

From Digits to Universes: Using Mathematics and Theoretical Computer Science to Simulate a Toy Cosmos

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Abstract

The greatest obstacles to understanding the cosmos, and beginning the journey to the union of quantum mechanics with General Relativity (quantum gravity), will be a) the human reluctance to accept a paradigm shift to determinism, and b) the human timidity resulting in the inability to be able to seriously consider the universe being generated by innumerable centuries of progress in computer / holographic science, and actually being constructed of mathematics.

This article begins with “vector-tensor-scalar geometry” interacting photons and gravitons to produce the quantum spins of matter particles, the Higgs boson, plus the particles of the weak and strong nuclear forces. It then proposes the universe uses base-2 mathematics (a.k.a. electronics’ binary digits), the topology of Mobius strips and figure-8 Klein bottles, plus the geometry mentioned before, to produce photons and still hypothetical gravitons and non-hypothetical mass. It’s then proposed that the three-dimensional figure-8 Klein bottles composing the universe possess space-time’s four dimensions (3 of space + 1 of time) when Wick rotation is programmed into them. This programming is adaptive, depending on the strength of gravity and electromagnetism (in Special Relativity, time slows in intense gravity and on approaching the speed of light).

Because of the rotating between the x- and y-axes in Wick rotation, there’s a space-time we call imaginary or higher dimensional that is just as real as ordinary space-time. Gravity also leads to mass here - “dark” matter – and that matter’s associated “dark” energy. Use of so-called “imaginary” time and quantum mechanics’ entanglement removes boundaries between the “imaginary” and known realities. Boundaries between the simulated universe and this known universe are removed by the imaginary’s affecting virtual reality to produce an augmented reality.

Keywords

Computer-generated universe, Mathematical universe, Simulation, Entanglement, Relativity, Augmented reality

Introduction

WORMHOLES AND WARP SPEED

The introduction's objective is to lead-in to the building of a toy universe based on the natural universe by using mathematics (geometry and topology without any algebra or equations) and theoretical computer science. It does this by speaking of wormholes and their use in interstellar/intergalactic travel. Such travel is not confined to the future simulation. Use of virtual reality, augmented reality, so-called "imaginary" time and quantum mechanics' entanglement shows, in section 5, that boundaries between the simulation and this known universe are removed. A 2009 electrical-engineering experiment at America's Yale University, together with the ideas of Albert Einstein, tells us how we could travel to other stars and galaxies. Electrical engineer Hong Tang and his team at Yale demonstrated that, on silicon-chip and transistor scales, light can attract and repel itself like electric charges or magnets (1). This is the Optical Effect.

For 30 years until his death in 1955, Einstein worked on his Unified Field Theory with the aim of uniting EM or ElectroMagnetism (light is one form of this) and G or Gravitation. Achievement of this means the quantum components (gravitons) of gravity/spacetime-warps[^] between spaceships and stars could mimic the Optical Effect and be attracted together, thereby largely eliminating distance (this is similar to traversing a wormhole, or shortcut, between folds in space-time). The beginning of achievement of this union would seem to be Einstein's paper "Do gravitational fields play an essential role in the structure of elementary particles?" (2) Though this paper was originally intended to explain atomic structure, it can explain G-EM unity if used as inspiration for a "vector-tensor-scalar geometry".

^ General Relativity says gravity is a push caused by the curvature of space-time and gravitation therefore is space-time.

Section 1 -

VECTOR-TENSOR-SCALAR GEOMETRY

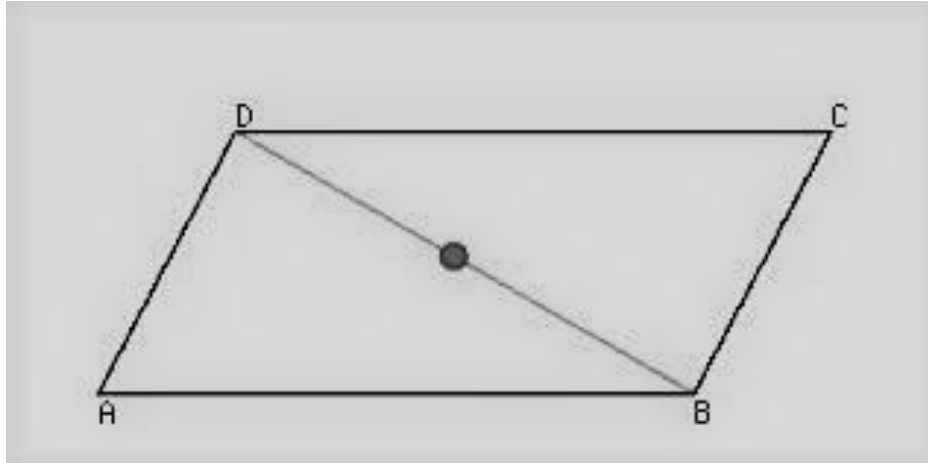


Figure 1 - PARALLELOGRAM WITH DIAGONAL AND CENTRAL SCALAR POINT

(this illustrates a simple geometry which includes vectors, tensor calculus, and the scalar – it was conceived by the author to help explain gravitational-electromagnetic unification.)

A **vector** is a quantity which possesses both magnitude and direction. Two such quantities acting on a point (represented by the central dot of the Scalar Higgs boson) may be represented by two adjoining sides of a parallelogram (e.g. CD and AD), so that the resultant diagonal[^] also represents the vectors. The two sides and diagonal thus illustrate the graviton's spin 2 and the photon's spin 1. The resultant diagonal represents the interaction of the sides/vectors ($1 \div 2$ equals the quantum spin of every matter particle: $1 / 2$). **Tensor** calculus changes the coordinates of the sides and diagonal into the coordinates of a single point on the diagonal. This **scalar** point is associated with particles of spin 0. If the mass[^] produced previously happens to be $125 \text{ GeV}/c^2$, its union with spin 0 produces the Higgs boson.

^ The resultant diagonal of those two sides can be pictured as a boat being driven in, say, the vertical direction across a river while simultaneously being pushed horizontally by the river's fast-flowing current.

^^ 125 GeV/c² united with spin 0 means the central scalar point of the Higgs boson is related to the vector of the graviton, and the Higgs field (the boson is an excitation of this field) is therefore united with the supposedly unrelated gravitational field (together with the latter's constant interaction with the electromagnetic field).

It must be remembered that referring to space alone is incomplete. Living in space-time, it's necessary to add some sentences about the time factor. The photon must interact with the graviton to produce the mass of the weak nuclear force's W and Z bosons. To produce their quantum spin, the photon's spin 1 needs to react with the graviton's spin 2. That is, the photon's turning through one complete revolution needs to be combined with the graviton's being turned through two half-revolutions.^ Incorporating the time factor as a reversal of time in the middle of the interaction: a gravitonic half revolution is subtracted from the photonic full revolution then the graviton's time-reversal adds a half revolution ($1 - \frac{1}{2} + \frac{1}{2} =$ the spin 1 of W and Z bosons). The strong nuclear force's gluon's quantum spin of 1 could arise in the same way as the spin 1 of weak-force bosons.

^ Professor Hawking writes,

"What the spin of a particle really tells us is what the particle looks like from different directions." (3)

Spin 1 is like an arrow-tip pointing, say, up. A photon has to be turned round a full revolution of 360 degrees to look the same.

Spin 2 is like an arrow with 2 tips - 1 pointing up, 1 down. A graviton has to be turned half a revolution (180 degrees) to look the same.

Spin 0 is like a ball of arrows having no spaces. A Higgs boson looks like a dot: the same from every direction.

Spin 1 / 2 is like a Mobius strip. A particle of matter has to be turned through two complete revolutions to look the same, and you must travel around a Mobius strip twice to reach the starting point.

The interacting gravity and electromagnetism produce mass e.g. they can form a Higgs boson or the weak nuclear force's bosons as well as matter. On a cosmic level - if gravitational and electromagnetic waves focus on a protoplanetary disk surrounding a newborn star, the quantum spin of the particles of matter in the disk (1 / 2) could imprint[^] itself on the waves' interaction and "concentrically construct" a planet (build it up layer by layer) from vector-tensor-scalar geometry's $1 \div 2$ interaction. If the waves focus on a region of space where there's no matter, the opposite interaction occurs and the graviton's spin 2 is divided by the photon's spin 1 to produce $2 \div 1$. The mass produced has the spin inherent in a body of gravitational waves, and could be an alternative method to supernovas for producing black holes.

[^] What do I mean by "imprint"? To explain using something different – when a laser scanner reads a barcode, the information in the barcode is "imprinted" in the scanner. When gravitational and electromagnetic waves scan a protoplanetary disk, the info in the disk is recorded or imprinted in the waves. When they scan "empty" space-time, the info pertaining to the graviton's spin of 2 ($2/1$) is imprinted since gravity is space-time according to General Relativity - it says gravity is just another term for the curvature of space-time.

Section 2 -

BINARY DIGITS AND TOPOLOGY

As mentioned above, the vector-tensor-scalar geometry inspired by Einstein's 1919 paper "Do gravitational fields play an essential role in the structure of elementary particles?" is only the beginning of gravitational-electromagnetic unification. Unity also requires this century's words about "bits and topology".

These five scientists support the idea of the universe being composed of information/mathematics:

- a) The digital physics pioneered by Professor Edward Fredkin believes that biology reduces to chemistry reduces to physics reduces to the computation of information. (4)
- b) In 1990, John Wheeler (1911-2008) suggested that information is fundamental to the physics of the universe. According to this “it from bit” doctrine, all things physical are information-theoretic in origin. (5)
- c) Erik Verlinde says gravity is not a fundamental force of nature, but an emergent phenomenon. In the same way that temperature arises from the movement of microscopic particles, gravity emerges from the changes of fundamental bits of information, stored in the very structure of spacetime. (6)
- d) Cosmologist Max Tegmark hypothesizes that mathematical formulas create reality. (7)
- e) “Pioneered (in the late 1980’s) by Rafael Sorkin, a physicist at the Perimeter Institute in Waterloo, Canada, the theory (causal sets) postulates that the building blocks of space-time are simple mathematical points that are connected by links, with each link pointing from past to future.” (8)

It seems plausible that the particular values of quantum spin could be determined by another set of particular values viz those in electronics’ binary digits, which always take the form of either 1 or 0. (Electronics could thus insert Artificial Intelligence and defiance of the Uncertainty Principle into everything from the subatomic scale through the biological to the astronomical.^) First, the 1’s and 0’s form the shape of a Mobius strip, which is merely two-dimensional (2-D).

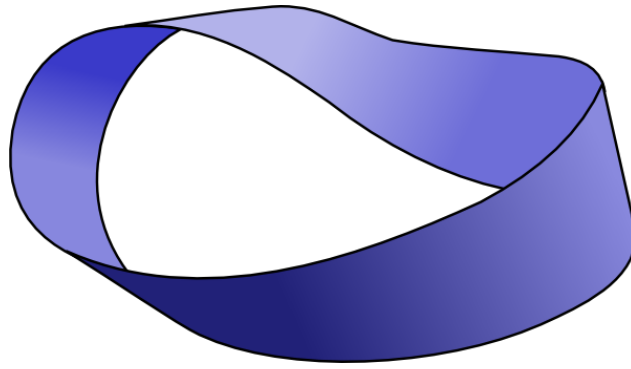


Figure 2 - MOBIUS STRIP (source:

http://www.clker.com/cliparts/3/7/a/9/1220546534781713951lummie_Mobius_Strip.svg_hi.png) Quantum spin of matter particles ($1/2$) is like a Mobius strip. A particle of matter has to be turned through two complete revolutions to look the same, and you must travel around a Mobius strip twice to reach the starting point.

To use words from a recent science paper-

In a holographic universe, all of the information in the universe is contained in 2D packages trillions of times smaller than an atom. (9)

("Holographic" would have the accepted cosmological meaning of the entire universe being seen as two-dimensional information – from Mobius strips, according to this article - projected into the three dimensions we're familiar with.)

^ Binary digits are proposed to be the Hidden Variables which "are an interpretation of quantum mechanics based on the belief that the theory is incomplete and that there is an underlying layer of reality that contains additional information about the quantum world. This extra information is in the form of the hidden variables, unseen but real quantities. The identification of these hidden variables would lead to exact predictions for the outcomes of measurements and not just probabilities of obtaining certain results." (10)

Then two strips must be joined to make a 4-D Klein bottle (11) which has length, width, depth and, when Wick rotation is programmed into the strips as a subroutine (see Fig. 4), the 4th dimension of movement in time. The type of Klein bottle formed would appear to be the figure-8 Klein. A diagram of many figure-8 Klein bottles would show that their positive curvature (on the spherical parts) fits together with their negative curvature (on saddle-shaped parts) to cancel and produce, on a cosmic scale, the flat curvature of space-time (12). When you have trillions of Mobius and figure-8 Klein elements assembled, you can follow the theory of the mass-giving Higgs field being the result of various couplings. (13) This theory has lost popularity since the Higgs boson was discovered. But an implication of a 1919 paper by Einstein called “Do gravitational fields play an essential role in the structure of elementary particles?” is that the coupling is between gravitons and photons. That could mean coupling is between the Mobius strip and the figure-8 Klein bottle (these exist on a level between photons/gravitons and 1's/0's, being built up into the particles and composed of the binary digits). With trillions of Mobius and figure-8 Klein elements assembled, these (now respectively called photons and gravitons) must interact via vector-tensor-scalar geometry to give matter what we call the emergent property of mass: similar to hydrogen and oxygen combining to give water what we call wetness. This proposed link between the Mobius strip and the Mobius doublet (figure-8 Klein bottle) would also be a link between the photon and graviton, suggesting unification of electromagnetism with gravitation. It also confirms Verlinde's idea that gravity is an emergent property (emerging from maths).

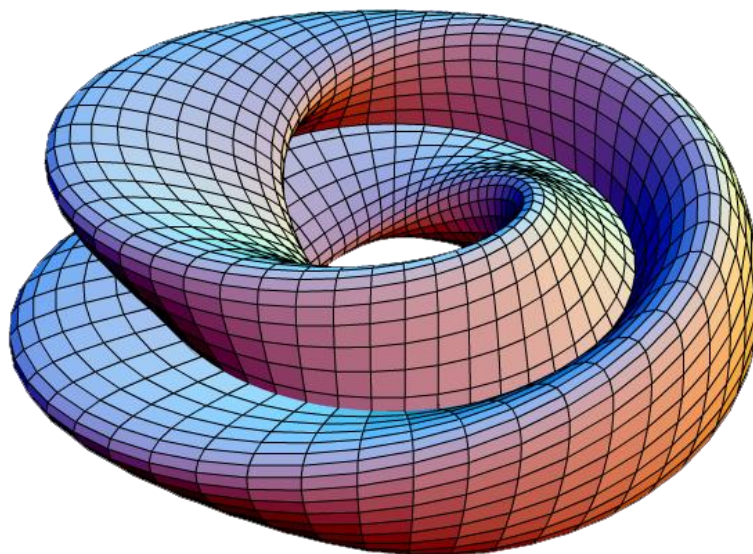


Figure 3 - MOBIUS DOUBLET (FIGURE-8 KLEIN BOTTLE)

(source: <https://upload.wikimedia.org/wikipedia/commons/7/73/KleinBottle-Figure8-01.png>) Note that, when considering many bottles, the reddish positive curvature fits together with the bluish negative curvature to produce the flatness implying space-time's infinity and, since space and time are always unified, its eternity. (In flat space-time, light beams travel in straight lines and can go infinite distance without ever meeting.)

Section 3 -

WICK ROTATION, SUPERSYMMETRY, AND SIMPLY-CONNECTED

Following Albert Einstein's example of turning Max Planck's quanta (which, for years, Planck and all other scientists considered purely mathematical) into explanation of the physical photoelectric effect, the Wick rotation used to describe imaginary time may be transformed from mathematical "trickery" to physical meaning, and provide a modern way to unite space and time into one space-time.

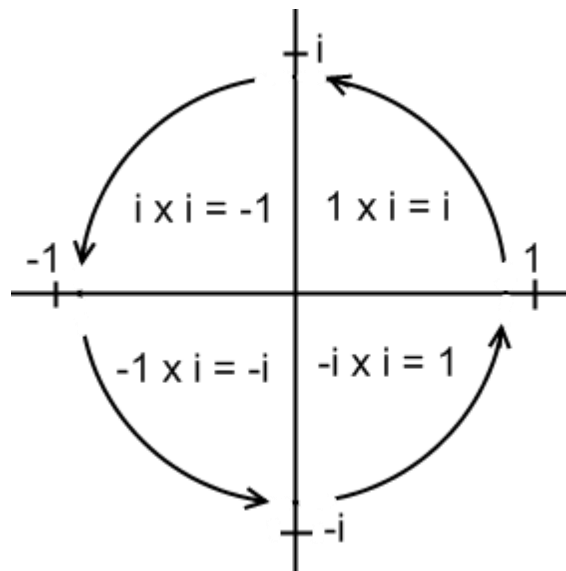


Figure 4 – WICK ROTATION: “The complex plane reveals i’s special relationship with cycles via the circle of i, also known as Wick rotation. Whenever a point on the complex plane is multiplied by i, it moves a quarter rotation around the origin or center of the plane.” (14)

Supersymmetry (SUSY) proposes a relationship between bosons and fermions. Some scientists believe supersymmetry is a failed theory. A new approach would be proposing that the Mobius strip is a fundamental constituent of not only fermions (particles of matter) but also of bosons (particles of energy) - and therefore unites all particles.

The inner and outer surfaces of a Mobius form a continuous strip in space – unification of space with time requires a temporal continuity. This is carried out by Wick rotation's continuous cycling between Fig. 4's horizontal x-axis of real time and its vertical y-axis of imaginary time. Therefore, the Mobius strip combined with Wick rotation and imaginary time provides a modern way to unite space, time, and other dimensions into one space-time. (The continuously curved Mobius surface + continuous Wick rotation = curvature of space-time.)

Informally - if an object in space consists of one piece and does not have any "holes" that pass all the way through it, it is called simply connected. A doughnut (and the figure-8 Klein bottle it resembles) is "holey" and not simply connected (they're multiply connected) Referring to the infinite universe (see text associated with Figure 3) - a flat universe that is also simply connected implies an infinite universe. (15) So it seems the infinite universe cannot be composed of subunits called figure-8 Klein bottles. But the changing of the Klein bottle's shape by binary digits composing photons and gravitons mimics the process of gaps in, or irregularities between, figure-8 Klein bottles being "filled in" by binary digits in the same way that computer drawings can extrapolate a small patch of blue sky to make a sky that's blue from horizon to horizon. This ensures the positive and negative shapes in different figure-8 Klein bottles are precisely joined, and makes space-time relatively smooth and continuous as Einstein thought. Plus - it gets rid of holes, making figure-8 Klein subunits feasible as building blocks of infinity.

Returning briefly to the topic of Wick rotation (as well as mentioning dark matter and dark energy) -

Many people believe the reason a jet aircraft is propelled forward is because its exhaust pushes against the air outside. This cannot be the reason a spaceship moves forward in

the vacuum of space where there is no air. The spaceship's movement is attributed to Isaac Newton's 3rd law of motion (to every action, there is an equal and opposite reaction). But what exactly is the 3rd law? Does it need to simply be accepted as a mysterious abstraction which "just is" the way things work? Could there be an explanation in physics for why a rocket in space behaves the way it does? Planets, stars, galaxies are – everything is - constantly in motion. In an infinite universe existing eternally, and where all space-time is entangled, (16) that motion guarantees any point in the remotest depths of space would have once been (or will be) occupied by dense matter for the rocket's exhaust to push against. If the rocket fuel and exhaust is composed of gravitational and electromagnetic waves which have components going back in time, the exhaust must inevitably and perpetually push against some form of dense, undetectable (dark) matter.[^]

[^] Since time can't exist separately from space, this matter in another time would actually be matter in another space-time. The extra-dimensional space-time can be unified with this dimension by two methods - a) in the same way that BITS (electronic Binary digiTS) make the many objects in a computer image seem to be separate when they're really connected, and b) by reversal of the direction of Wick rotation, which allows "advanced" waves that travel back in time to cancel the "retarded" waves going forwards in time, and to produce quantum mechanics' entanglement. This means "... 'dark matter' might be just ordinary matter", which was suggested by Nima Arkani-Hamed in an interview about his paper. (17) The only difference between them would be that dark matter is, to use Wick rotation, rotated 90 degrees from ordinary matter's horizontal x-axis to the vertical, "imaginary" y-axis. It's rotated into another dimension. Since this rotation twists the electromagnetic spectrum perpendicular to our perceptions and instruments, the dark matter is only detectable gravitationally (because it still resides in space-time and General Relativity says gravity is space-time). Though unified with this dimension, it may be visualized as existing "above" and "below" ordinary space-time: in "hyperspace" and "subspace". Following Einstein's $E=mc^2$, (18) the relation between Dark Matter (DM) and its associated Dark Energy (DE) would be $DE=DMc^2$.

Section 4 -

CREATION OF THE COSMOS USING BITS, PI AND IMAGINARY TIME

Most scientists don't believe there can be a rational explanation for an infinite, eternal universe. They much prefer ideas like the Big Bang, the multiverse and random quantum fluctuations causing everything to pop into existence from nothing. Our concept of time as something that only goes from past to future makes the thought of creating an infinite,

eternal cosmos unacceptable – a paradox which is seemingly absurd. But as 20th-century Danish physicist Niels Bohr said, “How wonderful that we have met with a paradox. Now we have some hope of making progress.” If he's correct, then this article's ideas about the universe may, when investigated, turn out to be valid.

Imaginary time - which is as real to physicists and mathematicians as our familiar real time - obtained its name because it was originally a purely mathematical representation of time which appears in some approaches to the special relativity and quantum mechanics theories developed in the early decades of last century. We can picture imaginary time in the following way. One can think of ordinary, real, time as a horizontal line. On the left, there's the past - and on the right, the future. But there's another kind of time in the vertical direction. This is called imaginary time (it's described with imaginary numbers such as i which equals $\sqrt{-1}$). Professor Paul Davies writes,

'The name has stuck, even though today we accept imaginary numbers are just as real as real numbers.' (19)

In the unification of a quantum gravity universe, the real and imaginary would be connected. Like the surface of the Earth, imaginary time has no boundaries (you can go around the world without falling over any edge) but, also like Earth, it is finite unless π or another infinite number is incorporated into each and every part - numbers could be encoded into parts using the BITS (Binary digiT'S, 1's and 0's) of electronics. Dr. Andrea Alberti of the Institute of Applied Physics of the University of Bonn says, 'Quantum mechanics allows superposition states of large, macroscopic objects. But these states are very fragile, even following (a) football with our eyes is enough to destroy the superposition and (make) it follow a definite trajectory.' (20)

So although we only see one Earth; it's within the realm of possibility that it, and everything else, is not finite but is infinite and superposed and actually existing in more than one place - even everywhere in spacetime. The condition of everything being infinite, superposed and existing everywhere/everywhen in space-time completely removes the need for cosmic expansion from a Big Bang. It sounds very strange because every object and event anywhere in space or time would be entangled with

and capable of affecting any other object/event. However, it might add some common sense to quantum mechanics which has been repeatedly verified by experiment but makes no sense at all if we cling to the notion of finite, separate objects and events.

The existence of Earth and everything else in every spot and time is consistent with a never-ending number of Cosmic DVD's extending infinitely in every possible direction, and any object's position not being restricted to any one DVD. The above need not violate Pauli's exclusion principle which says that two similar particles of matter cannot have both the same position and the same velocity. If electrons on different Cosmic DVDs occupy the same position, they must have different velocities. This strange state could give rise to the false idea of a multiverse - other universes with different laws of physics existing alongside ours.

A model of the cosmos might be built that uses π and imaginary time, and resides in Virtual Reality (an artificial, computer-generated simulation or recreation of a real life environment or situation). If the entire past and all of the future co-exists with our present, entanglement in the simulation is unable to remain separate from the quantum-mechanical and macroscopic entanglement existing in our perceived reality because imaginary time removes all boundaries between the two universes. They naturally merge, influencing each other and becoming one Augmented Reality (a technology that layers computer-generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it). The poorly-named imaginary time of physics and mathematics unites with π (both are necessary to generate an infinite universe - alone, unbounded imaginary time is finite).

As suggested by Elon Musk (founder of a number of high-profile companies, such as Tesla and Space X) -

"If you assume any rate of improvement at all, then the games will become indistinguishable from reality, even if that rate of advancement drops by a thousand from what it is now. Then you just say, okay, let's imagine it's 10,000 years in the future, which is nothing on the evolutionary^ scale."

So given that we're clearly on a trajectory to have games that are indistinguishable from reality, and those games could be played on any set-top box or on a PC or whatever, and there would probably be billions of such computers or set-top boxes, it would seem to follow that the odds that we're in base (non-simulated) reality is one in billions." (21)

^ Evolution doesn't 100% compute with this article. Evolution would always exist in the forms of adaptation and of modification to anatomy/physiology, but it would not explain origins. Consider the future revolution of time travel combined with the unimaginable biotechnology and genetic engineering of centuries to come. Isn't it conceivable that plants, animals and even humans are the product of entirely natural intelligent design by humanity of the distant future? Making production a two-way process is the fact that humans of the distant future rely on the reproductive instincts of past and present men and women for their existence.

Prof. Stephen Hawking says that boundaries and singularities exist in real time but don't exist in imaginary time. (22) There really are boundaries in real time and it must hypothetically be possible to step outside the universe if only real time exists. But when so-called imaginary time also exists, it is not possible to step outside the universe because the boundaries simply aren't there and the universe has no end or start (neither in space nor in time). Only one universe can then exist, and there is no multiverse.

Conclusion

The greatest obstacle to understanding the cosmos, and beginning the journey to the union of quantum mechanics with General Relativity (quantum gravity), will be the human reluctance to accept a paradigm shift to determinism – and the human timidity resulting in the inability to conceive of the universe being generated by innumerable centuries of progress in computer / holographic science, and actually constructed of maths. While determinism leaves open the possibility that God exists, it doesn't necessarily mean there's a divine being. In a science TV program (23), Dr. Graham Phillips reported that

"the physicist and writer Paul Davies thinks the universe is indeed fine-tuned for minds like ours. And who fine-tuned it? Not God but minds from the future, perhaps even our distant descendants, that have reached back through time ... and selected the very laws of physics that allow for the existence of minds in the first place. Sounds bizarre, but quantum physics actually allows that kind of thing."

(Author comment – maybe the term God should be redefined to mean “our distant descendants, that have reached back through time ...” Their population of billions would know how to apply the laws of quantum gravity to become omnipresent in space-time as well as other dimensions, and to become omnipotent and omniscient. They could then constitute the Elohim - a name used for God in the Old Testament which, according to World Book Encyclopedia, means the PLURAL MAJESTY OF THE ONE GOD.) (24)

This article is important and requires consideration because both theoretical and experimental physics have uncovered extremely powerful science in the past hundred years which needs to be recognized as susceptible to other interpretations. These other interpretations refer to the outgrowths of General Relativity, quantum mechanics and Unification known as the relationship between gravity and matter; the Higgs boson and field; the subatomic nuclear forces; and universal expansion from the Big Bang. These other interpretations must, of course, be consistent with known data – but the very fact that they exist would stop science from falling into the dead-end of believing current interpretations are correct because they're the only ones that can exist. Such belief prevents any possibility of progress and is the trap that religions fell into. Nobody wants science to become nothing more than dogma and creation myth. While there may be parts of this article that will be seen as too speculative, the speculation is purely scientific and could turn out to be correct. Some readers will find parts of this article to be deficient in experiments and equations. We could do much worse than leave the last word to Einstein. He's reported to have said that if an author can't explain a theory to a six-year-old, that author doesn't really understand the theory himself or herself.

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