Opinion and Perspectives

Implications of a Multiverse String Cosmology

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Abstract

Vafa’s (11+1) F theory is extended by means of Bars’ 2T holographic theory to yield a 14d Multiverse theory that permeates the brane of a 12d Universe in which both the Universe and the Multiverse have (3+1) space-times. Given the 2d toroidal compactification of F theory, we conjecture that the Multiverse has a 4d Cartesian compactification that is filled with 3D+T space-time via the standard 6d elliptic Calabi-Yau compactification, as in both M and F theory. The result is exemplified using supermassive black hole cosmology. Implications of the existence of a Multiverse and at the Planck scale, two Compact Manifolds, one for the Multiverse and one for our Universe, are explored. In particular, the Multiverse is proposed to be the pre-space-time for which gravity is nonlocal and instantaneous, and which allows quantum entanglement to achieve unity of mind.

Key Words: string theory, multiverse, cosmology, compact manifold, Bose-Einstein condensate, gravity, consciousness

Introduction

The term Multiverse, coined by William James in 1895 (James, 1956), has mainly come to refer to the parallel universes of Hugh Everett’s Many World Interpretation of quantum mechanics. A search for “Multiverse” in the Cornell physics archives arXiv.com yields 50 titled entries back to 2004 with over half-concerned with parallel universes. That, is not the kind of Multiverse we are concerned with here. Much of the remaining entries are concerned with the chaotic inflationary universe proposed by Andre Linde (Linde, 1996). This is closer to what we mean by multiverse as the range of superstring solutions is often considered properties of individual bubbles within the Linde universe. However, the size of an inflationary bubble in Linde’s theory is staggering \(10^{10,000,000,000}\) cm, which should be compared to a Hubble radius of \(10^{28}\) cm. I find this theory uninteresting just because of its bubble size.

Only one of the 50 entries (Vaidya, 2007), however, refers to Lee Smolin’s hypothesis of Cosmological Natural Selection and Weak Anthropic Principle (Smolin, 1999), which is the cosmology of interest here. Even though, in the brane cosmology of string theory, our Universe is considered a 4dimensional brane in a higher dimensional space, such thinking has largely supported cyclic cosmologies (Steinhardt, 2001), rather than Smolin’s cosmology.

Our particular interest in Smolin’s so-called “fecund universes theory” is twofold. First, it is the cosmology with the most obvious detail being amenable to string theory derivation. Very few papers about the
Multiverse are about the actual creation process, excepting perhaps Linde’s oversized chaotic inflationary universe and the cyclic universes. Second, and here I reveal a religious bias, the birth of baby universes from supermassive black holes at the centers of galaxies is consistent with the Hindu concept of the Cosmic Egg within which sits the God Vishnu with universes streaming out of his nose (Bhagvatam, 1989).

So assuming that supermassive black holes in the galaxies of our Universe and all other existing universes may spawn baby universes that flow into the space of the Multiverse, we argue that a 26d reality is required. This reality is split between a 14d Multiverse and 12d universes. The Multiverse permeates the brane of our 12d Universe (and all other universes). However, only a 12d GUT field is recreated in supermassive-black-hole singularities at the centers of galaxies in each universe consistent with Brookhaven experiments (Steinberg, 2009) at near Big-Bang conditions. In addition, mass in the brane of the Universe induces gravity in the Multiverse, which in turn distorts the space-time of the Universe; and so 3D orbital stability is maintained.

The 12d Superstring F-theory of Cumrun Vafa (Vafa, 1996) is a guide for the required compactification of the 14d Multiverse Superstring Theory. Based on the initial 2d compactification in the creation of our Universe into a toroidal fibration (or put simply, a grid), we conjecture that in the Multiverse there is a 4d compactification into a Cartesian grid. Thereafter or concurrently 6d compactifications fill the torus or the Cartesian grid with 3D+T spacetimes along with the 6d compact elliptic Calabi-Yau fourfolds (Cordova, 2009). The fibres that make up the 2d or 4d grids and the two 6d compact manifolds at the junctions of each grid are all at or below the Planck scale and therefore constitute an invisible, undetectable subspace (Note that small case letters are used for individual Planck-volume manifolds and the compactified dimensions therein; whereas caps are used for structures and expanded dimensions that permeate the universe or Multiverse).

Itzhak Bars’ 2T 13d S-theory (Bars, 1999) combines his holographic 2T Physics with Witten’s 1T 11d M-theory. We presume that 2T physics may also be combined with (11+1) F-theory and that it can be done with an additional three large dimensions. The result connects the space-time of the Universe to the space-time of the Multiverse. In the multiverse the 3D+T dimensions of the grid are perhaps infinite. But the 3D’+ T’ space-time of our Universe is finite.

The two Compact Manifolds (i.e., with 6d compactifications) are Bose-Einstein Condensates (BEC) possessing quantum entanglement since compactified dimensions are effectively motionless. At this point it is appropriate to quote from a quantum computer view of space-time at the Planck scale (Zizzi, 2003) which applies to either CM:

“Due to superposition and entanglement, quantum space-time can compute a Boolean function for all inputs simultaneously (massive quantum parallelism). We argue that the functions which are quantum-evaluated by quantum space-time are the laws of Physics in their most fundamental, discrete and abstract form.”

Therefore we conjecture that the laws of physics are stored and applied by either CM, but the Universe contains gauge forces whereas the Multiverse contains the force of gravity, gravitons, that induce space-time curvature in the Universe.

We also conjecture that Compact Manifolds of the Multiverse and of our Universe are entangled such that the Multiverse can make a copy of everything that happens in our Universe. It is presumed that the Compact Manifold of the Multiverse controls the copy process, perhaps by means of the Penrose-Hameroff Orch-OR process (Penrose, 1994). As such, the virtual space-time of the multiverse contains a record of every happening in our universe from 0<T<T’. We note that occult literature contains claims that all knowledge of human experience and the history of the cosmos are collected in the Akashic records. Such a copy process is also consistent with those who have returned from a Near-Death Experience (NDE) and had a life review in that process. It is also consistent with Sheldrake’s theory of morphic fields which suggests a living,
developing universe with its own inherent memory (Sheldrake, 1995), only the memory is stored in the Multiverse.

It may be appreciated that the space-time of the Multiverse is semi-infinite extending from now back to the deep recesses of time in the Multiverse, well beyond the birth of our universe. However, except for the present time T= T' the multiverse is static, possessing only a fixed history of everything in every universe. The Compact Manifold of the Multiverse as well as CM every universe exists only in the “now”. Yet because of quantum entanglement, all information is available instantaneously at some level of consciousness just as gravity is instantaneous (Hu, 2006).

The components of physical BECs are indistinguishable. That is, every matter particle has the same wave function. But that will not do for the Multiverse copy process and so we conjecture that every Planck volume in the space of the Multiverse, as well as the space of each universe, contains a distinguishable compact manifold from the 10^{500} thought to exist as solutions to the equations of superstring theory, primarily from F theory. Presumably, distinguishable Planck volumes are not required along the static T axis of the Multiverse. Therefore, as above, the Compact Manifold (CM) is not required to fill the Time Dimension of the Multiverse. That is, the present time is the same time everywhere.

In this cosmology, the CM of each universe performs instantaneous mathematical processing as part of its control of physical particle interactions. This aspect of our cosmology has some experimental verification (Steinberg, 2009) using a string theory where every matter particle is attached to a string, which is attached to the CM at its other end. We conjecture that every matter-particle in the universe is connected to the CM by a string and that this is how the CM carries quantum waves and controls the universe. Such control of physical processes is the grand implication of the existence of compactified dimensions. In this sense the Universe CM is omnipotent. Being a BEC it is also omniscient due to quantum entanglement, and of course omnipresent since it is a subspace that permeates the entire Universe. An even grander implication is the possibility that a CM cosmic consciousness may derive from either Universe and/or Multiverse CM mathematical processing of distinguishable Planck volumes. Any one of the several mechanisms proposed for consciousness in the human brain may be applicable to either Compact Manifold. But perhaps more interesting is that the Multiverse may be the non-spatial and non-temporal pre-space-time where gravity is nonlocal and instantaneous, and where the unity of mind is achieved (Hu and Wu, 2006). This is also consistent with the Buddhist concept of the “citta” which is the location of the human will or intention. Moreover, of course, the copy of all Universe physical events into the Multiverse is consistent with the concept of karma. One may speculate that human enlightenment is when all string connections to the Universe CM are severed.

Background

The existence of a Multiverse, in which our Universe and presumably many others are embedded as 3D branes, is inferred from two recent bodies of work in high energy theoretical physics that go beyond the Standard Model (SM) in order to solve some SM problems (e.g., the hierarchy and the cosmological constant). The first is the string phenomenology by Lisa Randall and Raman Sundrum (Randall, 1999) which has expanded into well over a 100 papers since then, mainly devoted to the search for ‘Large Extra Dimensions’ at the LHC. Here is the abstract of one review of these papers, “Large and infinite extra dimensions” by Rubakov (Rubakov, 2001):

“The emphasis in the development of theories with more than three spatial dimensions has recently shifted towards “brane world” picture, which assumes that ordinary matter (with possible exceptions of gravitons and other, hypothetical-particles which interact very weakly with matter) is trapped to a three-dimensional sub-manifold - brane - embedded in a fundamental multi-dimensional space. In the brane world scenario, extra dimensions may be large, and even infinite; they may have effects, directly observable in current or forthcoming experiments. On the basis
of simple field-theoretic models, various ideas in this direction are exposed at a non-expert level.”

The second inference comes from the *Two-Time Physics* investigations of Itzhak Bars and his students at USC. Quoting from his USC biography (Bars, 2009):

“According to the body of work in 2T-physics, there is more to space-time than can be garnered with 1T-physics. 2T-physics introduces additional one space and one-time dimensions, which can coexist with the familiar 3+1 dimensions as well as extra space dimensions of tiny sizes known as Kaluza-Klein-type dimensions, but the new ones have very different properties. First of all, the extra 1+1 dimensions in 2T-physics are not small. However, there are gauge symmetries that effectively reduce 2T-physics in 4+2 dimensions to 1T-physics in 3+1 dimensions without any Kaluza-Klein remnants. The reduction is not unique because there is an infinite variety of 3+1 embeddings in 4+2 dimensions”

Additionally, there are holographic properties of this model also from the work of Bars. To quote again from the USC bio:

“Similarly, even though according to 2T-physics a unique dynamical system in 4+2 dimensions generates a large variety of 1-time “shadows”, 1T-physics presents these “shadows” in 3+1 dimensional space-times as different dynamical systems in terms of different Hamiltonians (different times). In this way 1T-physics misses the underlying relationship between the “shadows” as well as the underlying properties (e.g. symmetries) of the higher dimensional space-time. Actually, it turns out that each “shadow” is a holographic image that retains all the information of the d+2 structure.”

Thus Bars might extend his 13d (4+2) S-theory (Bars, 1999) from 1 to 3 extra space dimensions, and apply it to F-theory, to support the inference of our Universe is a 3D brane embedded in a larger 3D (Multiverse) space. He replied to a query regarding the number of space dimensions:

“Yes, my theory admits any number of space dimensions. Limits on that number emerge from structures such as string theory, as you seem to be well aware of.” (Bars, 2008).

So string phenomenology and more directly Two Time Physics extrapolates to the notion of two (3D+T) space-times. The original 26d closed-string theory of Lovelace (Lovelace, 1971) had two time dimensions, as well as particles with imaginary mass, for which it was rejected. However to obtain a 26d Multiverse theory, 2T Physics must be applied to Vafa’s 12d F-theory where the 26d are split into 12d for the brane of the Universe and 14d for the Multiverse. One ambiguity is that F Theory is sometimes said to be (11+1) and at other times (10+2). That is, some references claim F Theory contains two time dimensions. We obviously require the (11+1) version.

**Top-down 26d String Theory**

So it seems that Vafa’s 1T 12d theory must be extended by Bars’ 2T physics to get a 1T 12d Universe along with a 1T 14d Multiverse. The details of the relationships between M-theory, F-theory, S-theory and Multiverse theory are outside the scope of this paper. However, as an aside, it is interesting that Vafa named his superstring theory F-theory where the F stands for Father, under the consideration that the M in Witten’s superstring theory stands for Mother. We presume that the S in Bars’ 13d theory then stands for Son. Therefore, a Bars-type 14d superstring theory would be called D-theory where the D stands for Daughter. In addition, it is a convenient oversimplification to think of compactification as resulting in a grid of 2d or 4d wires connecting 6d junctions (called compact manifolds).

Consider the following simple model: The original superstring theories were in 10 dimensions (10d) which is the most basic form of superstring theory. In such theories, 6d of the 10d are *COMPACTIFIED*. That is, 6d dimensions shrink down to the Planck scale or less, as 3D space dimensions *INFLATE* in the Big Bang and one dimension remains time T'. The inflated dimensions are referred to as (3+1) space-time. In 11d M-theory, the extra dimension just allows for incorporation of all 10d string theories plus 11d point-particle quantum gravity as duals. Duality just means it’s the same physics in a different approximation, like the wave-particle duality.

However, in F-theory, two dimensions are compactified into a torus before or perhaps coincident with the 6d
The 2d compactification into a torus indicates that in the creation of our Universe and maybe all universes, the first act of creation was to lay down a finite grid of Planck scale wires in the shape of a toroidal surface in which the space of the Universe (U-space) could expand. The 2d grid is relatively passive, perhaps only being capable of distortion due to the presence of mass in the Universe; whereas the 6d Compact Manifold may have active control of physical processes based on the laws of physics.

That leaves 14d for the MULTIVERSE. A conjecture is that all of the dimensions of the Multiverse are also compactified except for 3 Space and one Time Dimension. If so, then 10d dimensions form a fine mesh screen or matrix in the Multiverse. But if the creation of the Multiverse is like that of a universe, then 6d compactify as 3D inflate; and 4d may have compactified beforehand into a static 4d fine-mesh grid at or below the Planck scale, just like in F theory (except the 2d compactified into a flexible toroidal grid).

Occam’s razor suggests that the 4d grid is Cartesian with 3 space coordinates and one time-like coordinate into which the 6d compactification provides for expansion of 3 Space Dimensions. The Multiverse Compact Manifold is presumed to exist at only a single time T which is the same time T’ as in each universe, i.e., T= T’. Such a Multiverse grid and space-time are likely semi-infinite in the Time Dimension. We speculate below based on superstring landscape considerations that the M-space of the Multiverse is not infinite, and may be a part of something bigger, perhaps coming from a black hole in a higher level space.

A 26d String Cosmology

In the beginning was a 26 dimensional primordial UNIFIED FIELD where all dimensions were of uniform size. We speculate that the 14d Multiverse is first created within the unified field by the compactification of 10d and the expansion of 3D. One possibility is the compactification of an additional 8d, (perhaps along with the 10d compactification), to make a 3D’ core universe. The unified field could do this many times to make many universes which propagate out into the Multiverse. OR, each resulting universe could contain a mechanism that recreates a 12d GUT field in the singularity a black hole (that can create universes but not the Multiverse) which is consistent with the inferred observation of an upper mass limit of the supermassive black holes at the center of galaxies in our Universe. (Natarajan, 2008). If the primordial 26d unified field were a supermassive black hole we might characterize First Creation as the result of inflation and compactification of 14 dimensions of the 26d, e.g.;

26d primordial black hole → T(M-time) + 3D(M-space) + 4d(grid) + 6d(manifold) + 12d (black holes). Where the 12d black holes are carried along in the expansion of 3D M-space.

In a Second Creation the 12d black holes then generate universes. 12d black hole → T(U-time) + 3D (U-space) + 2d (grid) + 6d (manifold). Universes then make their own 12d black holes that generate more universes.

Conservation of phase space supports that conclusion. There is enough phase space (microstates) in a 12d black hole to fill a new universe, i.e.: For Planck-volume equality to fill 3 dimensions of space within the Universe:

\[(l/p)^N = (L/p)^3\]

we get \(L/p = (l/p)^{N/3}\), where \(N\) is the number of space dimensions in the black hole, \(l\) is the size of the black hole singularity, \(p\) is the Planck scale and \(L\) is the size of the resulting universe.

Then supposing the size in Planck units of a supermassive black hole singularity is \(l/p = 10^{36}\), or 100 meters, we get...
for the scale of the Universe, \( L/p = 10^{12N} \). The observable universe (Egan, 2009) is \( 3 \times 10^{80} \) cubic meters and so the number of Planck volumes in it is \( (L/p)^3 = 10^{180} \) or \( L/p = 10^{60} \) for which \( N = 5 \). The actual universe is of course much larger than the observable universe. However, since \( N \) can be as large as 9 (not counting the 2d grid or the time dimension) 100 meter 12d black hole singularities could provide for universes where \( L/p = 10^{111} \).

A 10 cm 12d singularity provides for \( L/p = 10^{99} \). Given \( 10^{500} \) or more distinguishable Planck volumes, the Multiverse then has room for about \( 10^{100} \) universes on which every Planck volume has a distinguishable string theory. Therefore, despite the gross uncertainty of our guesses for singularity and universe size, our conclusion that 12d black holes containing GUT fields are adequate. Deriving the number of microstates from 2D and (N-1)D holographic surfaces is even more robust.

Discussion
According to string phenomenology, gravity exists in the Multiverse and space-time distortion exists in the Universe as demonstrated by metamaterial experiments (Cheng, 2009). Matter and the gauge forces like the strong force, the weak force and the electromagnetic force only exist in the Universe. We conjecture that the Multiverse 6d compact manifolds control the copy process to the Multiverse; and the universe 6d compact manifolds control the gauge physics of the universe. In this context the grids control the shape of each space and the 6d junctions control and copy all physical particle-particle interactions.

Based on a string theory prediction of a “perfect liquid” (a BEC of quarks and gluons) at both near-absolute-zero and near-big-bang temperatures and their subsequent observation (Steinberg, 2009) wherein each matter-particle is attached to a string, we conjecture that every particle of matter in our Universe is connected to the entangled BEC Compact Manifold by means of a string. That suggests how the Compact Manifold controls all matter-particle interactions. It follows that the Compact Manifold of the Universe provides the vacuum Zero Point Energy ZPE and its virtual particles, and the connecting string is the location of quantum wave functions. Gauge forces being closed strings are relatively free. Gravity of course (due to space-time distortion in the brane of each universe) is not free. This model will be falsified if gravitons are detected.

The number of solutions to string theory is dominated by F-theory compactifications indicating that there are \( 10^{500} \) or more distinguishable solutions for the Compact Manifold CM. We have estimated that the extent of each universe may be as large as \( L/p = 10^{120} \) which amounts to \( 10^{560} \) Planck volumes. So every Planck volume could have a distinguishable compact manifold with presumably neighboring Planck volumes having slightly different properties but the same laws of physics. In fact, we can estimate the volume of the Multiverse assuming that every Planck volume in it is distinguishable. Given that the observable universe at \( 3 \times 10^{80} \) cubic meters has \( 10^{180} \) Planck volumes, the 3D volume of the Multiverse may be as large as \( 3 \times 10^{400} \) cubic meters with every Planck volume in it having a distinguishable compact manifold. (The 4D volume including the Time dimension does not need distinct Planck volumes for lack of a CM).

Some distinguishable CM solutions are needed for all the embedded universes. But unless the packing density of universes in the Multiverse is close to one, our conclusion regarding Multiverse size is unchanged. If every Planck volume in the Multiverse is distinguishable, the size of the Multiverse is about \( 10^{320} \) of our observable universes. Given that, we can observe out to about 13 Billion light years, the extent of the Multiverse if a sphere would be about or as much as \( 10^{17} \) light years.

Conclusion
In this cosmology, the Multiverse is a 4D space-time that apparently has always existed. In fact, time does not seem to exist except in the present, just as in our Universe. Time does exist as a pre-ordained infinite compactified dimension. In some sense, it exists as a semi-infinite 4D space dimension, but that dimension is static except for the “now”. Our conjecture is that everything that happens in every universe in the Multiverse is recorded as a function of time and location in the 4D space-time of the Multiverse. In
this scheme, the Multiverse does not record the future. It records the present and stores the past.

The subspace of compactified dimensions in each universe, the so-called Compact Manifold, actively controls all physical processes in the universe by strings connecting it to all matter particles; and being a BEC, it does so with its own instantaneous processing for which we expect that every Planck volume is distinguishable. In addition, because it is a BEC, the flow of information in it is not limited by the speed of light. If a human could "see" in the CM subspace, everything would be seen as it was happening and not delayed by the speed of light as in astronomy. For example, if the earth were to experience a nearby supernovae, something that on the average in the Milky Way should happen every 100,000 years or so, a person with insight could “see” it coming before its radiation arrived. Being outside a spiral arm of the galaxy, we have been spared for millions of years.

Finally, it is possible that the inherent divisibility of the CM provides for mathematical processing since every Planck volume is countable and perhaps programmable at some high level. That could be the basis of consciousness at the level of the CM and perhaps even for biological structures. Biological beings would then have three levels of consciousness: physical consciousness; a consciousness connected to the Universe CM; and a consciousness connected to the Multiverse CM. Unity of mind could be provided by either CM consciousness.

I offer this string cosmology as a possible synthesis of science and religion, and suggest the existence of two omnipotent, omniscient, omnipresent and perhaps conscious gods: one being the Multiverse Compact Manifold and the other the Universe Compact Manifold.

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