Metaverse Loop-String Cosmology

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Abstract

Most theories of everything (TOEs) like string theory are based on physics. But there are as well TOEs based on "mathematics" being fundamental to a reality based on science. In particular, one math-TOE is based on the discrete natural numbers famously used by Godel to derive his Incompleteness Theorems. Such math computational theories (math-comp) assume that the comp-machine has an infinite computation space. Our approach proposes that string cosmology limits comp-space as measured by the Bekenstein Bound/Lloyd Limit of available bits of information in a finite holographic universe.

We conjecture that the cubic lattice of Calabi-Yau (CY) compact-manifolds, which pervade the space of each universe, is an arithmetic comp-machine (due to the compact manifolds being enumerable) and furthermore, that its comp-power is limited by the effective holographic size of the universe. Moreover, we conjecture that our universe's comp-machine is insufficiently precise, because of its limited size, to compute physical particles; and for that, a collection of all universes in an effectively infinite metaphysical space called the Metaverse, is necessary. A Metaverse comp-machine in such a large space is effectively complete and consistent.

We further argue that all CY computations are instantaneous from a human perspective. These conjectures make possible Mind and Body consciousnesses in a Single-World Universe and a cosmic rebirth loop based on Smolin's Fecund Cosmology with Super-Massive Black Holes (SMBHs) giving birth to Metaverses.

Introduction

Our universe may be fundamentally mathematical. Max Tegmark is not the first, but probably most famously introduced the Mathematical Universe Hypothesis (MUH) as a theory of everything. His more restrictive Computable Universe Hypothesis (CUH) posits that all computable mathematical structures exist. The "comp" hypothesis is yet more restrictive: that quantum theory, string theory, cosmology and even energy, matter and consciousness come from the arithmetics of natural numbers; and indeed from very few axioms: that the natural numbers (ie., the positive digits 1, 2, 3, ... infinity) are discrete, distinct from each other, and ordered uniformly one after the other. What results is an "arithmetic-comp machine" that can compute the equivalent of every possible sound theory and their corresponding physical structures.

A sound theory is at least a consistent theory yet at some level must be Godelean incomplete. However, Tegmark also posits in CUH that “only Godel-complete (fully decidable) mathematical structures have physical existence”. But Turing and Church independently proved that the theory of natural numbers has no recursive consistent and complete theory. That would seemingly eliminate the

arithmetic basis of matter and energy if Tegmark were correct. A possible resolution of this "conundrum" is based on the conjecture that there may be “levels of completeness” depending on available computational power in units of bits of information. Together with a 26-dimensional string cosmology, this allows for computations to be performed:

1. in an Infinite (or nearly so) 14d-Metaverse:
to create Energy and Matter from near-infinite Completeness due to its near-infinite size

2. and separately in each Finite 12d-universe (that resides in the Metaverse):
to create Emergence, Life and Consciousness due to the relatively small size of each Universe.

Then as explained below, since the computations of the Metaverse comp-machine are consistent and (nearly) complete, being both very precise yet highly constrained, they may lack ordinary consciousness, maintaining a nearly static Block Space: whereas the computations of universe comp-machines are consistent, but (relatively) incomplete, allowing for consciousness and free will, as many conjecture.

Information Cosmology

The Landauer-Wheeler concept of physical law when applied to a finite universe suggests that arithmetic computations in our holographic universe may lack computational power because of the Bekenstein Bound/Lloyd Limit of information, ie., 10^120 bits. The Lloyd Limit [Davies] is based on the surface area of the observable universe (radius 46 BLY, but the actual holographic universe could be much larger). The de Sitter horizon due to the cosmological constant suggests an upper limit of 10^122 bits.

We conjecture, following Tegmark, that this is not enough bits for a universe comp-machine to develop physical laws, constants and matter or even energy. For that we need a Metaverse which even if finite, has an abundance of bits for effectively-complete computation (ECC) purposes. In general universes probably come in different sizes with differing horizons and computational powers, suggesting that levels of attainable complexity and degrees of completeness exist. Indeed, universes expand suggesting that computations and the laws of physics become more precise (or complete) with time. But that is not so if physics always come from relatively constant Metaverse comp-machine in an effectively infinite space.

Quantum Mechanics

A conjecture is that only a Metaverse comp-machine is large enough to derive all necessary mathematics for quantum theory to work and that all CY computations are independent of time. That is, from a human perspective they all happen instantly. The essential advancement necessary for quantum theory to work is the computation of complex numbers from the natural numbers. Complex numbers are two dimensional, being composed of a (-+) infinite set of continuous numbers plus an independent (and orthogonal) set called imaginary numbers.

From a third-person perspective(3p): "Rational numbers" being countable are probably a given. Then the unaccountable irrationals are computed, and so on up to computing a "complete-math" in one set. Next

two (2) independent (orthogonal) sets of theoretic-complete numbers are coupled to form a complete set of complex numbers. Sets of numbers that have directions and angles in a higher-level space called the Mindspace (see below) are the beginning of virtual dimensional structure. Next the transcendentals are computed, and Euler's Eq. and the Ramanujan relations (that link quantum computing and prime numbers) and so on, up to the Standard Model and beyond. However, from a first person perspective comp is Coincident, Simultaneous and Instantaneous. Comp-time is a third-person perspective of what turns out to be a time-like Mindspace dimension.

Quantum Probability

Quantum logic is based on a 2d-set of math-complete numbers, a like a World Sheet. A single set of analog numbers, which range from minus infinity to plus infinity, can be understood on the basis of Classical Logic and Classical Physics because one can always determine if a number is larger than, smaller than, or equal to another number in one dimension with the middle excluded. For example, Godel analysis is in this category. That is not true for quantum theory based on complex numbers. On the 2-d complex plane, we can only say how close or how far one complex number is from another.

However, to be in agreement with quantum theory, CY machine computations need only indicate the 'probability of physical events' which reduces quantum logic to the propositional Many-Values Logic (MVL). But it seems that physics may make the CY machine compute the seeds of that probability at a deeper level. The Metaverse comp-machine must first compute continuous & complex eigenfunctions as waves and fields of probability or potentiality and then quantize (compute the quantum state magnitudes) them as well, all instantly in the virtual Mindspace. Once the quanta state magnitudes are computed, then each quanta may become a physical particle as in MWI.

Quantum state probability can be seemingly dispensed with if every quantum state is realized with probability one (1) as a separate parallel world, the so-called Many Worlds Interpretation (MWI) of quantum mechanics . However, MWI still requires a different probability for each world in order to agree with experiment, the so-called quantum-state measure problem. The MWI fix to the measure problem is for each world to be highly-repetitive in the virtual Mindspace, wherein each quantum-state magnitude determines the frequency of occurrence of each quantum world.

String Theory

Quantum theory is fundamental to String theory which is a means to make quantum theory in a sense even more complete. The notion of dimension has already been introduced with complex variables. What string theory proposes is that the number of "real" dimensions in physical space may be unlimited. But in order to derive a particular string cosmology, a finite number of "real" dimensions must be assumed. Even with a finite number of dimensions, like 10, which is the basic dimensionality of supersymmetric string theory, the number of possible unique string theories, 10^500, is effectively infinite. This is thought by most string theorists to be the number of possible unique universes, the so-called string landscape. How this number 10^500 was derived indicates how quantum theory is fundamental to string theory.

The most important aspect of 10d-superstring theory is that 6 of the dimensions must be hidden from our physical experiments. The mathematics of how this happens, or rather the result once hidden, was derived from geometrical considerations by Harvard's Math Department Head, Professor ST Yau. He found that the 6 extra dimensions (beyond 4 dimensional spacetime) curl-up into tiny convoluted ball-like particles in a cubic lattice, each 6d-particle being 1000 Planck-scales across (a density of 10^90/cc if closely packed) and each convoluted ball containing about 500 topological holes. A constraining flux winds through the 500 holes. This 3d-flux is a primitive of string theory along with complex dimension. However, as indicated above, both are computed by the Metaverse comp-machine.

Now here is where quantum mechanics comes in. String theorists assume that the flux has 10 possible quantum states (due to the arithmetic quantization of eigenfunctions). Therefore the total number of unique windings thru 500 holes is 10^500. If the number of flux quantum states were say 6, the dimensionality of each compact particle, the string landscape would be 6^500 or 10^390. As an upper bound, if there were 100 flux quantum states, then the number unique universes would be 100^500 or 10^1000, a double-exponential dependence of universes on flux quantum states. Hence quantum theory is fundamental to string theory.

Calabi-Yau Compact-Manifolds

Most string theorists currently think that the number of unique universes (that is, the number of universes having unique physical laws and constants) is nearly infinite. Our opinion is that the number of different universes is considerably smaller and the reason is important the understanding of how natural numbers fundamentally exist in nature. Based on the astronomical measurements across the visible universe of Sommerfeld's fine-structure constant alpha (nominally equal to 1/137, a dimensionless property of electromagnetic interactions), we conjecture that each Calabi-Yau compact-manifold particle is unique and distinct from all others, and therefore enumerable and capable of machine computations.

The measurements indicate that alpha slightly increases monotonically from north to south in an Earth perspective. The conjecture is that similar variations in the compact-manifold flux windings result in a 3d-array of discrete and distinct CY compact manifolds. (These astronomical observations should not be confused with archaeological data from natural sources of fission that indicate that alpha also varied with time.) If so, the compact particles are enumerable and are collectively capable of arithmetic comp.

Metaphysical String Cosmology

We are now in position to postulate a metaphysical string cosmology. We first choose a finite number of dimensions which automatically excludes a large number of string theories. We choose that number to be 26, the dimension of the first bosonic string theory. We allow for 2 time dimensions (ie., complex time) so the 24 remaining space dimensions may take advantage of the Ramanujan number relations that link gravitation, quantum computing, prime numbers, string theory and the arithmetics of integers. We conjecture that Ramanujan relations apply in 24d-unified field of Super-Massive Black-Hole (SMBH) singularities. Smolin has hypothesized and even written a book on how black holes create universes.

Poplawski has recently provided a General Relativity Torsion "theory with spin" validation of Smolin's hypothesis. This provides for a loop in our string cosmology as discussed below.

The proposed cosmology contains one 14-dimensional Metaverse that initially contains very many, very small 12-dimensional universes in their singular state (like black hole singularities). The universes, whether expanded or in the singular state, all reside within the 3D-volume of the Metaverse. (In string theory singularities are infinitesimal but of finite non-zero volume. We will refer to them as universes in their singular state).

Big Bang String Cosmology

In an open-loop cosmology like if the Metaverse existed but not its primordial singularity, then the Metaverse must be infinite in time and rather undefined. In a closed-loop cosmology, how the Metaverse might have evolved from a Primordial Singularity constrains its characteristics. Fortunately we have a clue of how the Metaverse was created because the string physics of how a 12d-universe derives from its primordial singularity is known mathematically. First off 2 of the 12 dimensions formed a fine-mesh grid on the surface of the singular universe (presumably derived from a 2-d compactification when the Metaverse was spawned). The remaining 10 dimensions are unfolded and pervade the entire volume of the singularity. This differs from the standard treatment of 12d string theory which suggests that at some point in the Big Bang, two dimensions of the 12 were compactified into a 2d-brane which becomes the toroidal surface of the universe. (So in our cosmology the singularity itself may be toroidal).

In string cosmology during the Big Bang, 6 of the remaining 10 dimensions are compactified into tiny lines that each retain direction. That is, each line-dimension has a direction even after being "splined" into tiny segments. For convenience we may picture them lined up as follows:

1.east->west and 2.west-> east; 3.north->south and 4.south->north; and 5.up->down and 6.down->up.

In order for space to inflate in 3 dimensions, the various dimension directions must first line up two by two as specified above. If so the east-west spline folds up into a circle and is superimposed on the west-east fold. Coincidentally the north-south spline folds up on the south-north spline and the up-down spline folds up on the down-up spline. (The actual brane folding process is moreconvoluted than lines and circles providing for 500 or so topological holes.) The spin vector of the west-east fold is opposite that of the east-west fold and presumably they may cancel each other. This compact folding or compactification of "splines" with opposite directions allows (physicists think) for one space dimension to inflate and fill the entire volume of the resulting universe. Likewise the other 2 space dimensions inflate.

Metaverse Cosmology

In order for the Metaverse to be compatible with each universe, we assume that the 14d-Metaverse has a nearly infinite 4D-spacetime that within each universe is orthogonal to the 4D-spacetime of each universe. We assume that the Metaverse as well has a separate 3D-cubic lattice of 6d-Calabi-Yau compact-manifold particles, the Metaverse comp-machine, similar to each universe comp-machine .

That leaves 4 dimensions that might also be compactified. Somewhat like the 2D-surface of each toroidal

universe, a 4d-compactification is likely to form a Cartesian fine-mesh 4D-grid or lattice in which the Metaverse spacetime and its CY particles reside in a 3D-slice at "real" time T. We conjecture that the 4D-Cartesian volume is a 4D-Mindspace on which the quantum eigenfunctions and their quantum states are CY computed and written for all comp-time from zero to infinity, zero being the creation of the Metaverse.

Since the nearly infinite Metaverse CY subspace has a near infinity of bits to compute with, it can be consistent and effectively complete. If so the Metaverse CY subspace can compute all possible quantum eigenfunctions and their quantization into quantum states, some or all of which may result in the physical matter of each universe. Somewhat like the concept of a block universe where everything is deterministic, the Metaverse can in its beginning compute everything that will happen for all time with afterwards only minor "real time" corrections as discussed below.

From a cosmology perspective, the Metaverse comp-machine first computes the mass within the singularities that become universes and the gravitational attraction between them. It is thought that only gravity exists outside of universes whereas both gravity (via spacetime distortion) and gauge forces exist inside each universe [Ruquist]. The Metaverse computes as well the dimensional compactification and space inflation for each universe, and subsequently the gauge forces between physical particles as they decay from the GUT force to the Strong and Weak force to the Electromagnetic force; and finally it computes the evolution of biophysical molecular structure in an expanded universe.

The Block Mindspace

It is convenient to think of the 4D-Mindspace as including “all possible” Many-World multiverses in virtual form, whether or not they are actually realized physically. Computations by the Metaverse compact manifolds at any point in “real” time are deterministic including random stochastic processes (that the comp machine probably determines algorithmically) which seemingly makes comp “timeless”.

A “Block Universe” is static or timeless where all MWI possibilities are written. In a 4D-Block-Universe space, one 'time-like 'space coordinate runs from zero at the Big Bang to infinity or the Big Crunch. In analogy, the Metaverse "Block Mindspace" is a “timeless” 4D-Space that contains all virtual quantum functions and states, everywhere and forever.

The entire Mindspace was computed at moment of its creation. In fact, all matter has existed since then in our cosmology. If so, arithmetic processing must be instantaneous from a first-person perspective. This is consistent with the concept of a holographic universe where physics at the surface of the universe must be transmitted instantly to its interior since most of the interior is not in the light cone of its surface. One need for a “real” time dimension is discussed below. A rather interesting aspect of the Mindspace is that the Metaverse comp-machine leaves a trail of their computations as a function of "real time". .

MWI versus SWI Cosmologies

We conjecture that the Many World Interpretation (MWI) of quantum theory applies in our cosmology to the 4D-Mindspace. However, in MWI every quantum state in the Mindspace is realized physically but in separate parallel but overlapping worlds called collectively the multiverse. The alternative is a Single

World Interpretation (SWI) most famously due to Bohr and involving physical eigenfunction (or wave) collapse. However, it seems inconceivable that Wave Collapse can happen physically.

On the other hand, the Metaverse comp machine instantly computes the location of all quanta of all eigenfunctions in the Mindspace. That is, besides computing all possible eigenfunctions, the comp machine also computes a quantum state's stochastic probability and location associated with its eigenfunction well before any become physical. So each quantum state is like a singularity in the Mindspace. It is then easy to imagine how all of these singularities could become physical in a MWI universe at the price of creating a new parallel world for each quantum state, collectively forming a highly-repetitive virtual multiverse (due to the measure problem).

The SWI alternative is based on Feynman's Quantum-Electro-Dynamic (QED) theory, the most experimentally accurate physics theory in existence. In using renormalization to derive QED, Feynman assumed that anti-particles came back from the future to cancel unwanted infinities, an assumption that also seems physically inconceivable. But given instantaneous arithmetic processing in the Metaverse Mindspace, the virtual anti-particles are instantly available.As a result in any interaction only a single quantum state becomes physical rather than all of them. SWI perhaps benefits by having miniscule comp power requirements compared to the MWI requirements to compute a repetitive multiverse. But the Metaverse may have enough comp power for either cosmology.

Summary

The above is a bare-bones description of how Tegmark's Mathematical Universe Hypothesis (MUH) (really a conjecture as hypotheses can be tested) can be made more concrete (in the context of a 26d-string-theory Metaverse cosmology) by replacing the usual postulate of an infinite "information space" by a finite universe and an effectively infinite Metaverse. The primary comp machine is the 3D- Metaverse Calabi-Yau (CY) subspace (a cubic lattice of compact manifolds) that computes everything everywhere and forever in an effectively infinite 4D-Block Mindspace with one time-like space dimension.

Besides recording everything that might happen everywhere in the common future of the Metaverse and all its universes, the Mindspace also records everything that actually did happen including what became physical in the past. The Metaverse computation subspace is an extrapolation or 'of the same form' as the well-known compactification of 10d-superstring theory into a 3D-cubic lattice of Calabi-Yau 6d-compact-manifolds, thought by string theorists to pervade the 3D space of each universe.

Without going into mathematical detail, we indicated how the arithmetics of enumerable compact-manifolds (each being distinct from all others) is fundamental to quantum mechanics, which in turn is fundamental to string cosmology. We propose that from a human perspective, the computations of the manifolds are instantaneous (consistent with the contention of Computational Theory experts that computations are timeless) based on:

1. a holographic universe and by extension a holographic Metaverse; and

2. the likelihood that each universe CY subspace is totally BEC quantum entangled, and as well
3. the entire Metaverse CY subspace is quantum-entangled with itself and with universe CY subspace, both being Bose-Einstein Condensate s (BECs).

From the possibility of instant computations we suggest that Feynman's Quantum Electrodynamics as well as Cramer's Transactional Analysis may be realized without invoking particles coming back from the future which in turn leads to the possibility of a single-physical-world universe rather than the need for comp purposes of highly repetitive MWI virtual multiverses. That is, because of the MWI Measure Problem, the Mindspace of a MWI universe would require endless repetitions from which a frequency can be extracted. In MWI quantum theory that frequency is proportional to the probability associated with each quantum state. In SWI the comp-machine needs only to compute one virtual MWI multiverse. Except for the possibility of symmetry compression, the MWI repetitive multiverses would require vastly more computer power.

Degrees of Completeness and Mind-Matter Dualism.

This paper conjectures that algorithmic-information-theoretic computation complexity is limited. Perhaps the most novel aspect of this paper is the idea that the effective degree of comp-completeness is based on the size of the universe (or Metaverse). This connects to the conjecture that life and consciousness may emerge when the complexity of computing a physical structure requires more bits than available in a holographic universe. Such processes are said to be emergent. In other words, below the threshold of complexity, Universe comp can completely cope. But above the Universe complexity threshold the Metaverse comp plays a greater role. The Metaverse is probably where the emergent Platonic "forms" come from.

By introducing the concept of "degrees of completeness" in a "finite" information space, we get a Mind-Matter Dualism. That is, the Metaverse may be sufficiently complete or large enough to create physical energy and matter, but be nearly "timeless" just because it's computations are so precise, consistent with a static Block Space; whereas the bits available in any universe are too small to create matter, but small enough to allow both a universal consciousness and biological consciousnesses.

All energy and matter are created in the beginning of the Metaverse and is thereafter conserved but matter is still intimately coupled to the Mindspace by strings and their eigenfunctions. For example in string theory charged particles are modeled as charges on the end points of open strings that radiate eigenfunctions or quantum waves. Bosons being closed strings are relatively free.

A nearly infinite Metaverse can compute the consciousnesses that exist in each universe even though the universe comp cannot. So it knows so-to-speak about consciousness but may not itself be capable of consciousness. More generally all forms of life that are emergent in any universe (because of the incompleteness of universe comp numbers) are computed in the Metaverse. And of course the inflation and compactification of universe dimensions must be computed in the Metaverse as the universe comp machine does not yet exist until after universe compactification. That also suggests that if the Metaverse came from a primordial singularity, then its compactification must have been computed in an even higher-level space. It may be turtles all the way down- an open-loop cosmology.

Mind-Body Consciousness

We conjecture that a cosmic Mind consciousness of each universe results from the arithmetic incompleteness of the finite cubic lattice of Calabi-Yau compact manifolds in each universe. We expect that in a Mind/Matter duality, our individual (human) virtual Mind consciousness resides within that universal consciousness and couples (by means of BEC entanglement) to our separate physical matter consciousness. We expect that physical consciousness will be scientifically found to depend on Bose-Einstein Condensates (BECs) and that a physical BEC pervades the entire human brain. Frolich was the first to suggest that possibility based on BEC (quantum-coherent) membrane dipoles, but that model was falsified. A current theory of consciousness by Penrose and Hameroff is also based on BEC quantum coherence, but in membrane microtubules.

Experiments on physical BECs indicate that information in one BEC may be exactly copied in another even if the other has different materials. This supports our conjecture that the human BEC Mind couples via entanglement to BEC media in the physical brain. BECs entanglement is immaterial, so-to-speak.

The Problem of Time

Lastly we have been discussing string cosmology as if time exists but at the same time we suggested that the Metaverse computations are timeless, which is probably quite confusing. Time is a given dimension in string theory. We have conjectured a separate time for the universe and the Metaverse, to get a complex "real" and "imaginary" (or virtual) time. But at the same time (so-to-speak) we conjecture that the fundamental arithmetic computations are timeless, or instantaneous from a human first-person perspective. The problem is that if the computations are deterministic, then there is no need for “real” time as a dimension. Comp-time will do. It follows that if so, there is no need for consciousness or free will either. Time may just be a convenient way to explain things.

However, based solely on our subjective experience, (many of the above conjectures are at least based on physical experiments and/or mathematical theory) we expect that our conscious free will is at least partly unpredictable. That is, ahead of time (so-to-speak) the Metaverse realizes that physical consciousness will evolve and have free will and make unpredictable decisions that will force the Metaverse to constantly re-compute the future. As a result we might expect that the Metaverse would introduce a uniform “real” time dimension to begin with in order to conserve comp-time.

Conclusion

Metaphysics cannot be a Theory of Everything (ToE). It's more like a Theory of Anything (ToA) since with metaphysics anything is possible. The value of metaphysics, if any, is the possible interpretation of experiences like quantum mechanics. So metaphysical or meta-system models may give meaning to both to objective science and to subjective experience like the possibility of afterlife. But whatever meta-model

is cobbled together into a system, it must be self-consistent as well as consistent with science and in particular experimental and theoretical physics.

For example, whenever possible the meta-model should be consistent in 'form' with science. Looping or periodicity is in general requirement for any system and indeed the Metaverse/Universe Fecund Cosmology is a periodic system in 'form' in the same manner as EM waves and steam engines, but differs in math detail.

We conclude that Super-Massive Black Holes (SMBHs) in the center of most galaxies, each spawns another Metaverse (instead of a Smolin/Poplawski-type single universe) to complete a loop-string cosmology with high fecundity. So it's not turtles all the way down. It's turtles begetting turtles. The Cosmos is a form of life.

Appendix

Reality consists of :
1. Dualisms:
like the Mind-Matter Dualism
or the Compact Particle-Natural Number Dualism

2. as well as Open and Closed Trisms:
like our closed-loop Math->Mind ->Matter->Math cosmology
or the open-loop (Penrose) Matter->Mind->Math cosmology
or the open-loop (Tegmark) Math->Matter->Mind cosmology.

Penrose suggestion 'that the correct "Picture of Reality" is Materialism->human Consciousness->human Math' does not contain a loop. Tegmark suggestion 'that Math->Matter->human Consciousnes is more fundamental' also does not contain a loop.

Our Meta-cosmology, given that the Metaverse creates all Energy and Matter in the beginning, is more like a Math->Matter cosmology, and a separate Math->Mind cosmology, resulting in a Mind<->Matter Dualism.

The loop-mechanism is Black hole->Metaverse Fecundity. That is, Super-Massive Black Holes(SMBHs) begetting Metaverses. The key Creation Mechanism in this Meta-system is that the SMBHs (in the center of most every galaxy in a universe) reconstitutes the 26d-Unified Field, to give birth to the next Metaverse.

To form the Unified Field, each SMBH swallows up the both:
1. local universe constituents: matter, energy and its 3D-space and including its 6d-Calabi-Yau subspace;
2. and the local Metaverse constituents: the 4D-Metaverse-Spacetime with its 6d-Calabi-Yau Subspace and its local 4D-Mindspace where Calabi-Yau computations are written in memory. So memory may be lost in "Black-Hole Creation".

The key conjecture however is that arithmetic number systems can be computationally (comp) limited by the size of the universe. So that for example a small baby universe could make only imprecise computations. Such

a universe then has great dependence on Metaverse computations which are relatively constant. But after inflation to a size corresponding to around 10^120 bits of information, the universe comp machine can satisfy most system requirements. When it lacks sufficient comp power at some threshold level of complexity, life is emergent. And human consciousness may gain access to abstract Metaverse forms.

The Bit-Limit Conjecture also leads to the concept of "effective degrees of completeness" so that the near total completeness of the Meta-comp machine allows computation of Energy, Matter and the laws and constants of physics and the rest of science, as well as creation of a universe space Contraction->Inflation Dualism and a structure CY manifold-> Natural Number theory Dualism; whereas the "relative incompleteness" of the Universe comp machine yields human consciousness.

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