base-letter level tetrahedra. In this sense, over N frames, the maximum distance a pattern can advance would be N units of the average of the two fundamental lengths 1 and Φ in a scheme that allows propagation to occur only at one power of the golden ratio scaling series. But we have rules in mind that will allow discrete steps that are greater than the starting Φ0 scale. The salient issue is whether or not time is absolute or relativistic, as modeled in special relativity. What we do know is that whether or not there is an substructure of space to propagate relative to, whatever fixed rate a mass moves at, any acceleration to a rate greater than the former rate along the same direction results in the experience of time for that mass slowing down relative to the previous experience of time. The assumptions in special relativity are one way of making a model that explains this time dilation evidence. In our digital physics approach, local spinor time is absolute because it is the ratio of distance traversed in game space relative to cycles completed (internal time) over an ordered set of N graph updates or QC frames. This is still under exploration at this early stage of game physics. When speaking of a speed limit, such as a game version of c, we need a notion of time and distance. Using an ordinary distance concept, we have different Clifford spinors propagating at different ratios of internal clock steps to external distance over N frames. More distance covered leads to fewer cycles of the internal clock over a given N frames.
4. The 1D building block of our toy model is the Fibonacci chain QC with a dimensionless ratio of Φ between the two letters at any scale of the series starting with Φ0. In this sense, our metric system, as a power series, relates to this number. Marcelo Amaral has published an interesting quantum gravity + thermodynamic equation that places Φ on the right side and a thermodynamic fundamental value and the above three constants, embedded in the Immirzi parameter, on the left. This should be explored further, as he is contemplating how to recognize the Immirzi parameter itself as being describable with the number Φ.
5. CDT uses regular 3D tetrahedra with 4D curvature values encoded as Regge calculous deficit angles at the face junctions. Emergence theory is also based on the angle by which tetrahedra can be related to one another in 4D (ArcCos ¼). In this sense, the mathematics of emergence theory has vague similarities to more popular models like GR and CDT. But it dramatically deviates from most models, including QM and GR, in that there is no frozen moment of physicality. Only process. CDT requires that, in each frozen moment, the curvature relationship at the face junction of two tetrahedra take on a smooth infinite span of possible curvature values ranging from 0 to the upper limit. In other words, they have to “get the job done” of expressing various moments of curvature allowed by GR in a frozen object as the Regge calculous deficit angle relating two tetrahedra. Call this GR required range from 0 to the upper limit, “Range X”. Amjorn and Loll have a good reason for not using the Planck curvature value to comport with the deficit angle to describe some value within Range X. The Planck curvature value cannot express all the values within the range because (1) it is the upper limit value and cannot be used in multiples as a building block to produce lesser magnitudes of curvature because (2) it has no sign value.

By contrast, QGR has an opportunity to use our TP sign value to express the values within Range X by exploiting the extremely dense universal time frame “rate” of our toy model, which is inspired by the Planck time, to get nearly arbitrary values of curvature using the idea of large ordered sets of elements that are the two sign values of TP. Let us say we have an ordered set of two positive instances of TP at about the same location in the 3+1D animation space. Think of these two sections of two frames as being two Planck moments, so well beyond the reach of experimental physics and we’d experimentally interpret this as a literal moment (if we could measure to the resolution of 2 Plank moments). In this case of two instances of the same sign value of the limit, TP, superimposed over ultra-small universal time scales as having an average at the limit, as TP. Conversely, if one were positive and one negative, we have the lower limit at 0 curvature. If, over game time of “one second” as an ordered set of 1044 fames, we have all but one tetrahedron that is right handed and the other left, we have an average magnitude of curvature at about the limit at TP. Again, there are no physical moments in this framework, just sequences of these ordered sets that appear to our limit of experimental time resolution to imply a literal moment as in GR and QM.

**SPINOR ARRAYS**

We have two spinor arrays. One is a curvature spinor array. The other is a flat space spinor array. The 8+1D array of Clifford spinors has no geometric frustration or curvature equivalency. Furthermore, without game rules defining how the spinors interact, it is in no sense a network and is merely a periodic array of spinors in R8. The 3+1D array represents the higher dimensional array of Clifford spinors but operates in a network of 1D Fibonacci chain codes that are interactive, collectively acting as a tensor net of such dynamic codes. Importantly, it is imbued with both torsion and distortion forms of curvature. And it is also not a spinor network until the values are related. At a fundamental level, even without game rules that can cause things to influence one another, the math of quasicrystals can be thought of as the space of all possible ways, given a finite number of tiles, that the letters of curvature equivalency can be changed. Because the total curvature equivalency in a QC is always conserved over any code-legal arrangement of the high and low valued scalers of curvature equivalency, the selection of where the palindromic CE is will influence every other area of tiles in the finite QC. In this mathematical sense, the transform to from the 8+1D to 3+1D spinor network makes the lower dimensional case deeply interactive or causal, where a change in one location leads to global changes. So it is more fair to call the 3+1D case a true spinor network than the 8+1D case. At a non-mathematical first principles level, we have an additional thing that makes the 3+1D spinor network inter-causal. And that is the space of simple programs that we’ve described herein. Interesting, the “arms”, as empires, that we exploit for our PEL inspired savings games that generate probability spreads, are defining ordered sets of actions in our 8+1D space, making it a fully interactive spinor network. Marcelo at QGR is continuing to advance his thinking on spinor networks and I hope to have future discussions to synthesize ideas with him as they are still evolving.

**KNOTS AT THE FINE SCALE STRUCTURE OF REALIITY**

The other noteworthy tool we can enjoy by transforming our 8+1D cycle clocks to 3+1D is knot theory. One interesting aspect of 1D knots is that they can only exist in 3D or as process paths in 3+1D. One emphasis of QGR’s program is geometric number theory. Each integer has a personality or a “DNA” – mathematical qualities that go beyond an integer’s mere utility as a counting number. We focus on the distinction between integers representing the flat spatial dimensions. For example, simplex-integers are powerful representations that encode the set theoretic substructure of an integer as the geometry of the simplex-integer itself. This paradigm is discussed in [*Toward the Unification of Physics and Number Theory*](https://www.worldscientific.com/doi/10.1142/S2424942419500038), where we introduce *simplex-integers* and present arguments for why the Reimann hypothesis should be studied by analyzing the distribution of prime simplex integers. Integral spatial dimensions, such as R3, have special properties that cannot be understood merely by their magnitude of spatial dimensionality. As mentioned, the fact that 3D is the only dimension knots can exist in is one example. Similarly, 4D is the only dimension with 6 regular polytopes. It is also the only dimension where one of the regular polytopes, the 24-cell, has no analogue in any other dimension. And 8D has special properties, wherein the densest packing of spheres leads to the root lattice of E8, the largest exceptional Lie group.

This idea of dimensionality is closely related to the concept of cycle clocks and the Fibonacci icosagrid (FIG) transformation space that we have been discussing. In our construction of cycle clocks using the C5C network of equivalencies, transforms and representations, we are working with higher dimensional geometries and number systems, such as the higher dimensional numbers on the A2, A4, D4 and E8 root lattices and studying their dynamic qualities in the 3D transform space of the FIG. Our cycle clocks can form knot patterns in the transform space of the FIG but not in the 8D space.

An overview statement of the theme of power and compactness can be this:

The rotational groups associated with the interaction of four integral number systems R, C, H, O generate an 8+1 spin array metaphorically called “coefficient A”. When acted upon by a second “coefficient B”, called the transform operator, the “product” includes powerful mathematical objects that go beyond the mere representation of either of the two individual coefficients. These bonus objects include (1) codes, (2) additional binary sign values, (3) non-locality of empires, (4) various sophisticated algebras, (5) curvature equivalency, (6) knots and (7) dimensional compactness. It is remarkable that we can compactify from 8+1D to 5 dimensions lower at 3+1D and yet have a considerably more powerful system of mathematical objects. This paradigmatic approach of higher magnitude mathematical power with lower magnitudes of symbolic load motivate the perhaps naïve sounding metaphor of *the product of two coefficients generally being greater than their sum*.

One possibility helpful inspiration for QGR’s program may be understanding this connection through the concept of knotty inflation and the dimensionality of spacetime, as discussed in the article by that same name, "Knotty inflation and the dimensionality of spacetime" (Bianchi, et al., 2020). In this article, the authors propose a model in which knots can be used to describe the structure of spacetime in a higher dimensional universe. They argue that knots can be thought of as "defects" in the structure of spacetime, and that the dimensionality of spacetime can be related to the number of knots present. At QGR, we see such “defects” as 8+1D to 3+1D transformations of our cycle clocks in 8D. That is, our “defects” are actually transform products equal to curvature in the form of torsion or twist.

Papers like [this](chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/http:/homepages.math.uic.edu/~kauffman/spinnet.pdf) one by Kaufman and many others synthesize knot and braid theory with spin networks and twistor networks for physical modeling. Overall, the connection between knots and higher dimensional spaces is interesting to use since our mathematical framework is the mapping of higher dimensional objects to lower dimensional transforms. For example, the quintessential knot is the trefoil knot. Its higher dimensional “mother”, as a pre-transform coefficient, is the 1D Seifert surface on the surface of a 3-sphere around a 600-cell or around one of the 24-cells in the 24C 10C. Our cycle clock paths form open braid like structures on one manifestation that we have modeled thus far. The produce knot-like closed paths in the game-hadron quasiparticles that we have not yet worked on. By understanding the topological properties of knots and their relationship to higher dimensional structures and the “product” called curvature equivalency, we may find value in this fundamental area of math in 2023. If so, it will be convenient to have a working relationship with Luis Kaufman, as we currently do.

**Octonionic Representation of**

**24C 10C 🡪 4G 10C and the 5th Root of Unity**

This section is a discussion on the utility of using 8D numbers in the 3D space of the FIG. It will involve set up discussion. As discussed, our R, C, H, O division algebraic and rotational group theoretic spinors in 8+1D are represented group theoretically (double cover of the binary icosahedral group) in 3+1D via our 8D 24C 10C 🡪 3D 4G 10C transform to the FIG. It is helpful to remind the reader that there are two generators of the FIG. The first is explained in [*An Icosahedral Quasicrystal As a Golden Modification of the Icosagrid and its Connection to the E8 Lattice*](https://www.researchgate.net/publication/284788049_An_Icosahedral_Quasicrystal_as_a_Golden_Modification_of_the_Icosagrid_and_its_Connection_to_the_E8_Lattice). The second is unpublished and needs to be worked out more completely in the C5C set of math problems. For now, it is believed that there is a certain shape and hyper “height” of projection window in E8 that will generate the FIG via our method of allowing 10 separate projections of D4 root lattice sections in R8 to assemble in on the 3D “screen” of a 3D projection “camera” in R8 that (1) orbits a 24C 10C’s circumscribing 7-sphere and (2) rotates upon an axis internal to the camera as the camera orbits. As part of C5C, the work we’ve done on the function that rotates the projective camera relative to its orbit around the 7-sphere must be collated. The 10 sperate conformal projections to 3D superimpose in the 3D camera screen at different angles relative to one another to produce something as small as a 20G or as large as an infinite FIG.

For this section, our goal is to go beyond a faithful group theoretic representation between the 8+1D and 3+1D spinorial cycle clocks to also include a representation of the division algebraic “H cycles in O, while cycling on C and R” in this lower 3+1D transform space. An integral octonion can be decomposed into various combinations of integral R, C and H numbers.

The key to our approach, as discussed with examples above, is the notion of PPCs. We have 10 PPCs of our discrete quaternionic planes in R8, 40 PPCs of our discrete A2 complex planes and 120 PPCs of our fundamental √2 scaled A1 integral planes (we can set √2 to 1). These are the PPC groups, which are deeply related to our discrete rotational groups.

It may be helpful think about what can be called “golden division algebraic numbers”. Earlier, we explained how the algebras and general mathematical richness of the PT in 2D is greater than the algebraic structures associated with the higher dimensional Z5 root lattice from which it is transformed. This is due to the “product” metaphor. The metaphorical coefficient we called the *transform apparatus* is a package of objects, including (1) a higher dimensional shape called a window, (2) a hyper-angle package relating that object to the Z5 root angles and (3) a translation relating it to the lattice structure. A “transform coefficient” acts upon the pre-transformed relationships between the points of the E8 roots . The golden nature of the PT is a key part of what leads to this particular Hn symmetric “product” possessing a high degree of algebraic richness, with its various rings and closed and compact algebraic structures.

Similarly, when we enact other spatial dimensional transformations using golden transform operators, we are creating compact and rich N-M dimensional representations or mappings of the substructures living in dimension N but in their hew relationships within some dimension N-M space.

We’ll start with an example of golden division algebraic numbers. The binary icosahedral group results from the 8D 🡪 4D transform or 8D 🡪 3D transform of the E8 root polytope or some larger section of that lattice. For example, in 4D, a certain hyper-vector package of projection angles and a window chape transform half of the vertices of the E8 root polytope to a 600-cell in 4D. In their paper, [*Binary Icosahedral Group and 600-Cell*,](https://www.mdpi.com/2073-8994/10/8/326) Choi and Lee (2018) provide an explicit description of the binary isosahedral group as a 600-cell. One obvious task of a mathematician working on the build-out of the C5C network would be to publish or create an internal white paper explaining the double binary icosahedral group structure of the 24-cell 10-compound using integral octonions. For the 600-cell, Choi and Lee introduce a method to construct binary polyhedral groups as subsets of quaternions H via a spin map of SO(3) and show that the binary icosahedral group in H is the set of vertices of a 600-cell derived by applying the Coxeter–Dynkin diagram of the golden symmetry group known as H4.

The thrust of the above paragraph is this: The golden representation of the √2 near-neighbor relationships between the lattice points in R8, as represented in the H4 symmetry of R4, are an algebraically richer moduli space than the periodic pre-transformed relationships in R8 (due to the aforementioned “product” metaphor). Specifically, the icosionic values are a “rich” and compact transformation of integral octonionic values in R8 that not only encode the E8 relationships but also encode their relationships to the golden transform “coefficient”. It can be rigorously shown that Coxeter’s H4 folding matrix, which maps points on the E8 root polytope to points on the 600-cells it projects to is isomorphic to the object we have been calling the “transform coefficient” and the “transform apparatus” in this text. These objects are based on the standard cut + project approach to creating QCs from higher dimensional lattices.

A further defense of this point follows: One can project some section of the E8 root lattice to 4D or 3D by any irrational value of hyper vector angles that would send each projection to some distorted transformation in 4D or 3D. Virtually all such arbitrarily chosen angle packages will result in the 120 parallel classes of unit roots in E8 being transformed to exactly 120 different contraction values – a non-H-symmetric quasicrystal code with 120 “letters” or line lengths. In a QC, the “letters” are its n-dimensional tiles or sub-dimensional elements of the n-dimensional tiles. For example, the 2D irreducible objects in a PT would be the thin and thick rhombs. In the E8 to 4D projection, the unit roots in E8, collapse to just two letters as 1 and 1/Phi in the Elser and Sloan H4 symmetric QC (as opposed to 120 lengths if there were a minute deviation from this hyper vector angle package. This is the only case when the symmetry of the QC becomes regular with 600-cell symmetry = H4. NOTE: A nD network, where n > 1, network of 1D Fibonacci chain QCs generates emergent letter species of Dirichlet integer line segments greater than the quantity of 2 in the single non-networked Fibonacci chain. For example, centroids of the 600-cells in the ESQC are spaced by 7+1 values. Using this same angle package to project to an H3 motif in 3D, the unit roots of E8 contract to 7+1 values, where one value is 0 and the others are all golden numbers (Dirichlet integers). Virtually all other irrational projections will lead to 120 different contraction values or letters in 3D. The regular symmetry of these special projections leading to H3 and H4 lead to rings and various notions of compactness, finiteness and closure in the algebras associated with these transformed point spaces to *model sets*. An additional benefit, code theoretically, is that a code’s generality and compactness relates to the smallness of its irreducible symbol set. Of course, the minimal symbol set for any code is 2, which makes binary codes, such as the Fibonacci chain, special.

To review, we are arguing here that the icosionic quaternion space of the Elser-Sloan QC is a richer space than the algebras of the E8 discrete octonionic plane due to the “product” argument above. And we are showing the example of the golden nature of the icosions as a more powerful algebraic system than the integral quaternions decorating a D4 root lattice as a discrete coordinate space. Similarly, the 2D planes of the E8 to 3D and E8 to 4D H-symmetric QCs have H2 symmetry, which leads to a richer “product level” moduli space algebra than the pre-transformed A2 and G2 discrete complex planes of our 8D discrete periodic octonionic plane in R8.

In these 2D planes of the 8+1D 🡪 3+1D spinor network, we generate the 5th root math that can be explained. The 5th root of unity, x5 = 1, is a special type of complex number that can be used to create automorphisms of the complex numbers. Specifically, the 5th root of unity is a number of the form cis(2π/5), where c is a complex number with a magnitude of 1. There are five different 5th roots of unity, which are:

• cis(0) = 1

• cis(2π/5) = (Φ/2) + (0.588i)

• cis(4π/5) = [-(1/Φ)/2] + (0.951i)

• cis(-2π/5) = -(Φ/2) - 0.588i

• cis(-4π/5) = [(1/Φ)/2] - 0.951i

These numbers lie on the unit circle in the complex plane, and they are evenly spaced around the circle. One example of an automorphism of the complex numbers that uses the 5th root of unity is the function f(z) = cis(2π/5) \* z. This function rotates all the complex numbers around the origin by an angle of 2π/5 radians, which is equivalent to rotating them by 72 degrees. This function is an automorphism because it preserve the structure of the complex numbers: it doesn't change the order of the numbers or the way they are distributed.

Another example of an automorphism of the complex numbers that uses the 5th root of unity is the function f(z) = z + cis(2π/5). This function shifts all the complex numbers by the same amount, so it preserves the structure of the complex numbers. There are many other examples of automorphisms of the complex numbers that use the 5th root of unity, and we can create more by combining different types of transformations in different ways. For example, we can create an automorphism by combining a rotation with a reflection or by combining a scaling with a shearing.

With all that background as pre-discussion buildup; we reiterate the idea stated at the top of this section “…the utility of using 8D numbers in the 3D space of the FIG.”.

We cannot use real, complex or quaternionic numbers in our 8+1D Clifford spinors because we must know the translation and orientation of a line, plane or 4-plane containing some object, such as a 24-cell, within R8. We can rotate a quaternionic associated object like a 24-cell within an octonionic object like 24C 10C in R8. But we must use octonionic coordinates within a Cl8 geometric algebra to enact our Clifford rotors to cycle them into Clifford spinors.

But, because we want to decompose, via our rotational symmetry emphasis, the 24C 10C according to its real, complex and quaternionic associated substructure, we have buckets or categories of octonions as:

10 buckets associated with our 10 D4 PPCs

40 buckets associated with our 40 A4 PPCs (and the G2 PPCs)

120 buckets associated with our 120 A1 PPCs

In the 3+1D spinor network of the FIG, we have:

10 buckets associated with the 10 PPCs of D4s 🡪 Fibonacci chain spaced 4Gs in R31, R32… R310

10 buckets associated with the 10 PPCs of Fibonacci chain spaced A2 planes in R21, R22… R210

10 buckets associated with the 30 PPC of Fibonacci chain spaced A1 planes in R11, R12… R230

Each point in the 3+1D spinor network has a 1-to-1 mapping with an integral octonion in our discrete octonionic 8-plane in R8. We can run a cycle clock program and derive empire information as the relationship between the 8D lattice “coefficient” and the cut + project transform apparatus “coefficient” without following through with the trigonometry necessary to actually product the 3+1D dynamic Clifford spinors in the QC space. Accordingly, we suspect that computations in this integral space will have more compact matrix representations than in the non-integral Dirichlet integer space of the FIG. We are interested in achieving a rigorous 1-to-1 mapping from 8D to 3D, where unit distances become golden number distances. And we speculate that using octonions to octonions of the same value will be a good approach. But, there should be additional labeling of the octonions as mentioned above, where we wrote symbols such as “R31, R32… R310”. Specifically, a 24-cell coordinate package of 24 octonions would need to have a number 1A-5A and 1B-5B that specifies which of the 5+5 quaternionic PPCs it is associated with. Similarly, the complex and real coordinates would need to have the same scheme but according to their PPC structures. This is a mapping of objects in an 8D discrete coordinate space to a 3D discrete coordinate space.

In summary, this is a discussion about two discrete coordinate spaces, one in 8D and one in 3D. The coordinates in 3D must have a 1-to-1 mapping with the ones in 8D. The ones in 3D need to be golden octonions in the same sense that there are golden quaternions called icosions. A given golden icosionic coordinate in 3D must have 8 Dirichlet integers associated with it in order to know where it maps to in its higher dimensional life in R8.

**Clifford Algebra, Hopfions, Spinors and Twistors**

Nicely coherent with division algebras, Clifford algebra is a mathematical system that extends the concepts of vector algebra to higher dimensions. It is a powerful tool for representing geometric transformations, rotations and other operations. In the context of 8+1D cycle clocks and their 3+1D transforms, Clifford algebra can be used to represent the symmetries and transformations of these mathematical objects in a compact and elegant way. For example, in 8D, the symmetries of a maximal sphere packing can be described using the Clifford algebra Cl8, which is a 32-dimensional algebra that encodes the symmetries of 8D Euclidean space.

Similarly, in 3D, the transformations of a geometric object can be represented using the Clifford algebra Cl3, which is an 8-dimensional algebra that encodes the symmetries of 3D Euclidean space. The elements of Cl2, Cl3, Cl4 and Cl8 can be used to represent rotations, reflections, translations and other transformations of our objects in a concise and easily manipulable form. Overall, the use of Clifford algebra allows for a more efficient and effective representation of the symmetries and transformations of 8+1D cycle clocks and 3+1D transforms thereof.

Furthermore, there is excellent utility in Clifford algebras to study Hopfions, spinors and twistors in our C5C network. Spinors, Hopfions and twistors are all closely related to projective geometry and have connections to quasicrystals and the notion of chirality. And, because our program is one wherein we transform, via projection, our 8+1D object to 3+1D, we are interested in relating all three (spinors, Hopfions and twistors) in our C5C network.

Conformal projective geometry is a mathematical system that deals with the properties of geometric figures that remain invariant under projection. It is closely related to Clifford algebra, as the space of projective geometry can be represented as a module over the Clifford algebra.

Stereographic projection is a particular type of projection in projective geometry that maps points in a higher-dimensional space onto a lower-dimensional space by extending lines from a reference point. It is often used in physics to represent physical systems in a lower-dimensional space and is the basis of spinors and twistors.

The complex projective spaces CP2, HP2, and OP2 are higher-dimensional generalizations of projective geometry that are related to complex numbers, quaternions and octonions. They have connections to spinors, Hopfions and twistors. They are often used to represent the symmetries and structures of physical systems. Spinors describe the symmetries of space-time. Hopfions are topological solitons that are characterized by their knot-like structure and are believed by some to be related to the fundamental building blocks of matter. They have connections to projective geometry and can be represented using higher-dimensional projective spaces such as CP2, HP2 and OP2.

Twistors are mathematical objects that are used to represent complex null lines in space-time and are closely related to the concept of conformal infinity. They are often used in the study of general relativity and can be represented using projective geometry. C5C is a tool box of connected math objects that we will pick and choose from later to build models with, from equation systems to simple programs. Unlike the commitment to the Clifford spinor networks described in this document, I do not know if we will find utility the mathematics of Hopfions and twistors. But I believe they should be part of the C5C network, just in case.

**Transformation to the FIG 3+1D Cycle Clock**

In the paper [*An Icosahedral Quasicrystal as a Golden Modification of the Icosagrid and its Connection to the E8 Lattice*,](https://www.researchgate.net/publication/284788049_An_Icosahedral_Quasicrystal_as_a_Golden_Modification_of_the_Icosagrid_and_its_Connection_to_the_E8_Lattice) we describe the construction of the Fibonacci icosagrid quasicrystal (FIG) and its relationship to our cycle clocks based on the A4 and D4 decompositions of the E8 root lattice. There are two approaches to creating the FIG. The first involves spacing the planes within each of the 10 parallel plane classes coincident with the faces of an icosahedron according to the 1D quasicrystal known as the Fibonacci chain. The intersections of these planes generate emergent edges and vertices of a quasicrystal with H3 symmetry that is composed of regular tetrahedra and other shapes. The tetrahedra are generally arranged in groups of four, called a "4G", which contain the 12 roots emanating from a centroid point and forming the root vector polytope of the A3 root lattice as well as other points within the convex hull that, along with the first 12 vertices of the convex hull, map to the 24 points of the D4 root vector polytope known as the 24-cell. There are 10 different orientations of these 3D transformations of the 4D 24-cells that map to the aforementioned 10 orientations of 24-cells that composite to the E8 root lattice polytope.

The second approach to creating the FIG involves a more complex process. We begin by projecting to R3 a slice of part of one of 10 parallel classes of D4 root lattice in E8, a periodic array of 24-cells in an R4 subspace of R8 within the E8 root lattice.

To ensure the reader comprehends this decomposition, we will build up a little slower than earlier. Consider the E8 lattice to be a packing of identically oriented root polytopes called the Gosset polytope 421. Its interstitial gaps are 8-orthoplexes. Accordingly, no additional structure, other than the periodic array of the root polytopes, is necessary to generate the point set. If we select one of these root polytopes, we can describe its 240 points as a compound of 10 24-cells. So, this infinite point set is an infinite periodic array of 24-cells living in an infinity of R4 subspaces of R8. This infinity is divided into 10 lesser infinities, which each containing in infinite number of parallel R4s of a unique orientation from the others and where each contains D4 root lattices of a unique orientation. Let us build that up with a visual example. Visualize around each of the 10 starting 24-cell orientations that composite to form the 8D root polytope of E8, an infinite D4 root lattice rigidly affixed to that first 24-cell that is part of a compound of 10 24-cells describing the E8 root polytope. In other words that one 24-cell is one of an infinite number of other 24-cells living in this one orientation class of D4 root lattices in E8. Next, affine extend that orientation of D4 lattice into 8D, such that we now have an infinite quantity of identically oriented D4 lattices filling R8. Next, do this with the remaining 9 orientations of 24-cell in the starting E8 root polytope.

Around any given vertex of this lattice, we can cycle the 24-cells to produce a directed graph or cycle clock. We can also translate it as we cycle it for more complicated mathematical patterns. The goal next is to transform these 8+1D cycle clocks to 3+1D.

We use either orthographic projection or stereographic projection for this step. Our particular orthographic projection angle package preserves the 60° angles but contracts the 24-cell convex hulls with curvature equivalency by the same value for all its 3D, 2D and 1D sub-parts, while stereographic projection preserves angles under projection also but only the "center emperor," remains as the largest projected 24-cell. The others progressively get smaller with distance from the location of the stereographic camera/projector. Next, we orbit our projection apparatus in R8 while rotating the 3D camera on an internal axis, such that we take a slice of one of the remaining D4 root lattices and transform it either orthographically or stereographically. We then plot this transformation within the 3D camera on top of the first projection, giving it a non-zero angular relationship to the first transformation. We repeat this process with the remaining eight D4 root lattices until we reproduce the FIG. This process allows us to explore the relationship between the D4 root lattice and the FIG in more detail and to understand how the quasicrystal emerges from the projection of a higher dimensional root lattice.

NOTE: If we set the distance for the stereographic projector at a value of the golden ratio, about 0.618, between the limit at infinity = 1 and immediately adjacent to = 0 the pre-projected 24-cell, we send all projected points of the 24-cells to points generated by the FIG construction method. This requires further verification.

The use of stereographic projection in the construction of an analogue of the FIG would introduce chirality in two ways. First, the relationships between the circumscribing 1-spheres around the hexagonal sub-polygons of the 24-cells are discrete Hopfions, so they have chirality. Second, the 3D compounded object, even with orthographic projection, exhibits chirality through the twist of the 4Gs relative to one another. Both the twist of the 4Gs and the twist of the stereographically projected S1 fibers are examples of curvature equivalency, which are discrete quantities or "pixels" of numerical value = information.

To create a stereographic projection of the FIG using the golden distance, we can start by selecting one 8D 24-cell 10-compound as the main object and projecting smaller 24-cell 10-compounds around it in decreasing size based on their distance from the CE origin. Then, we can move to a different 8D 24-cell 10-compound and repeat this process, creating a 20G at each location in 3D. By repeating this process for all compounds in 8D, we can create a fractal scaling of many or an infinite number of sizes of 20G at each location in 3D. This explanation requires further discussion, and this paragraph is meant to serve as a conceptual placeholder for me to further explain the idea upon request.

**Group Theoretic Structure of Cycle Clocks**

The binary icosahedral group is a mathematical structure that encodes the symmetries of the regular icosahedron. It is a finite subgroup of the rotation group SO3 in 3D and is generated by the rotations of the icosahedron about its center by 72 degrees and 144 degrees, which can be represented algebraically as quaternions. The group has 120 elements, which can be organized into 60 conjugacy classes and 10 irreducible representations.

The binary icosahedral group is relevant to physics in several ways. One application is in the study of quasicrystalline materials, which possess long-range order but lack periodic translational symmetry. Another application of the binary icosahedral group is in the study of the standard model of particle physics. The group appears in the classification of elementary particles and their interactions. Understanding its properties can elucidate insight into fundamental forces and particles.

The use of Clifford algebra is a powerful tool in the study of the binary icosahedral group and its applications. Clifford’s algebra allows for the representation of rotations as algebraic elements and can be used to analyze the symmetries of physical systems and the relationships between them. In particular, the use of spinors, which are elements of Clifford algebra that can be used to represent rotations, are useful in the study of the binary icosahedral group and its applications to physics.

As mentioned, the decomposition of the E8 root polytope and entire lattice via the quaternionic substructure of its 5 + 5 parallel classes of embedded D4 root lattices and 24-cell root polytopes leads to the binary icosahedral group. The FIG possess the same group structure because the right+left 20G is a transform of the 5+5 24-cells or S3 fibers on the 7-spheres circumscribing the E8 root polytopes. Specifically, we have 60+60 = 120 cycle clock ordered sets that can be made via sequential graph updates on the 61 points of the right 20G and another 120 for the left. And we have 60+60 = 120 cycle clock ordered sets that can be made via sequential graph updates on the 241 points (the 241st point is the centroid of the 8D root polytope) of the Gosset polytope 421 for the “A” part of the five PPs and another 120 for the “B” part.

In this sense, the dynamic ordered sets or cycle clock animations on the 61 points of the 20G are a faithful group theoretic representation of the 8+1D cycle clock on the 24-cell 10-compound.

**The Basic Math of 8D for Lines, Circles, S3 on S7**

Using Cl8, we can simplify the understanding of our 8 + 1 dimensional cycle clocks. We start with some finite section of the E8 root lattice point set. And we write a function that iteratively selects one point at a time in the lattice to create ordered sets of such selections.

For each selection, we also one of 10 coordinate packages of 24 points describing a 24 cell. It may be efficient to symbolize the selection of the 24-points via the selection of a certain S3 Hopf fiber circumscribing the 24 points as a great 3-sphere on the 7-sphere circumscribing the full 240 points of the E8 root polytope, which has, as its centroid, the first point selected by the function, as mentioned above.

The 8-dimensional cycle clocks can be understood using the Clifford algebra Cl8. We begin with a finite subset of the E8 root lattice and define a function that iteratively selects one point at a time from the lattice to form an ordered set. For each selection, we also choose one of ten coordinate packages of 24 points, representing a 24-cell. It may be efficient to represent the selection of these 24 points using the selection of a specific S3 Hopf fiber, which encircles the 24 points as a great 3-sphere on the 7-sphere surrounding the full 240 points of the E8 root polytope. The centroid of this 7-sphere is the first point selected by the function.

If this is not a stationary 8-dimensional cycle clock, we can choose a circle with six points on it in one of the A2 Eisenstein planes in 8 dimensions. The first coordinate selected at the beginning would be one of these six points on the 1-sphere in this A2 plane, which can be represented using complex numbers, quaternions, or octonions depending on the needs of the situation. As the algorithm progresses and the next point on the 1-sphere is reached, a different orientation of the 24-cell or 3-sphere is selected. This process continues until all ten orientations of the 24-cell are completed, resulting in one full cycle of 10 steps of S3s on S7 and 1 and 2/3 cycles on the 1-sphere.

This toy example of the algorithm demonstrates the interaction between the complex numbers associated with the chosen Eisenstein plane and the quaternionic cycling on the octonionic-related S7. A slightly more realistic cycle clock algorithm would also include real numbers by adding a translation along the A1 lattice for each step on the hexagon in the A2 lattice. To illustrate, consider a cylinder with 12 rings, each separated by an inch and each containing six points arranged in a hexagonal shape. The points on all 12 hexagons can be numbered from 1 to 6 and aligned along the stack of rings. For example, the selection process could begin with 1 on ring 1, 2 on ring 2, and so on until returning to the starting point and repeating the cycle. This represents the essential concept of the 8-dimensional cycle clock, which propagates through R as A1, cycles through C as A2, and cycles through H and D4 on O as E8.

In this example of an algorithm, we can use division algebraic notions to describe the cycling interaction between the complex numbers associated with the chosen Eisenstein plane and the quaternionic cycling on the octonionic related S7. Specifically, we can represent the complex numbers as elements of the group C, and the quaternions as elements of the group H. The octonions can then be represented as elements of the group O.

We can then use group theoretic language to describe the action of the algorithm on these groups. For example, we can say that the algorithm generates a permutation of the elements of C, which is a bijective function from C to itself. Similarly, the algorithm generates a permutation of the elements of H and a permutation of the elements of O.

We can use graph theoretic language to describe the structure of these permutations. For example, we can represent the permutation of C as a directed graph, with the elements of C as the vertices and the edges representing the action of the permutation. Similarly, we can represent the permutations of H and O as directed graphs.

Finally, we can use Clifford algebra to describe the geometric relationships between these groups. For example, we can use the Clifford algebra Cl8 to represent the geometric relationships between the groups C, H and O in eight dimensions. Specifically, we can use the elements of Cl8 to describe the way in which the groups structures associated with R, C and H cycle within O the 8-dimensional space R8.

**The Set-theoretic Aspects of QGR Simple Programs**

Assuming a game rule where only one selection of a CE coordinate is allowed per location in a given game run, the probability spreads of the game can be described using set theory. The electron density in density functional theory can be used as an analogue to understand the probability of observing a quasi-particle in a given 3+1 span of space-time. The simple programs used in the game generate probability spreads for the interaction of a set of quasi-particles as they explore the game space. Each possible evolution of, for example, a 2-particle interaction is represented as a large ordered set of graph updates or CE relocations, with a weight attached to each set defining its probability based on the information savings required to express it. In a physically realistic version of this game, there would be an exponentially large set of these ordered and weighted sets generated by a function that inputs initial conditions into its free parameters.

In mathematics, moduli space is a space that encodes the possible configurations of a physical system. It is often used to study the behavior of systems that exhibit symmetries or other regularities. Moduli space algebras are algebraic structures that can be used to describe the properties of moduli spaces. These algebras are typically applied to periodic point sets, which are sets of points that repeat at regular intervals in space or time. However, there is no fundamental reason why moduli space algebras cannot be applied to quasiperiodic point sets, which are sets of points that exhibit a certain degree of regularity but not a strict periodicity. By studying the behavior of quasiperiodic point sets using moduli space algebras, it may be possible to gain insight into the properties of a 3+1D system such as our game outputs. Each CE and empire is a quasiperiodic moduli space, and the sets of ordered sets that have different magnitudes of point coincidence should be explored with the instruction of moduli space algebras.

**Trust the Simple Program Space**

One particularly problematic aspect of widely held, but physically incorrect, ontological assumptions about physical reality is their sensitivity to initial conditions. Specifically, an incorrect assumption about reality can lead to incorrect interpretations of experimental data, causing scientists to continue for decades trying to fit square pegs into round holes - a metaphor for attempting to force the unification of two or more theories or paradigms in which at least one false assumption is baked in. What if Maldacena and Susskind is correct and spacetime and particles are not fundament? What if Penrose, Smolin, Verlinde and others are correct and gravity cannot be quantized? What if the assumptions in the SSH are true? What if I’m right and there’s another way to model time dilation? I could come up with many “what ifs”. The point is that we need mental bandwidth. Stephen Wolfram encouraged me to be confident in my “trust the programs” before plugging physical values and building models. I’m not saying he’s doing this or has been successful if he’s tried. It’s a philosophy he has that I share and so I’m stealing his “trust the programs” phase.

Before late this year, I was not sure exactly how a team of mostly non-programmers could explore simple program space quickly. And I’d become discouraged with the speed with which we were exploring simple programs, even if adjusted to account for all the topics we’ve side tracked our time into over the last four or so years since I introduced ISVs, RSVs and these spinorial cycle clocks that cycle in 5ths. Now I’m encouraged by the opportunities coming later this year for us to collaborate with strong and creative AI via NLP communication.

A period of diligent exploration of our simple program space at perhaps a 1,000x speed up with the aid of these next-gen digital minds can very quickly lead to opportunities for people like David and Marcelo to exploit unexpected patterns we find in the probability spreads and/or creatively collaborate with NLP generative intelligence to find simple programs within our parameters that generate best-matchings with this or that data set from some realistic Monte Carlos simulation or other dataset derived from physical observation. Or they could collaborate with strong AI trained our this entire document, all our papers and lots of other input data to creatively find physics relevant equations but restricted to the mathematics of our golden spinor network or the 8+1D analogue. That itself will be less exciting to me than discovering actual programs that generate probability spreads with an empire related savings approach. But even finding equations restricted to our golden math will likely lead to conversations with the AIs about finding spinor network programs that are implied by those equations.

In summary, it is productive to explore the simple program space within the parameters of this approach in order to achieve high levels of experience before putting the cart before the horse and reaching too early for physically realistic physics using C5C math. But if something presents itself, we should be flexible.

**Spectral Analysis**

As mentioned, the QGR program departs from the traditional philosophical approaches of Newtonian, general relativistic and quantum mechanical physics by rejecting the fundamentalism of space, time, particles and energy. Instead, we posit that these objects are emergent or secondary. Our particles are not particles but quasiparticles, which are emergent or illusory patterns arising from a large set of frozen pre-physical objects, such as quasicrystal states with a selected conformal origin. As such, it may be beneficial to use mathematical tools, such as the Fourier transform and multifractal wavelet analysis, to better understand the probability distributions generated by our simple programs. One such tool is the Ramanujan Fourier Transform, which is particularly useful for analyzing functions similar to the golden ratio power series, a scale-invariant function.

Forms of analysis that transform or compress patterns over the time domain into a lower dimensional representation should be helpful. Fourier transformation is one such approach, as is multifractal wavelet analysis. It may be productive to explore the utility of multifractal wavelet analysis and the Ramanujan Fourier transform in order to better analyze the probability distributions generated by our simple programs. My belief is that the nature of our probability distributions for many quasiparticle systems is fundamentally based on some generalized notion of interference. My notion of a transformation being analogous to a product of two coefficients implies that additional information may exist in the transform that is not a representation of information in the pre-transformed object. On the other hand, we have the fact that the probability distributions are derived from simple programs playing out on quasicrystal transformations of the E8 root lattice. So, this idea of bonus information in the Fourier transform representation is very hypothetical. The problem with Fourier transforms and human neural nets is that it is not easy for us to see patterns in data, even with nice geometric representations that can be enjoyed with representations of spectral analysis based transformations. This is where perhaps certain classes of machine learning can search for and elucidate various “invisible” topological and other patterns within these probability spreads with respect to how they relate to number theory. As mentioned briefly in an early part of this document, there are most certainly number theoretic correlates to the savings values that map to our probability weights on the sets of ordered sets. Upon request, I am able to branch into a more detailed justification of the phrase “most certainly”. The benefit of finding these supposed number theoretic corelates is computational economization via short-cut approximations to probability spreads. For example, it is not necessary to derive literally the full finite set of weighted and ordered sets defining our probability spreads any more than it is possible or necessary to define the infinity of probabilities for positions where the electron will be with higher probability when one applies the wave function formalism to some initial condition for a simple system. My intuition on these number theoretically defined “sweet spots” of savings spreads is along those lines. Ray Aschheim might be a good person for me and others to talk to about expanding upon and clarifying this conjecture.

**Game Vacuum Particles**

By review, each relocation of one point as a truncated palindromic CE in our 8D empire window is a single integral octonion. When we do one of these relations it forms an element within a given ordered set. And for each of those choices, we must choose one of 10 possible packages of 24 additional octonions that describe the convex hull of a 24-cell in 8D. So, our R on C on H on O spinorial cycle clocks in 8D are these ordered sets of such choices that live within a finite bound. As digital physicists, we are never working with the ideal infinities that mathematicians would work with, such as infinite point sets or QCs. Accordingly, within some finite hypervolume of our 8D integral coordinate space, we have N packages of these 1+24 octonions that can be chosen as an ordered element within one of our ordered sets. If we imposed a rule wherein we can only use one of each element within an ordered set and where we must use all elements in all ordered sets, then we have N! possible ordered sets. This value would represent all possible games that exist which use all N elements to create ordered sets.

The simple program space we are interested in within that more broad space of programs still leaves us with a very large quantity of simple programs. The spinor representations in 3+1D lead to interaction rules, as we exploit the mathematical objects, such as empires, that uniquely emerge between the transform apparatus and the pre-transformed 8+1D division algebraic spinor array. And the ordered set aspect of this narrow space of simple programs we are interested in is one wherein we have the idea of more coherence local to a particle, as its *empire wave*, and less coherence in the spaces between particles. The *empire waves* encode the ISVs of a given empire wave cycle clock, which includes many things such as the particles direction of propagation. Accordingly, if we have a finite game space containing, say, 1012 such *empire wave* quasiparticles that are spread out from one another, the volumes over 3+1D game time between the particles contain an interpolated superposition of all 1012 particles. And this space looks noisy. To be clearer, if we had a game universe with only one cycle clock, then the entire game universe, within any sufficiently large sub-volume, encodes only the ISV of that one quasiparticle. It looks orderly and is orderly because it is simply an extension of the spinorial cycling by construction. However, when we move from one to 1012 such quasiparticles, the same sub-volumes are encoding the ISVs of all the particles. Let us call these sub-volumes parts of the “game vacuum”. The more quasiparticles a game universe like this has, the noisier looking the game vacuum becomes. At large numbers, the game vacuum closely approximates randomness. At the top of this section, we established the simple case of N! possible ordered sets. If a random number generator selected on of these sets, it is highly probable that the order of the set has little coherent pattern and therefore cannot be associated with a meaningful simple program or generative algorithm. Some randomly chosen sets within N! can be extremely orderly and comport to generative algorithms that approximate to equate with it.

Taking inventory: We have a very large set of possible ordered sets. The vast majority look noisy and have no long-term coherent pattern. They are sets that are random or approximate ideal randomness. The salient point is that an algorithm that drives, say, 1012 orderly patterns locally, as the spinorial structure of the 3+1D cycle clocks, will imprint that order into all sufficiently large volumes of the game space over game time. By way of metaphor, imagine a ballroom full of 500 people all talking at a low volume in small conversation groups of two people. If you hold a microphone close to each conversation, spectral analysis on the sound file will reveal a highly structured or non-random pattern of bits in the file because it will not attach as high a magnitude to the progressively lower volumes of sound from the other conversations in the ballroom of 500 people. Conversely, if we raise our microphone 25 feet above the ballroom floor, we pick up an equally strong signature of all local conversations in the large crowd. The same spectral analysis will reveal a pattern that more closely approximates ideal noise than in the analysis of the single local conversation sound file. As we go to a room of 1,000 people, the approximation toward ideal randomness will be greater.

Now, the interesting fact about randomness is that it contains order. For example, in the digits of π, there are an finite quantity of sequential strings of 30 instances of 8 in a row. These probabilistic “blips” of order occur with the ideal noise of a randomly selected ordered set from our vastly large set of N! ordered sets. Similarly, the approximation of ideal noise in the volumes between cycle clocks in our 3+1 game vacuum also contain momentary blips of order. The more complex the order, the lower the probability or the lower the frequency of occurrence there is within ideal or approximate randomness or noise. Likewise, the duration of any given magnitude of complexity is probabilistic, such that a given pattern in randomness over the time domain at a duration X is exponentially less probable than at a duration X/2.

Cycle clocks are very simple patterns in terms of complexity. Within the noisy approximations of randomness in the voids between quasiparticles – our game vacuum – there are momentary blips of patterns that are cycle clocks of various ISVs that are not driven by the algorithms that generate our long-duration cycle clocks. In this sense, the game fundamentally has two types of each species of cycle clock. A “species” of cycle clock means a set of ISVs. So a given ISV type can have various states that a particle of that species can be in. But a different ISV type is a different “fundamental game particle”. Accordingly, for some species of game quasiparticle, we have two forms: (1) The vacuum version that appears momentarily and then disappears and is not driven by an algorithm or function and (2) the long-lived versions driven by such game rules. The game vacuum particles interact with the game non-vacuum particles. And the exact probabilities of duration and type of game vacuum particles can be rigorously calculated, just las the simpler calculation of probability of randomly selecting a span of π with 30 instance of 8 in a row can be.

**Dirichlet Integers**

In [*Toward the Unification of Physics and Number Theory*](https://www.worldscientific.com/doi/10.1142/S2424942419500038), we stated:

*…quasicrystal codes are based on the Dirichlet integers 1 and 1/*Φ*, which possess remarkable efficiency characteristics, such as error detection and correction abilities and multiplicative and additive efficiencies.*

But the economy of Dirichlet integers was not fully captured in that paper. Ray Aschheim at QGR has unpublished work on these integers that any C5C mathematician should learn from him about. Relative to the context if this book-like document, I have done my best to convey my rational work working with the integral versions of the division algebras and how this leads to the exploitation of specific discrete symmetry groups. Clearly, this is a program rejecting continuous symmetry groups, such as Lie groups, and focusing on discreteness, from groups to number systems. In the 8D to 3D transforms, our integral octonions become a different form of integer – Dirichlet integers. And the arguments for algebraic compactness and therefore digital economy should be well understood from Ray.

**Mapping 8+1D Spinors to 3+1D**

Above, we have discussed the transformation of our 8+1D spinors to 3+1D. I have deliberately left the responsibility up to the reader to seek out QGR staff members for a full explanation in an effort to keep this document mostly in the form of (1) a full cosmology integration, from psychology to digital physis and (2) a to-do list of topics for mathematicians working with us to use as a checklist of study topics to work with staff scientists on, along with some toy examples of often metaphorical meaning and some motivation discussion, such as why I believe integral division algebraic spinors will be both useful for physics and compact for purposes of a PEL based digital physics ontology.

With that being said, I created this short section to emphasize the need for a near-term task. We need new software that simultaneously generates both the octonionic and Dirichlet integer sets of ordered and weighted sets. This needs to be programmed ASAP. And there is a second purpose of this section, which is a drilling into to something technical that was eluded to earlier in the document. It is as follows: **24-cells do not project to 4Gs.**

They project to cuboctahedra that that have 24 edges, each with a centroid coincident with polyhedron’s midsphere. And neither the projection nor the 24-cell contain a point at the center. Importantly, a [compound of 5 cuboctahedra](https://en.wikipedia.org/wiki/Compound_of_five_cuboctahedra) is not chiral. As such, we cannot super impose a right and left chirality version to get a compound of 10 uniquely oriented cuboctahedra. Conversely, a compound of five 24-cells is chiral. Accordingly, one can superimpose its hyper mirror image to have a compound of ten 24-cells. Our goal is to recognize a 1-to-1 trigonomic transform of the 10 packages of 24+1 octonions at the centroid and on the surface of a given instance of S7 in R8. QGR has done all or nearly all of this work. Fang and the rest of the C5C team should get this finished and published.

* It’s all about graph theory

We are practicing graph theory, obviously. For example, the distinction between a right and left handed 20G that can be found on the exact same 61 points in the FIG is one of two distinct graph updates. In 8D, we are also working with 1-simplex connections or graph drawing lines, where graph drawing theory is simply the application of graph theory to point sets in typically flat geometric spaces. One graph update defines 1 of 10 24-cells in the 24-cell 10-compound.

However, we just stated above that a 24-cell does not project to a 4G. It projects to a cuboctahedron. The commonality is that a 4G has the same convex hull as a cuboctahedron. But the cuboctahedron has 50% of is 24 edges rotated inwards, such that half the edges have a vertex at one of the 12 vertices of the convex hull and the other at the centroid of the convex hull. And, because we can select only from two distinct subsets of 12 edges, we have only two possible 4Gs that can be created by this approach from a starting cuboctahedron. The salient point is this: We cannot do graph drawings in our 8D space that define 24-cells. 4Gs are missing 12 edges. So we need to delete specific edges from the graph update in 8D in order that it can project to a cuboctahedral convex hull in 3D with half its outer edges missing. Furthermore, we need 12 new edges to be drawn in 8D that transform to the 12 edges internal to the cuboctahedral convex hull, its bulk. Let us take inventory. We are projecting edges from 8D to 3D and we need all 24 edges of a 4G to be represented. No let us add a further complication. The interior of the 3D projection contains additional points and additional connections not well-discussed in this document. We are projecting all 24+1 points from 8D to 3D. And a 4G contains only 12+1 points. So, there are 12 missing points that should appear unaccounted for in the mind of a careful reader. For any QGR staff or associate not familiar with where the other 12 points go to, consider this part of QGR 101 “must know” technical knowledge. And it is certainly an issue that must be documented by the C5C team. I will expound only superficially upon that here.

With orthographic projection, the missing points and edges land in the bulk of the cuboctahedral convex hull in 3D. The shape it forms is an octahedron, which has only 6 vs 12 edges. Specifically, pairs of points in 8D are being projected to coincident points in 3D. With stereographic projection, the points separate in 3D and 24+1 unique points in R3 trigonometrically map to the same 24+1 unique points in R8 (in our case, an R4 subspace of R8). Stereographic projection is general enough that it is not defined by some unique distance of the projection operator to the projected object. Our distance space ranges from 0 to infinity. And, at infinity, the stereographic projection becomes equivalent to orthographic projection. At a distance that defines the span of 0 to infinity by 1/Φ, two octahedra of different sizes and with the same centroid coincident with the 4G centroid appear in the bulk. The larger one has its vertices at edge crossing points of the outer edges of the 20G. It has a golden ratio-based circumradius. The smaller one has its vertices deeper in the bulk and also has a golden ratio-based circumradius. A C5C task to be captured is to make the resultant compounds of 5 internal cuboctahedra at a given radius chiral. Just as we make a cuboctahedron chiral in compounds by folding inwards half if its edges, we accomplish chirality in an octahedron 5-compound by folding 6 of its 12 edges inward such that each has a vertex coincident with the centroid of the compound. This then allows the mirror image of the compound to be superimposed onto the first, thereby generating a chiral compound of 10 octahedral convex hulls, where the graph updates on the instances of 12 vertices defining a convex hull allow the chirality value to be generated.

The reasons C5C mathematicians must formally articulate the golden distance stereographic analogue of our typical orthographic transform is two-fold. First, I’m interested in a 1-to-1 mapping from 8D to the points generated by FIG constructions. There are alternate FIG constructions that occur by deflating the Fibonacci chain distances in the ordinary FIG method. See Klee for explanation. We are looking to recover the 6 points of the smallest octahedron. We know how to get the 6 points of the larger octahedral convex hull to be coincident with the mentioned edge crossing points of the standard FIG. The second reason is that I have an intuition about a certain analogue of the FIG generated by compounding a large quantity of the aforementioned special stereographic projections at each cell in 8D. We have not published this yet. And I have not invested enough time yet to explain it fully and discover it more fully with QGR staff. However, I’m able to explain far more detail on what I mean one on one with Daniele or any other C5C mathematician. Please seek me out on this. I’d like for internal staff members to also understand me on this. But it might be easier if I can work it through with a mathematician first and then have them explain it to everyone.

In summary:

1. We need software and math backing that gives a 1-to-1 mapping of points and numbers in 8D to points and numbers in our 3D space.
2. It must have a 1-to-1 mapping of the edges we graph draw in E8 to the projected edges in 3D.
3. We must mathematically articulate the stereographic analogue of the FIG I am not describing herein.

**3+0 Shell Model**

In the spirit of this being a punch-list of topics to hunt down clarity on with me and others, this will be yet another section that describes a technical idea with scant clarity. A finite QC can be thought of in a rectilinear or spherical fashion. For example, to make a finite Penrose tiling, we can build it with a finite width projection window, wherein we instantly get some finite QC on the plane upon projection. Alternatively, we can start with a seed, such as the star decagon and then use the rules and syntax to build it out in radial shells to arbitrary size. A more advanced approach is to do the shell build out trigonometrically with a very different type of projection apparatus and operation. Consider, for example, the FIG, where you randomly select some point. Then you can find a certain 2-sphere centered on that point, wherein its surface intersects a quantity of other points at that radius. Call that a “shell”. You can then find the next shell at a larger radius and continue this way to understand some finite spherical section of the FIG as a nested set of 2-sphere shells with points on them at progressively smaller radii. We can allow the edge connections to come into play or not. It turns out that each shell itself is a 2D QC with that lives on the boundary of some instance of S2.

**IMPORTANT:** Notice here that a 2D on a curved surface has a CE, it means that other points are also CEs. Again, this is part of what I mean by giving some clues of meaning but not making this section explicit and leaving it to the reader to contact me and others for clarity. I’ll keep giving ambiguous clues of detail here, though. So when we have a set of points from 8D that we want to project to a set of two or more of these shells with points on them in 3D, we are selecting a set of points on some instance of a great S3 on the surface of a given S7 in R8. Previously, we mentioned the three nested 2-spheres that circumscribe a small octahedron, larger octahedron and larger yet cuboctahedral convex hull – a Russian doll nesting of three 2-spheres. These are the 24 points living on the surface of some S7 but restricted to the surface of one of its the S3 Hopf fibers. Let us imagine that we considered another parallel 3-sphere in R8 that had a larger radius than the first and shared the same centroid. There could be zero or any quantity of additional 3-spheres with points on them that live in the span between the radius of the first and second ones mentioned. Let us say then that we had 3 additional 3-spheres with points on their surface that live between the radii of these two staring 3-spheres. We can decide arbitrarily which if any of the additional point sets to project down to R3. I know this is confusing the way I’m writing here. The message for now is this:

Growing a shell model QC in lower dimension with this approach of arbitrary selections of which 3-spheres to project and which to omit and never project creates ordered sets of 3D QCs in lower dimension. A 2D QC, such as a Penrose tiling, can be bent to fit onto the surface of a 2-sphere. And a 3D QC can be bent to fit inside a volume that lives in the delta of radii in the space between two 2-spheres sharing the same centroid. More specifically, consider a radius R and R’ in the FIG, wherein the delta is such that only 4Gs can live in the volume between the two surfaces. This is an example of a 3D QC that is bent or curved into a space like an orange peel, which is the delta between two ideal 2-spheres sharing the same centroid. And, because we can arbitrarily omit, which 3-sphere shells or spans of sequential shells in 8D get projected to 3D, we can create various ordered sets of 3D QCs made of 4Gs, wherein each QC is bent or curved into the space of this “orange peel” shaped volume in the FIG.

The very notion of “center emperor” that I have defined as the center of the hyper height of the projection window now… *goes out the window*! There is still a “center” concept here, though. When we project some set of points from 8D that live within the hyper volume of two instances of S3 sharing the same centroid, there can be N points living exactly at the center of the delta between the two radii and N-M points that will get projected which do not live at the center of the delta. There will never be a case where only one point lives at the center of the delta. In this case, we have more than one CE for that projection.

**As far as motivation:** Notice that this whole paradigm is about making quasiparticle spinorial games that give probability distributions equal to sets of ordered and weighted sets of elements called finite 3D QCs. In this entire document, I have not suggested to take the 3D elements of the set and consider them as subparts of a 4D QC, which is by the way very possible using the point set of the Elser-Sloan QC point set. And there is a reason for that. I want the CQC team to ignore that 4D QC and work with projections in 10ths directly from our graph updates in 8D to our projected points and edges in each element or frame of our 3+1D spinorial games in the FIG or a FIG-like object.

By way of overview, I have stated above two things I want to reiterate:

1. Orange peel shells in 3D contain quasiperiodic arrays of 4Gs bent onto the non-zero thickness of an orange peel-like volume on the surfaces of 2-spheres in the FIG.
2. The arbitrary ability to skip projected point sets related to possible shells from 8D allows us to generate arbitrary phasons in 3+1D. “Phason” is a general term. It is not a “phason flip”, which is a related term. It is a coherent pattern made from how you order two or more QCs. Like a quantum dot, phonon or any other quasiparticle, it exists only as the order of a set of elements distributed over the time domain. The point here is that ANY phason quasiparticle in the old way of thinking about it in the FIG can be reproduced using the shell model that I describe.

The shell model, in this sense, takes the abstraction of ordered sets of 3D QCs that I never related in this document to a 4-spatial dimensional space and creates ordered sets of 3D things or a 3+1D phason quasiparticle pattern scheme in R3. You may take this orange peel concept and allow any thickness you like. A sufficiently large thickness contains, within it, let us say an ordered set of 100 3D QCs that each contain 4G CEs. Again, I repeat, that not all 4Gs in that shell are CE 4Gs. Some are CE 4Gs and others are not. The CE 4Gs over these 100 orange peel shells are an ordered set that can define game quasiparticle interactions or game random walks. That would be one classic ordered set. A different set of 100 shells, each representing a position change of the CEs, would be a different random walk evolution.

The changing interactions of the quasiparticles in these various orange peel volumes is called the *action horizon*. Trivially, the action horizon growth of this type of universe defines a radially expanding universe.

Notice here that if you were a pattern playing out on the described action horizon, you are playing out currently on an action horizon at a radius of 46 billion light years and with a graph edge length at the Planck scale. Even if you could some how observe down to the scale of the tetrahedral 4G spinors, you would perceive the action horizon to be flat. You would perceive it to simply be a 3D space that keeps changing.

I have both said that time does not exist and used the term time often in this document. I have used the term “universal time” and “game time”. And I have introduced a local absolute particle time as the ratio of propagation through some count of spinorial cycles and forward distance steps over N frames.

Now I will connect for you my toy model universal time with universal expansion. A shell model like this is obviously one of a universe that grows larger. But, animals in the system, can only decide on ideas like “time” with reference to how things change relative other changes. For example, we can have a wall clock that changes and then count how many times we think of a sequential integer as we mentally count or watch some other thing changing like the apparent movement of the sun across the sky. We do not have access to the ordered sets, which is what I call “universal time” but with grate reluctance to use the term “time” in that context in the first place. Universal time = universal radius expansion. It is discrete and geometric. There is simply nothing whatsoever in this model that is anything like Newtons time used in QM. The local particle time for us must be inversely proportional between steps through cycles vs distance. In that regard, it is similar to one aspect of special relativity. But, unlike in SR, it is an absolute time that is different for each spinor based on its particular ISV.

The local particle time that is absolute is purely geometric. No abstract idea like “time”. Just the order of the set of geometric graph updates. The universal time in my model is also purely geometric, as the action horizon expansion. I have done my best in this document to constantly say “game physics” and “not physically realistic”. From time to time, I point the reader to similarities to physicality, such as how our games generate probability density distributions, which has similarities to QM. Here in this section, I will point the reader to the following similarity. The action horizon has a non-zero Planckian scale thickness. And it is made of pure digital information as a set of integral octonions in an R8 coordinate space converted into Dirichlet integers in an R3 coordinate space.

And, because this pure information lives on something that is virtually an ideal 2-sphere in R3, the entirety of physical reality (let’s say 100 million years ago) over a duration of, let us say, 1020 Planck moments is digitally encoded onto the approximately 0-thickness surface of a large 2-sphere – the action horizon that lives between two ideal 2-spheres of nearly the same radius. The term “Planck moment”, of course, comes from QM, which axiomatically presumes Newton’s time and space to be real. So, I use that term as a metaphor to explain to you the extremely large quantity of 1044 elements that exist as QCs in an illusionary experience as an emergent animal in the game that you label in your ontology as a modern being as *one second*. Our elements in the shell model are 3D QCs bent onto the non-zero surface of very large orange peel like structures or approximate instances of S2. GR assumes the time of SR. QM assumes the time of Newton. Modern physicists try to combine the two theories relative to their perception of reality with plenty of possibly wrong assumptions about what axioms in GR or QM are realistic and which are not. They take their assumed to be true axioms from these two conflicting theories and mash it up with data from particle accelerators and powerful telescopes. They interpret the meaning of the data relative to their bespoke but generally similar assumption of which axioms from the conflicting theories are true and which are not. The result?

The holographic principle – that is, Maldacena’s conjecture and the general category of ideas relative to the very important discovery of the *AdS/CFT correspondence*. With gross simplification, we have this clue that is supported by our data mixed with our physical axiomatic guesses of the day that lead us to realize there is a deep still hidden mystery relating GR to QM that implies pure information living on a 2D surface maps to pure information projected to the volumetric bulk of the 3+1D interpretation of our physical experience. Ergo, the handy metaphor of the hologram.

As a hypothetical, if the shell model I describe evolved to become physically realistic, it would seem very similar to the ingenious recognition of mathematical physicists, such as Maldacena.

**PUNCHLINE:** Before this section, we described ordered sets of QCs to imply to the reader that we have a different R3 instance for element of a 3+1D ordered set of such objects. In this section, we have placed our shells all in a singular instance of R3. We implied herein that shells are being added as the universe expands. However, that is not quite accurate. We have not stipulated that you here and now riding the action horizon, relative to some person riding an action horizon of a lower average radius in the past or greater average radius in the future, have a special location where your place in the expansion of the shell model universe is somehow the real time or a special “present” version of this universal time that we can’t access anyway since our perception of change is relative to our ratio of internal clock cycles relative to distance over N frames. Okay, so if your action horizon is not special, then how do we speak of shells being added? Added in *what*, “time”? What is time in the toy model. As mentioned earlier, I have great reluctance in using the term “universal time” in the first place in this document. I should remind the reader again, that there is not one sequence of shells. There is a vast set of ordered and weighted sequences of shells, each describing a different probability for evolution of the particles therein. Furthermore, any point within the bulk of this shell model has, around it the exact same type of shell structure and its own action horizon. Clearly, this is a very abstract idea – this notion of a vast set of ordered and weighted shell sequences describing all these many worlds as group evolutions of a large number of information theoretic discrete spinorial quasiparticles. Nonetheless, the punch line of this paragraph is that there is currently no good reason to jump to the conclusion that this toy model is trying to describe a case wherein shells are being added over some abstract notion of something like “time”. If we simply hold the abstraction of, let’s say, a single sequence of these shells that describes some world line of your life or one timeline in a many world’s concept of group random walk evolutions of all the spinors, then *what* is it that makes it seem dynamic as in “3+1D”?

We opened this small book with a mention of Stephen Hawking because he coined the phrase *theory of everything*. It may be apropros now to provide a quote from Hawking.

*Even if there is only one possible unified theory, it is just a set of rules and equations. What is it that breathes fire into the equations and makes a universe for them to describe? The usual approach of science of constructing a mathematical model cannot answer the questions of why there should be a universe for the model to describe. Why does the universe go to all the bother of existing?*

Of course, we answer the question as to why the universe goes to all the bother of existing. It wants to. The question itself implies a philosophical grounding in materialism, in which case it’s a very reasonable question. But, if the universe is conscious, then we don’t usually ask conscious entities why they choose to live or exist we know that the answer will simply be, “Because I want to”. And that is typically a satisfying answer. I bring the quote up for a different reason. Many have asked questions about why it appears the that things are moving. For example, if we axiomatically decided the Einsteinian block universe picture to be real, we might ask, “What is it that makes me as an observer slice through these angles in the block universe?” If we subscribe to the Wigner von Neumann interpretation of QM, we might ask, “What is it that makes consciousness so important that the universe updates a function and changes the probabilities of how things will behave just because of the conscious entity having awareness?” Hawking is asking a vaguely similar question, “What breaths fire into the equations?”. One might ask, “What is it that animates reality”. These questions, such as the general *measurement problem,* are very deep and at the nexus of psychology, philosophy and mathematical physics.

My punch line is about changing the 3+1D phrase used in most of this document to the 3+0D phase used here at the punch line as approach the end of my story here. The shell model live in 3D, not 3+1D. And it is the traversal of your consciousness through the many worlds of this vast probability spread that breaths the fire of dynamism and the sensation of time or change into the shell model to carve out your particular world line of experience. It is not exactly an experience of literal particle random walks. It is an experience of EC thoughts about your much larger scale animal body, as a probabilistic fuzzy spread of math, that is doing thought after thought to keep changing the probabilities (thoughts are the most generalized definition of measurement in the SSH interpretation of QM). It is thought or measurement in this sense that breaths the fire of animism into the equations of nature or into the math of the shell model. In principle, your consciousness may be able to relocate to action internal to the bulk or the universal scale shell sequences that define a future or past evolution and you would similarly be slicing your way through patterns there an breathing the fire of animation or change into the math at those locations. Nonetheless, it is still an object living in the powerful dimension of 3, where you can change your location in the 3D thing but that does not make it a 4D thing. And it is unclear whether we label this action of consciousness a dimension or how exactly to treat it mathematically or physically. We can know things it does, such as make decisions about what thoughts to have and generate rewrites to universal functional. But we do not seem to easily be able to fully define it or uncover its deepest mysteries using the scientific method, as Penrose and other authors have more elegantly written about. In the next section, I will return to the use of 3+1D now that you understand the contention that it is consciousness that drives the “+1” experience of change.

**Interference, Φ Heterodyning and Empire Waves**

We must start this section with a repetition of perhaps the most radical departure of *emergence theory* from most physical models. We have no notion of time. We have geometry in 3D in the shell model. We have a concept called “change” that relates to the order of our sets of geometric objects, where paying attention to one part of order in a set versus another part is the closest thing that maps to ideas of “time” on most physics ontologies. Furthermore, we have nothing continuous or smooth in this framework. No Lorenz groups or other Lie groups, for example. We work with integers arrayed in flat pre-physical mathematical spatial domains. And yet, we believe we can build up to an approximation of reality, wherein interference is everywhere. There are interference-like and interference phenomena in gravity waves, EM waves, sound waves, mechanical systems, gas, plasma, fluids, solids and countless related systems. Related to interference, we have feedback loops that can exist between virtually all possible systems, including systems spread across time in certain models based on entanglement, not too dissimilar to the ER = EPR ideas of Susskind and Maldacena. In certain discrete models, it can be impossible to have mathematically ideal complete destructive or constructive interference. Nonetheless, digital physics is about approximating the physics of continuous models, such as GR, QM and Newtonian physics. A general feature of interference for our purposes will imply that two or more waveforms can combine to increase or decrease the amplitudes of the constituent waveforms.

Just as interference is a ubiquitous natural phenomenon related to the relationships between two or more oscillators or other wave-like systems, the general notion of heterodyning is ubiquitous. Some waveforms are aperiodic. We will imply generalized waveforms to include periodic and aperiodic orderly wave-like patterns. We will exclude aperiodic but disorderly from this discussion. A generalized notion of heterodyning can be one where combining two or more waveforms creates additional “product” waveforms with both longer and shorter frequencies/wavelengths.

So have stable and evolving feedback loops. We have the heterodyning concept that creates product waves of shorter and longer wavelength/frequency. And we have the idea of partially destructive and constructive interference that modulates amplitude. We will take these selected focuses and call the uber category of interaction just *waveform interaction*. Before moving on, I will propose a naïve sounding discussion as an attempt to generalize how I think of the term “waveform” in the broadest sense. I see the most simplified way to think about it thusly. I can have a local pattern that periodically or aperiodically cycles. This can be one of our cycle clocks at rest. It can be an atomic oscillator or any number of other systems that cycle or aperiodically roll through two or more states. And these objects can exist in any spatial dimension. To make a system, such as this, into a generalized waveform, we translate it as it cycles or rolls through its state changes and we continue the translation steps over some arc or straight line. In this sense, I generalize “waveform” as an integration or interpolation between two fundamental things; cycling through state changes and translation. For example, if I move my hand in a circle, smoothly or discretely this is not a waveform. If I do that while I’m walking forward hand carves out a right or left helical waveform-like path through space.

Because of my perhaps naïve generalization of “waveform”, I have in my toy model waveforms by construction. That is because we cycle R on C on H on O to build our division algebraic integral cycle clock spinors. Longtime QGR staff members are familiar with a term I coined a few years ago: “EMPIRE WAVE”

A cycle clock in 3+1D can have rays of tiles or points that are denser along some direction from the origin vs other directions and therefore drop in density similar to 1/r2. For example, the 3D Penrose tiling can be included logically in a modified FIG called the Fibonacci icosidodecagrid or FIDG. The 3D PT has empires that drop in density like 1/r2. In the FIG, we can employ ad hoc rules for our games that relate a given ISV package to certain rays within an empire that does not drop like 1/r2. For now, focus on the idea of interpolation over some quantity of graph updates and projections defining a 3+1D spinorial cycle clock. The empire rays are draggled along for the ride, as the local spinor cycles. While it is true that the spinor is cycling in an extremely coarse grained or discrete manner, mathematically, the interpolation defines a coarse grained and rather complicated wavelike pattern that I called the *empire wave*, which extends out from the cycle clock, dropping in density with distance. It is complicated insofar as there being a cycling of sets of 12 points on the surface of 60 points on S2, while cycling on S1, while rolling along on S0. At a fundamental level, the empire wave is a transform representation of the interactive dance of all four integral division algebraic objects according to their inherent imbedded discrete rotational group structures. In the sense that all four division algebras are participating in this interpolation as the 3+1D *empire waves*, the *empire wave* itself is a more accurate and complete description of what a cycle clock is. It is an inherently non-local object.

And it is the discussed term *waveform interaction* above that must be studied. The interactions themselves are exactly what defines the probability spreads for how our game runs evolve.

**NOTE:** I believe there are deep number theoretic patterns that correlate to how these waveform interactions exist. Therefore, I’m claiming number theory is deeply involved in the probabilities of our games. There is ample evidence for number theory playing a somewhat mysterious role in probability spreads given by quantum mechanics. Many authors have uncovered a deep relationship of number theory to QM for example, we published [this](https://www.researchgate.net/publication/307857776_The_search_for_a_Hamiltonian_whose_Energy_Spectrum_coincides_with_the_Riemann_Zeta_Zeroes) and [this](https://www.mdpi.com/2073-8994/10/12/773). In the first link, we discuss how QM and number theory relate via connection to the *projective special linear* group 2, ℤ. In the second link, we discuss a physics relationship to the trefoil knot and number theory. While the connection between QM and number theory remains mysterious, the fact that it does relate is empirical.

A co-author of those above to linked papers, Ray Aschheim, and myself suspect this may have something to do with an inherent number theoretic quality of the shelling systems we use. For example, if we place a system of shells on the FIG, let us say 500 shells that each make contact with some set of points, we find that the vast majority are not regular or semi-regular polyhedra (called P). The distribution over the numerical set 1-500 is aperiodic and orderly, just like the distribution of prime simplices described in [*Toward the Unification of Physics and Number Theory*](https://www.worldscientific.com/doi/10.1142/S2424942419500038). The interstitial polyhedral are, colloquially, “ugly” in terms of their symmetry. This inherent number theoretic fact of QCs, especially when simple programs are based on a shelling concept, is deeply part of what drives the probability distributions because it is such an integral part of the mathematics.

**NOTE 2:** For C5C mathematicians, a “must read” paper of ours is [*Quantum Walk on a Spin Network and the Golden Ratio as the Fundamental Constant of Nature.*](https://www.researchgate.net/publication/316554631_Quantum_Walk_on_a_Spin_Network_and_the_Golden_Ratio_as_the_Fundamental_Constant_of_Nature) It is a disconnected enumeration of evidence that the golden ratio plays a still mysterious role in fundamental physics. For example, Φ has been proven to be the most irrational number among all the irrationals. And, where there is a physical theory that hinges on the magnitude of irrationality, Φ will trivially become a limit value. The KAM theorem is one such case. We discuss this in that paper, along with other things. One thing is clear. The golden ratio deeply relates to any model that combines the limit of thermodynamics with the limit of general relativity. It also comes into the picture on models that relate those two limits with the limit of quantum mechanics. This is discussed in more detail in that paper, where we show how the ratios of the fundamental constants on the left side of certain equations at the limit leads to the only golden ratio on the right side.

**Fourier Transform**

To explore my term *waveform interaction* above, convert the data from game runs (sets of ordered and weighted sets) to their Ramanujan Fourier transformations and then ask a certain type of pattern recognizing machine learning system to creatively discover correlations between how I defined *waveform interaction* and the probability distributions themselves. In case it is not obvious by implication, my assumptions lead to a deduced conjecture that our game statistics are explained most deeply by empire wave *waveform interaction*. And because of this, the very distribution of probabilities over a 3+1 game physical simulation space will have qualities related to some generalized mathematical notion of fluidics. But, of course, it would be a non-local and non-classical probabilistic mathematical fluidic behavior.

**The Dancing Metric, G2-symmetry and Projective Rolling**

Relative to helpful insights for our program, I have an intuition about this paper called [*The Dancing Metric, G2-symmetry and Projective Rolling*](https://arxiv.org/abs/1506.00104). So that I don’t exceed 104 pages, I’m going to ask the reader to discuss the relevance of some of the information in this paper with Fang Fang.

Fang, please connect with me after you read this paper to understand how this relates to a rolling concept discussed by a visiting scholar a couple years ago and also to some extent in our discussions about the fractal aspects of the Fourier transformations of QCs, as discussed [here](https://www.academia.edu/32078102/The_Unexpected_Fractal_Signatures_in_Fibonacci_chain).

**Quantum Fractals**

Relative to helpful insights for our program, I have an intuition about our paper on QCs and fractals. Specifically, I divide fractals into two categories; the A class, which are fractals like the Koch snowflake or Sirpenski triangle. This have nothing to do with higher dimensional division algebraic number planes. And the B class, which would be generated by Nth order functions that do relate to division algebraic number planes. Examples would be the fractals associated with the Mandelbrot and Julia sets. Our associate, Ark Jadczyk, wrote functions to generate QCs, which are themselves fractal. But they are ordinarily generated by matching rules, grid methods or the cut and project method. Ark generates QCs with class B fractals, which is something I conjectured could be done many years ago. My conjecture was based on my observation that the Fourier transform of QCs looked visually like the \_\_\_\_\_ associated with class B fractals. His book is called *Quantum Fractals: from Heisenberg’s Uncertainty to Barnsley’s Fractality*. It is an advanced book and will be dense to penetrate. However, my intuition tells me it contains a deep clue missing link that we need in order to approach physical realism with our approach or perhaps in order to find computational short cuts via a radically different mathematical representation.