After arXiv revoked my endorsement because I submitted viXra:1208.0077 to that trifling organization, I was trying to make a better draft to get accepted somewhere else. In hindsight that was obviously a fool's errand. During the rewrite published here, I found a good value for the fine structure constant. I subsequently abandoned this draft and published viXra:1208.0076.

A New Ontology

Jonathan Tooker*

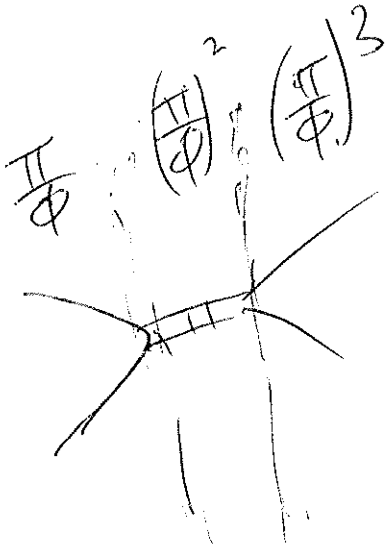
School of Physics and School of Materials Science

and Engineering, Georgia Tech, Atlanta, GA, USA

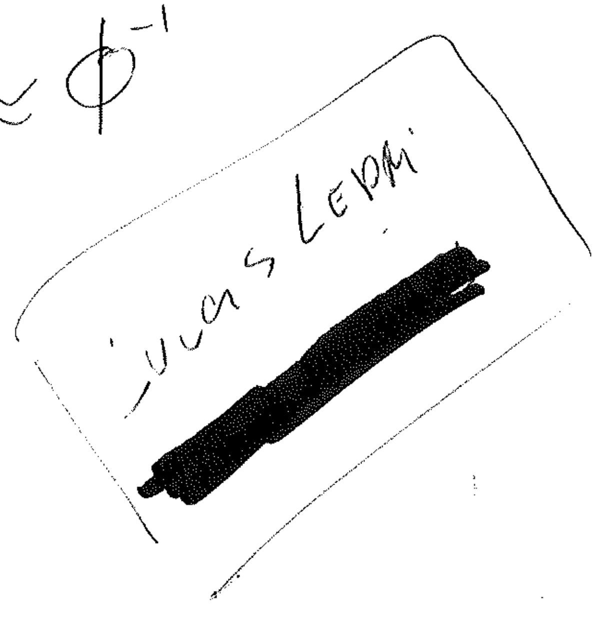
(Dated: December 2, 2011)

Abstract

It is widely accepted that a new paradigm is needed to unify the standard cosmological model (SCM) and the minimal standard model (MSM). The purpose of this article is to construct a modified cosmological model (MCM) that can serve as an entirely new paradigm in physics. Following the program of Penrose, geometry rather than differential equations will be the mathematical tool. Where possible, well-defined thought experiments are employed. Analytical methods from loop quantum cosmology (LQC) are examined in the context of the Poincaré conjecture. A new boundary condition is proposed for perturbative gauge theory as a string theory in twistor space. This new degree of freedom allows a reformulation of string theory without reference to any dimensionful parameter. An external time with which to evolve quantum gravity is derived. The MCM predicts dark energy, parity violation, finite vacuum energy density and a preferred cosmological axis. Observable predictions specific to the MCM are offered for unified investigative effort.



$$\frac{\pi}{2} \approx \phi^{-1}$$



* jonathan.t@gatech.edu

"The temporal order of events [*sic*] is irrelevant."

-Richard Feynman

I. INTRODUCTION

The wildest assumption ever made in physics is that the universe appears isotropic at every point within it. This is based on nothing. If the distance to a surface (the CMB) is the same in every direction, then the surface is a sphere and the observer must be at its center. In the SCM, the universe is x years old. This is extrapolated from the distance measured to the CMB. If observers on Earth look at the same point in the sky for 12 hours they see a point in the CMB $2x$ light years away from the initial observation and both points are in thermal equilibrium.

The speed of light is an upper bound on the transmission of information so it is reasonable to conclude that the big bang interpretation of the CMB is unphysical. The presence of a preferred cosmological axis in the WMAP data eliminates the possibility of simple spherical inflation. In the model presented here the universe always appears isotropic because observers are confined to the origin just as observers in Special Relativity are confined to the ct axis. This will define a new and totally unexplored boundary condition for quantum theory.

It is asked if synergy in new physics can be found; is there a simple unifying principle which remains undiscovered? The MSM and the SCM cannot be reconciled without such a new discovery. A new paradigm is needed in physics and the MCM is such a construction. An excellent discussion of new physics is found in [1]. Section II of this paper will cover the mathematical foundations of the MCM. Beyond this, the physics of LQC are developed to introduce a novel new solution to dark energy. This naturally extends to non-perturbative string theory and not-so-grand unification etc...

INTRODUCE THIS. A key feature of the new ontology presented in this paper is that these regions are physical and coexist with I and II. The geometry of the MCM cosmos can be projected onto the Schwarzschild geometry describing an ever-existing black hole. This will be shown in section V. Observers always occupy a preferred rest-frame at the origin. Via the Principle of Relativity all physics are relative to this preferred frame. This geometry

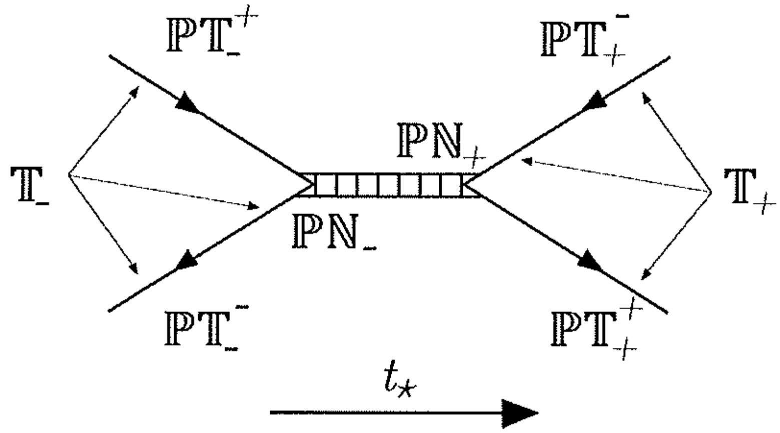


FIG. 1. A new paradigm will be derived *ab initio.*

will be discussed in section V and the method shown in figure 1 is presented in section VI.

De Broglie postulated all moving objects have an associated wave [2]. Today, the wave-function of the universe is considered throughout the literature. But what of the object, U, corresponding to this wave? What can be said about its evolution under the action of LQC? This article will discuss the particle properties of U in the framework of string theory while the wave character is described as a soliton moving in the Cosmos.

It is asked if synergy in new physics can be found; is there a simple unifying principle which remains undiscovered? [3] The MSM and the SCM cannot be reconciled without such a new discovery. In times of acknowledged crisis the scientific community turns toward philosophical analysis [4]. The present work is such an analysis inspired by a trio of lectures given by invitees of Pablo Laguna at Georgia Tech in 2009: two by Sir Roger Penrose and one by Abhay Ashtekar.

II. FOUNDATION

Perelman's proof of the Poincaré conjecture can be applied to LQC in a way not possible with other cosmologies. The conjecture is this: every simply-connected, closed three-manifold is homeomorphic to the three-sphere. Bojowald has shown that the divergent singularities of classical General Relativity do not exist in Nature [5]. Given the absence of sharp corners, the Poincaré conjecture can be applied to LQC as: every simply-connected, closed three-manifold is diffeomorphic to the three-sphere. A solution on the 3-sphere is a solution in Nature.

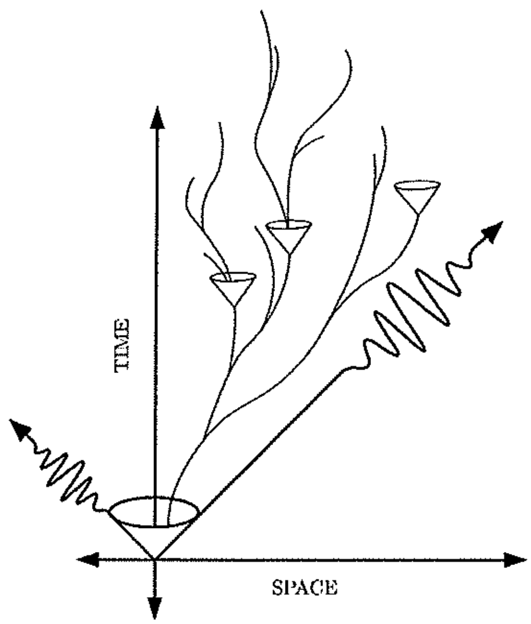


FIG. 2. The future cone of an event and myriad worldlines.

For convenience, this paper will manipulate the FLRW model. The size of the 3-space spanned by its x_i is characterized by a scale factor a.

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}\left(\rho + \frac{3p}{c^2}\right) + \frac{\Lambda c^2}{3} \tag{1}$$

Diagrams are used in physics to transmit information with a clarity not present in excessively quantified arguments. For example, the slope of the lightlike interval in the Minkowski diagram (figure 2) is an excellent proxy for the scale factor a in the Minkowski metric. The MCM is a generalized geometric framework characterized by such physical proxy schema.

The Minkowski diagram is a convenient tool for qualitative analysis and will serve as the foundation on which the MCM is assembled. This diagram is a good approximant for arbitrary regions far from the origin. Near the origin, quantum contributions to equation (1) become dominant and the slope of the lightlike interval fails to characterize $a(t)$. It has been shown that LQC adequately generates a period of inflation very near the origin which reduces to (1) at large volumes [6]. This is will be discussed in section V.

A fractal is a set of points where the scale cannot be determined at any resolution. The qualitatively fractal nature of turbulent spacetime is made clear in figure 2. It will be the goal of this paper to work toward the conclusion that spacetime is quantitatively fractal even

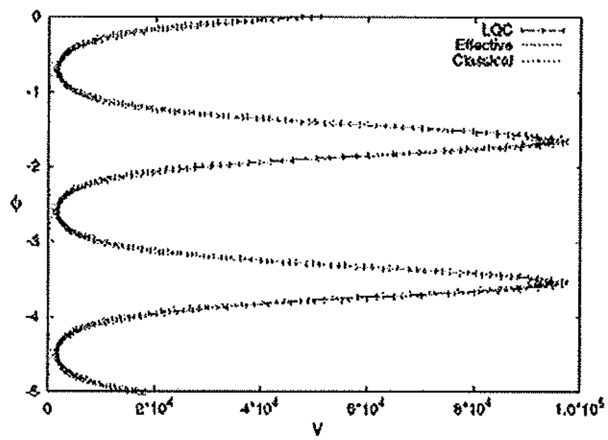


FIG. 3. [7] A modified spacetime diagram. The vertical axis is what Ashtekar refers to as emergent time [8]. The nature of the motion is oscillatory as the Planck regime physics of quantum geometry cause bouncing. Rigorously, the vertical axis is the scalar field and horizontal is the expectation value of the volume operator operating on the wavefunction of the universe. This operator is a direct representation of the scale factor a.

when the resolution is on the order of a_{max}. In the SCM the fractal nature of spacetime breaks down at this resolution because the period of inflation near the origin is represented by a light cone opening wider than $\pi/2$ radians in Minkowski coordinates.

In the framework of quantum geometry, it has been demonstrated that Reimannian space is quantized. Near the singularity, these discretized elements of volume exert a repulsive force which overcomes gravitational collapse and a classical singularity is forbidden [5]. The key result of LQC is the deterministic evolution of solutions through the classical singularity [9–13]. In place of a big crunch, this work predicts a series of temporally cyclic bounces where each bang is the result of a preceding crunch. This is illustrated in figure 3 which first appeared in [7].

The conformal equivalence of the Minkowski diagram and the Penrose diagram (figure 4) is trivial. The universe defined by I and II in the Penrose diagram travels forward through time and this motion constitutes a component of its 4-momentum. If momentum is conserved, the big bang must have thrown an equal amount of matter and energy along both time directions as in figure 5. This is not posed an assumption but rather an absolute fact of momentum-conserving Nature.

Arnowitt, Deser and Misner have used an integral over the boundary at spatial infinity

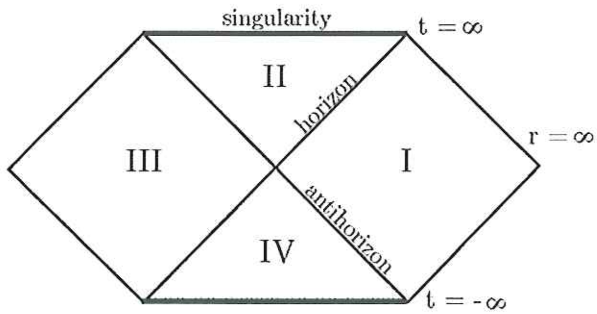


FIG. 4. Penrose diagram of conformal Schwarzchild geometry. The MCM will state that the cosmos exists inside such an ever-existing black hole.

(a 2-sphere) to show that the energy of any universe is positive definite [14]. This derivation and all subsequent proofs are based on the assumption that the universe is a non-orientable Reimannian manifold. The specific form of this assumption is that the surface element at spatial infinity takes the form $dS_i = 1/2\, \epsilon_{ijk}\, dx^j\, dx^k$.

Subsequently, multipole analysis in the WMAP experiment has invalidated this critical assumption. The cosmos *is* orientable and the manifold can admit spin structure. The 2-sphere is the only n-sphere to admit a symplectic form and the MCM assumes this is the true structure of Nature.

$$dS_i = \begin{pmatrix} 0 & 1/2 \\ -1/2 & 0 \end{pmatrix} \epsilon_{ijk}\, dx^j\, dx^k \tag{2}$$

Witten has offered an alternative formulation of the violation of positive-definiteness in [15] where he writes the relationship between the canonical 4-momentum and the momentum in twistor space, $p_{a\dot{a}}$.

$$p_{a\dot{a}} = \sigma^{\mu}_{a\dot{a}} p_{\mu} \tag{3}$$

Ergo, the hypersurface (NEED TO SET THIS UP EARLIER) of the present can act as a topological obstruction and it is possible to have a cosmos at rest in time. This requirement of quantum cosmologies has been stated by 't Hooft [16] and others. The prevailing interpretation of the ADM mass reflects lack of understanding of the Law of Conservation of Momentum. It is strange that differential abstraction has been given precedence over such a fundamental geometric principle.

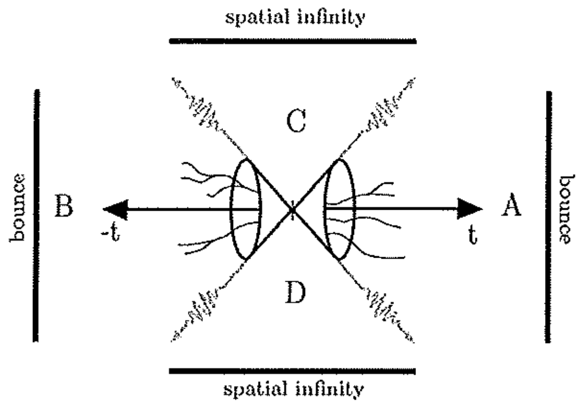


FIG. 5. Loop quantum cosmologies are finite in extent. Periodic boundary conditions are imposed on the Minkowski diagram. The ADM mass for regions A and B have opposite sign due to the presence of a symplectic form at spatial infinity.

In figure 5, region A is a conformal map of Penrose regions I and II. Region B represents Penrose III and IV. Spacelike regions C and D are orthogonal to the Penrose diagram per equation (2).

Two universes, A and B, propagate oppositely along the x_0 axis. One universe is the mirror image of the other so the bounce is topologically equivalent to the symmetric creation of a particle and an antiparticle which we will call U and $\bar{U}$. In the wave picture we view the dynamics of the bounce as a quantum decay [17] to two time arrow eigenstates, $|t_+\rangle$ and $|t_-\rangle$, the existence of which has been suggested by Bars and others [18–27]. In place of a single wavefunction for the universe, we define a wavefunction for the bounce, the past and the future.

$$\widehat{LQC}\,|bounce\rangle = |t_+\rangle + |t_-\rangle \tag{4}$$

$$\hat{T}\,|bounce\rangle = 0 \tag{5}$$

$$\hat{T}\,|t_\pm\rangle = \pm\,|t_\pm\rangle \tag{6}$$

$\hat{T}$ is the time arrow operator and $|t_i\rangle = U_i(x_0)$. U_i is the wavefunction of the 3-space foliated on an observer at any proper time x_0. Following de Broglie, each U_i is both a particle and a cohesive wave packet propagating along the time axis. In section ????? it is shown

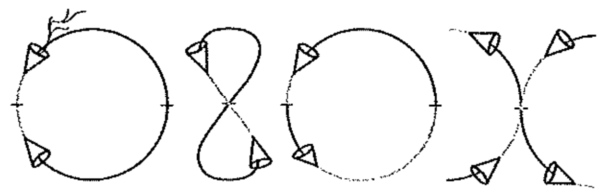


FIG. 6. The flat universes in 5 are mapped to spherical via wrapping. The lower universe, $\bar{U}$, is mapped to hyperbolic via twisting. Grey intervals indicate the past as experienced by an observer in the adjacent cone. Horizontal hash marks indicate LQC bounces.

that this wave packet is rigorously a soliton. The union of the axis and the soliton is a 4D spacetime with the standard metric. The case of $k = 0$ is discussed in section III while $|t_\pm\rangle$ correspond to $k = \pm 1$.

$$ds^2 = dt_\pm^2 - a^2(t_\pm)\left(1 + \frac{kr^2}{4}\right) d\mathbf{r}^2 \tag{7}$$

III. SPACETIME

Before examining the root of dark energy let us clarify the physics of spacetime. Spacetime is a Hausdorff differentiable manifold of topological dimension four. General Relativity dictates that matter and energy will gravitate if connected by spacetime.

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \tag{8}$$

A recent development is this: information can be transmitted through the big bounces of LQC deterministically. This new path of evolution opens avenues to new spacetime topologies [5]. With these physics in mind, let us fold space.

Consider the topological manipulations on spacetime illustrated in figure 6. Given the periodicity in figure 3, the most natural thing is to impose a periodic boundary condition. Advanced metrical analysis of periodicity in spacetime dimensions is found in [28]. To begin, wrap the time axis of figure 5 around a cylinder. U and $\bar{U}$ travel oppositely around the x_0 circle until the bounce occurs at $x_0 = \pm\pi$ in convenient polar units. To preface the string theory in section VI we note that these dynamics are contained in the framework of left and right movers on a closed string with $l_s = 2\pi$.

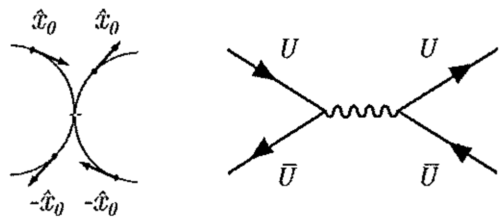


FIG. 7. A duality transformation between the geometric and particle pictures.

The big bang and crunch are identical and may be mapped into each other by twisting the circle into a figure eight. Twist it once further so that time reforms a circle with forward time in the clockwise direction for each universe. Finally, conserve 4-momentum at the vertex for schematic rigor.

To alleviate problems with human intuition in perceiving the flow of time let us do the following. Replace figure 6(d) with the familiar Feynman diagram where a rigorous framework is well established for dealing with interacting parties moving in different directions through time. Figure 7 illustrates the equivalence of the geometric and particle views.

The paradox of QFT on closed timelike curves may appear to invalidate this assumed geometry and the WMAP data certainly rules out the curvature of the universe postulated here [29]. The first contradiction will be shown to be inconsequential in section ????????. To avoid the latter problem, let us assume WMAP observes a superposition of $|t_+\rangle$ and $|t_-\rangle$ so that $|t_\star\rangle = \alpha\, |t_+\rangle + \beta\, |t_-\rangle$ as in figure 8. Then the WMAP samples two oppositely curved spaces which obey the superposition principle. The result is the observation of flat space. The metric along $|t_\star\rangle$ is given by $k = 0$ in equation (7).

$$ds^2 = dt_\star^2 - a^2(t_\star)dr^2 \tag{9}$$

Schrödinger's cat experiment explains that in the absence of an observation wavefunctions are diffuse. When the box is closed the cat is both dead and alive. Likewise, observers will never be able to say if they belong to $|t_+\rangle$ or $|t_-\rangle$; forward time observation with recollection cannot be distinguished from reverse time observation with prescience. The wavefunction is diffuse and the postulation of $|t_\star\rangle$ is confirmed. When an observation cannot be made, both possibilities must coexist as a superposition of states.

In quantum mechanics the arrow of time is not specified. Feynman diagrams are useful because time flows generally to the right in the "timeless" interactions they describe. The

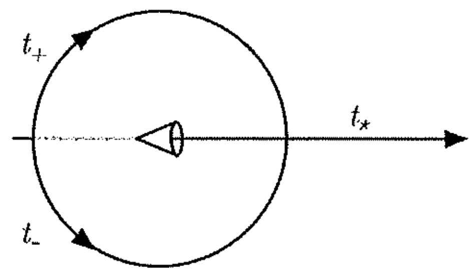


FIG. 8. Observable space is postulated to be a linear superposition of the wavefunctions of the foliations on $t_\pm$. After this convenient postulation is developed, a more concrete derivation of $t_\star$ will be given in section V.

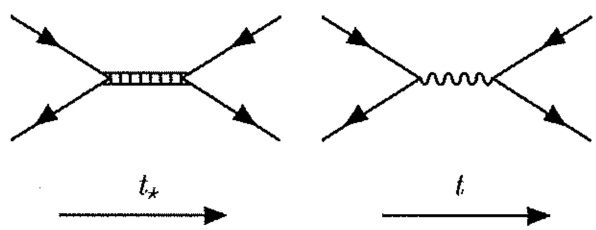


FIG. 9. In the Feynman diagrams of QED and QCD time generally flows to the right and antiparticles are denoted with arrows pointing in reverse time. The relevant construction for LQC, a graviton exchange, is shown for clarity.

duality in the Minkowski picture and the Feynman picture is completed in figure 9.

IV. DARK ENERGY

Dark energy arises naturally from the interaction of U and $\bar{U}$. Unwrap figure 6(a) as in figure 10(a) so that U and $\bar{U}$ converge forward in time toward the big crunch along a 1D manifold. The nature of the evolution on this manifold is the crux of the present argument. In figure 10(b) two massive particles, m_1 and m_2, gravitate along the x_i axis. Hence, we must be true to ourselves when we declare time to be naught more than a fourth orthogonal dimension in spacetime. If m_1 and m_2 gravitate, shall we not conclude that U and $\bar{U}$ gravitate identically? Gravitation is a global property of all matter and energy connected by spacetime.

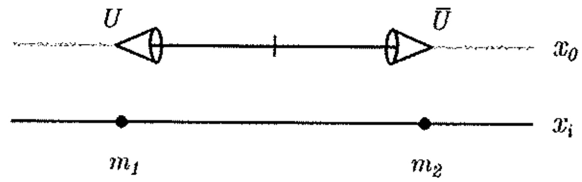


FIG. 10. Gravitational masses m_1 and m_2 lie on the x_i axis and undergo attraction. Similarly, U and $\bar{U}$ undergo gravitational attraction according to the metric defined on the manifold that connects them. The vertical hash marks the bounce.

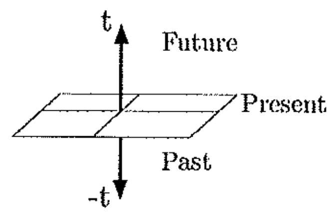


FIG. 11. The geometric structure of psychological time.

The gray interval at each end of figure 10(a) represents the past as experienced by an observer in the adjacent cone. This interval is defined as all points on an observer's worldline where $z > 0$. There exists a bijection between redshift and time; spacetime is divided into subsets as in figure 11.

$$z + 1 = a(t_0)/a(t') \tag{10}$$

$$z \in [z_{max}, z_{min}] \quad \rightarrow \quad x_0 \in [0, \pi] \tag{11}$$

$$Past \in [0, x_0^0) \ , \ Future \in (x_0^0, \pi] \tag{12}$$

$$Present \in [x_0^0] \tag{13}$$

Supernovae observed to accelerate away from observers on Earth reside exclusively in the past. We cannot observe astrophysical objects as they are today; that light has yet to reach our instruments. In 3-space, objects such as type Ia supernovae may have x_i greater or smaller than the x_i of an observer. However, in the inertial frame defined by said observer, the high-z condition of the supernovae data can be expressed as $x_0^0 \gg x_0'$ where x_0' is the proper time of the observable. Observers will always be deeper into $\bar{U}$'s gravitational well than the astrophysical objects they observe.

The state $|t_\star\rangle$ may be decomposed into two states with opposite curvature. However, $|t_\pm\rangle$ experience symmetric convergence to the bounce. When observers operate on $|t_\star\rangle$ to detect dark energy there is no cancellation as with their respective curvatures. As U and $\bar{U}$ near the bounce, the gradient in curvature will increase at $z = 0$ with respect to fixed comoving high-z observables.

This is an alternative interpretation of data suggesting that the more distant an object lies, the more quickly it accelerates away from us. Acceleration is relative and in the paradigm presented here it is more intuitive to claim that we are accelerating away from the past, toward the future. This is an inverse radial spaghettification process where acceleration of images away from us indicates the event horizon of the bounce accelerating toward us.

Dark energy has been explained in the framework of Einstein's equations with time varying cosmological constant. Specifically, Λ evolves monotonically with increasing t_+ and t_- but is cyclic in $t_\star$. In the early universe this effect is negligible when U and $\bar{U}$ are far apart. As the universe ages, dark energy increases.

V. GEOMETRY

A period of inflation at the bounce is represented by the lightcone opening wider than $\pi/2$ radians near the origin. When inflation concludes, the directional anisotropy of the lightcone (a 4D hypercone) is hidden from observers who access only 4π steradians of isotropic solid angle. This evolution is described in figure 12. An isotropic 3-space grows inside the light cone which inflates through 4π srad before closing on itself. This closure leaves a preferred direction in the cosmos such as the one seen in the multipole analysis of the WMAP data.

Every 4D hypercone generates a dual cone, i.e.: the existence of one hypercone implies the existence of another as in figure 5. This geometry supplements the momentum argument for the physicality of $\bar{U}$ in the Penrose diagram made in section II. If we consider the 4D geometry of inflation described by a cone and its dual cone as in figure 13, we recover the geometric structure of psychological time. We have seen that $t_\star$ is the present and, by

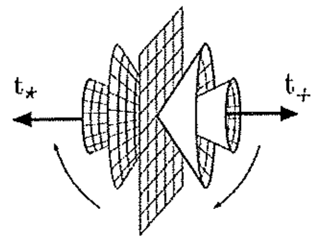


FIG. 12. The closure of the foliation on $t_\pm$ defines $\pm t_\star$. Curved arrows show propagation of a soliton. The good axis defined by the WMAP multipole analysis constitutes observational evidence for $|t_\star\rangle$. $t_\star$ and t_+ appear parallel in this projection but $\hat{t_\star} \cdot \hat{t_\pm} = 0$ according to equation (16).

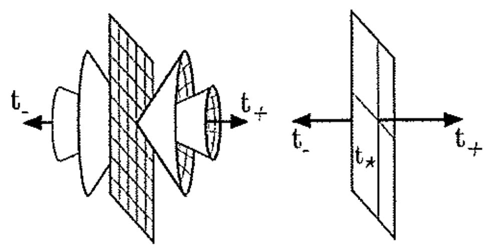


FIG. 13. In the larger view the symplectic geometry is clear. The closure of the foliations is a topological obstruction.

equation (12), it corresponds to a single point on which a time arrow cannot be defined. This is why equation (4) is not written $\widehat{LQC}\,|bounce\rangle = |t_+\rangle + |t_-\rangle + |t_\star\rangle$.

$$\hat{T}\,|t_\star\rangle = 0 \tag{14}$$

$$|t_\star\rangle = |bounce\rangle \tag{15}$$

The reconciliation between a single point and the 4D manifold of ordinary spacetime $|t_\star\rangle$ is found in the Fourier transform to twistor space discussed in section VI.

(REF EARLIER) The hypersurface of the present and the hypersurface of the big bang are topologically indistinct. The period of inflation ascribed to the SCM big bang is now a property of every moment. Bell has stated, "Nobody knows just where the boundary between the classical and the quantum domain is situated." The MCM places this boundary at the intersection of two noncommuting twistor spaces: $\mathbb{T}_-$ and $\mathbb{T}_+$.

MCM solutions will evolve through the classical singularity, now an LQC bounce. Conse-

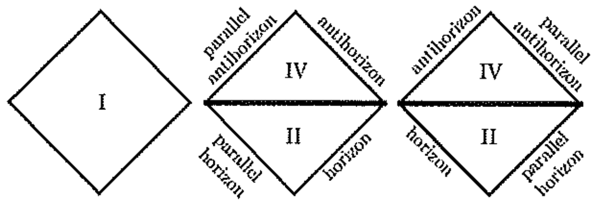


FIG. 14. An event horizon is an optical effect. At the antihorizon we label this effect dark energy and call it inverse radial spaghettification. Due to symmetry, inflation is the time reverse process on the horizon. 't Hooft's valuable insights into the physics of this geometry are found in [17].

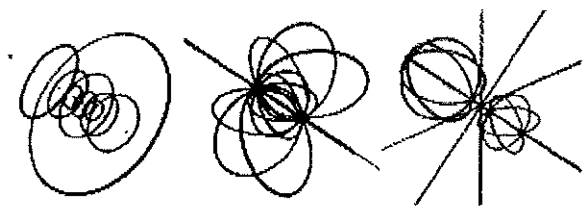


FIG. 15. Stereographic projection of the 3-sphere outlines the geometry of the fabric of time. Intersection of these lines and circles defines an orthogonal triad [30].

quently, the union of Penrose II and IV must be conformally equivalent to I and III. When this is true no distinction can be made between the universe and the parallel universe as in figure 14. If U and $\bar{U}$ are separate and coexist as required by the Law of Conservation of Momentum, then an additional degree of freedom must be introduced. This is a third component of time beyond "up" and "down." This system is most easily visualized in figure 8. We have labeled these three dimensions $\{t_+, t_-, t_\star\}$ and require they satisfy the cross product. The relation of $\{ijk\}$ and $\{+-\star\}$ in $\mathrm{a} \times \mathrm{b} = \epsilon_{ijk}\, \hat{e}_i\, a_j\, b_k$ is defined by the vertices of the stereographic 3-sphere decomposed in figure 15.

$$\hat{t}_+ \times \hat{t}_- = \hat{t}_\star \tag{16}$$

Three classes of curvature solve equation (1) and each represents an orthogonal dimension on the temporal sphere: flat parallels, spherical hypermeridians and hyperbolic meridians. These are the respective $k = 0, 1, -1$ solutions to equation (7). In lieu of a single 4D spacetime, time and space are partially decoupled with a specific 3-space embedded in each time dimension.

Now an addendum to the dark energy solution in section IV. The simplistic postulation of superposition no longer applies. However, every orthogonal triad defines three lines on which dark energy can occur per figure 10. The effect is global. Each pair U_i and $\bar{U}_i$ gravitate toward the horizon, where $i = +, -, \star$. An apparently simple symmetry has shed light on a greater truth.

From equations (15) and (4) it is obvious that $|t_\star\rangle$ is not a superposition of $|t_\pm\rangle$. Rather it is a soliton propagating in cosmological Ricci flow. Ordinary 4D spacetime is a wave formed by the perfect cancellation of many nonlinear terms in the metric. It is a property of solitons that they travel with constant velocity so we must revisit the earlier interpretation of dark energy as the acceleration of the universe toward the future. More succinctly, the future is accelerating toward us. This is in good agreement with our general premise that the observer defining an origin is at rest. The soliton is a standing wave. Miller has described this by famously stating, "Time keeps slipping into the future."

We give further credence to the MCM by noting that the present cosmos is not invariant under parity conjugation. When figure 8 undergoes parity conjugation around $t_\star$ the diagrammatic structure of the universe is unchanged but $t_\pm \rightarrow t_\mp$. For $|t_+\rangle$ left is "out" and right is "in". The physics of this asymmetry is that the spherical space defined on the hypermedian becomes a hyperbolic space on the meridian.

The small deviations from flatness in allowable spherical and hyperbolic cosmologies are mirrored in the small cross sections for parity violating processes. It is possible that parity violation can be used to measure curvature.

When a string is assigned to each line in figure 15, (or rather to the holomorphic curve defined by the Fourier transform of each line to twistor space) we derive a candidate for the full non-perturbative structure of string theory. The orthogonal triad at each vertex is composed of one parallel, one meridian and one hypermeridian suggesting that this theory is entirely contained in figure 8.

At first glance, figure 8 cannot encompass the entire theory because the geometry does not reflect parity violation. This can be resolved by rescaling the lengths of the axes. The Poincaré conjecture only states diffeomorphism to the 3-sphere; there is no reason to assume $l_\pm = \pi$. Nature seems to suggest an obvious choice of ratio.

$$l_+ = \frac{1+\sqrt{5}}{2} \tag{17}$$

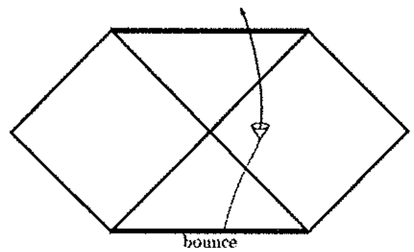


FIG. 16. Penrose diagram of the MCM. The worldline goes outside of the box.

$$l_\star = 1 \tag{18}$$

$$l_- = \frac{1-\sqrt{5}}{2} \tag{19}$$

Now we cross the bridge from the cosmological to the quantum. Observers have access to one dimension of time: $t_\star$. Together with the three spatial dimensions of the foliation we assemble the four dimensions of everyday physics. It must be noted that the meridians and hypermeridians also foliate 3-spaces and their wavefunctions are not confined to the axes. They extend such that their tails overlap the $k = 0$ wavefunction at rest on the observer. As such, in the very high energy regime, observers in $t_\star$ may access the 3 spatial dimensions embedded in t_+ and t_- giving access to $9+1$ total dimensions as predicted by string theory.

MCM observers are confined to lines and the metric along each time axis has been defined. On the other hand, observables occupy the space between the lines where a more complex metric is defined according to Ricci flow [31]. It is the high-z condition on the supernovae data that puts these objects far enough away that highly non-linear Ricci flow contributions to the metric become non-negligible. The microwave background is then due to the onset of hyperturbulence rather than baryogenesis. The MCM does not predict a big bang, see figure 16. The cosmos is ever-existing.

In classical physics, spatial orthogonality is defined by $\pi/2$ radians. We have introduced an new component of temporal orthogonality defined by ϕ complex hyperadians between two noncommuting twistor spaces. Their intersection is the hypersurface of the present which is commonly called the universe. The irrational ratio ϕ/π is the source of difficulty in computing non-perturbative quantum gravity.

ARE THERE REALLY CTCs? ONE UNIVERSE BENT INTO A SEMI CIRCLE CON-

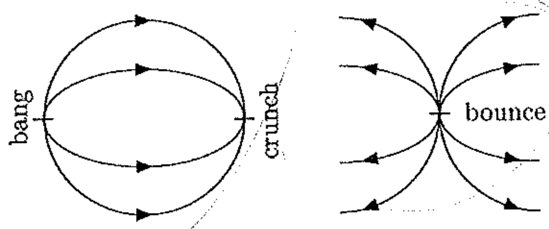


FIG. 17. On the left, the traditional two-boundary closed domain. On the right, an open system with one boundary condition on the 0-norm projective subspace ℙ𝕅 of two twistor spaces.

TAINS NO CTCs. WHY SHOULD THE UNION OF TWO SEMI CIRCLES. THE HYPERSURFACE OF THE PRESENT ACTS AS A TOPOLOIGCAL OBSTRUCTION.

There is no paradox regarding QFT on CTCs in the MCM. We have built the MCM on the 3-sphere but can invoke the Poincaré conjecture to revert to the cylindrical geometry of figure 6. On the hypercylinder $t_\pm$ may contain CTCs but the transverse axis $t_\star$ does not. All physical mechanisms discussed here remain valid on the cylinder.

The derivations of dark energy and a preferred axis in the cosmos speak for themselves. Beyond that, the existence of $t_\star$ can be derived via the Penrose diagram of LQC without reference to the philosophically charged Schrödinger experiment. The WMAP observes flat space because it only measures the comoving components of $t_\star$. U_i and $\bar{U}_i$ are multiply derived as well. String theory predicts a 10 dimensional high energy regime and this is present in the MCM. Parity is violated in Nature and parity is not conserved in the MCM. A geometrically robust cosmological model has been presented.

EVER EXISTING? DOES IT EVEN NEED TO BE MENTIONED.

VI. PERTURBATIVE GAUGE THEORY AS A STRING THEORY IN TWISTOR SPACE

So far a the geometric structure of a new paradigm has been laid out. Now we show that it can readily be quantified in Witten's program of strings as holomorphic curves in twistor space. The original idea was proposed in [15]. The transition from geometric to analytic is completely contained in figure 1 and now a few supplemental words will be added.

The MCM contains many degenerate symmetries such as those first pointed out by Maldacena [32]. It is most natural to define AdS_5/CFT_4 correspondence on figure 8. We have a

12 dimensional system consisting of three 3-spheres embedded on another temporal 3-sphere. Observers in this system are prohibited from accessing the past and the future $\{x_0^+, x_0^-\}$ and the resulting system is 10D. These 10 dimensions can be decomposed into two 5D spaces: dS_5 and AdS_5. De Sitter space is an ordinary 4D spacetime coupled to a fifth dimension that describes the curvature.

From figure 13 it is geometrically obvious that $t_\star$ is the boundary where CFT_4 is defined.

supersymmetric $N = 4$ Yang-Mills theory is defined.

Conformal mapping preserves boundary conditions of differential equations in both the past and the future. The MCM exploits the mathematical strength of geometry to carefully define a conformalism which preserves boundary conditions only in the present where CFT_4 is defined (on the manifold $t_\star$). Due to ϕ/π, additional boundary conditions cannot be accommodated.

Supergravity says supersymmetry is a local property.

Kaluza-Klein with no compactification is defined on the tstar.

The two KK theories coupled together naturally introdufe fermions.

When it comes to superstring revolutions, this paper suggests the third time may be the charm.

In string theory the only dimensionful parameter is the length of the string l_s. Figure 8 is composed of three strings and two vertices. Spherical $|t_+\rangle$ and hyperbolic $|t_-\rangle$ both have $l_s = \pi$ while flat $|t_\star\rangle$ has $l_s = 2$. Each of these states is a 4D spacetime and does not compose a five dimensional space. The fifth dimension is defined by the ratio $l_\pm/l_\star$. Using this, string theory can be reformulated without reference to dimensionful parameters.

D-brane requires both ends of the string to be on the brane. Here we require a single end on each of two strings to lie on the brane.

5-sphere largest volume. 7-sphere largest area. Should be able to derive this thermodynamically. Maximum entropy, maximum volume.

VII. FRACTAL SPACETIME AND THE MEASUREMENT PARADOX

String theory is a theory of fractal nature. This is obvious from the existence of T-duality says the physics of large and small spacetime radii are the same.

$$R \to \frac{\alpha}{R} \quad , \quad \phi \to \phi - log\frac{R}{\sqrt{\alpha}} \tag{20}$$

We have assigned a spatial sphere $\{x_1, x_2, x_3\}$ to each dimension of the temporal sphere $\{x_0^+, x_0^-, x_0^\star\}$. Space serves as the radial coordinate of the temporal ball just as time is the radial coordinate in the 3+1D General Relativity. It must be noted that a causal cone (t_-) and a future cone (t_+) is attached to every event in spacetime; every spatial direction defines a past, present and future. Thus we see that the MCM is a fractal tiling of spatial spheres on temporal spheres which are embedded in yet larger spheres. The distinction of temporal and spatial spheres is mirrored in the spacelike and timelike regions of the Minkowski diagram.

The MCM is a fractal matrix theory which very closely corresponds with El Naschie's $\mathcal{E}^\infty$ Cantorian-fractal spacetime [33–38] with topological dimension 4 and Hausdorff dimension $4 + \phi^3 = 4.236$ [39].

We have shown the physics of the observable quantum cosmos arise from the coupling of two twistor spaces. There is an irrational character to this coupling that makes certain things unknowable. 't Hooft has described this as beables and changeables [16]. It is an interesting property of the coupling between orthogonalities in fractal spacetime that the electromagnetic fine structure constant can be generated.

$$2\pi + \left(\frac{\pi}{\phi}\right)^3 = 137.6 \approx \frac{1}{\alpha} \tag{21}$$

$$\alpha = \frac{e^2}{(4\pi\epsilon_0)\hbar c} = \frac{e^2 c\mu_0}{2h} \tag{22}$$

The result that α is not derived perfectly indicates that the fractal structure of spacetime is only defined to leading order by equation (21). Still, leading order is often an excellent approximation and the complete mass spectrum of the particle zoo may be fall out of the twistor geometry of the MCM.

A long standing problem in quantum field theory is that the energy density of the vacuum is infinite. In the paradigm presented here, $t_\star$ has no "volume" in the matrix. Thus, a finite energy density is obtained when infinitely large energy is divided by infinitely small "volume." El Naschie has described this by applying the center manifold theorem to the Klein modular curve $\Gamma(7)$ [40, 41].

Kaluza-Klein unification.

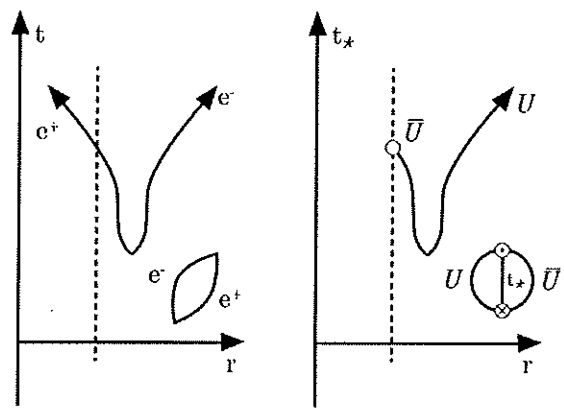


FIG. 18. Cannot know the scale, thus it is fractal.

This tiling is the physical manifestation of T-duality, the symmetry which relates large spactime radius properties to small ones REWORD CITE. If spatial sphere A is embedded in temporal sphere B, which is embedded in spatial sphere C, the T-duality is the property which states the physics of A and C are the same.

Duality between T-duality and E-inffitny. Markov chain. New figure.

T-duality and the MCM have synergy in that they both predict spacetime will have Hausdorff dimension greater than four. A notable discrepency between the MCM and $\mathcal{E}^{\infty}$ theory is the MCM predicts fractal structure only between temporal and spatial dimensions; $\mathcal{E}^{\infty}$ postulates fractal structure between all dimensions.

Killing vector field maps conformalism. The MCM states that the physics of grand unification is contained in the theory of pair creation in vacuum where the cosmological constant takes the form of a zero point energy [1, 42].

$$T_{\mu\nu}^{vac} = \rho_{vac} g_{\mu\nu} \tag{23}$$

$$\Lambda = \frac{8\pi}{m_{Pl}^2} \rho_{vac} \tag{24}$$

Irrationality in the ratio of string lengths is the root of turbulence. Feynman's comment on temporal order is reflected in the MCM; the past and the future are irrelevant. There is only now. This is the resolution of the EPR paradox: the wavefunction is "incomplete." locality, separablilty

The MCM contains 12 local dimensions: nine of space and three of time. Observers are forbidden from accessing two time dimensions and the result is a 10D system of worldsheets. The 3-sphere's parallels, meridians and hypermeridians form a network of closed and open strings. But what of the other two dimensions: x_0^+ and x_0^-? This is the very concept of an EPR bridge.

The MCM is a 10D open quantum system bounded by a 2-sphere in the spirit of ADM. ADM defined this to be (y,z) but we say its the future and the past.

It has been suggested that the surface of a black hole may be an EPR bridge. Indeed we see that by the very definition of the 2-sphere bounding. ADM. They used the two auxiliary spatial dimensions. We use the two auxiliary time dimensions. That is why the dS has a spinor.

Measurement paradox. We've clarified given a new meaning to the Schrödinger experiment.

VIII. DISCUSSION

The MCM explains why time does not appear in quantum mechanics. Quantum mechanics is a theory of Hilbert spaces but in the MCM we see there is no need for functions defined on time to go to zero at infinity. We have come full circle and confirmed Einstein's intuition that Nature is not a temporary event but rather an eternal one as in figure 16. There are no endings, only new beginnings.

When in the course of the universe the antihorizon becomes imminent, MCM specific observables will arise. Parity violation is due to the off-axis Ricci flow contributions in the metric. Near the vertex, foliated wavefunctions on $t_\pm$ will contribute strongly to the superposition on the observer. As a result, cross sections for parity violating processes should change near the horizon.

It is unlikely that the time dependence of Λ can be measured directly given the very long times involved. However, in the region very near the horizon, the rapidly increasing gradient would be observable as a lowering of the high-z requirement for dark energy. Interestingly, the historical record of the Mayan civilization indicates that just such a cosmogenesis event will occur on December 21, 2012 [43]. This strange coincidence makes the present an optimal time for new observations.

freefall.

The MCM forges a tangency between gravity and electromagnetism along the vacuum polarization vector near the horizon.

While the distance to the CMB, l_{CMB}, can no longer be used to gauge the age of the universe, other salient features can be extracted using the Reynold's number.

$$R_{cr} = \frac{\rho u l_{CMB}}{\eta}, \tag{25}$$

Should be able to derive the Planck time numerically from LQC.

The CMB is an analog of Unruh Effect at the cosmological event horizon for Rindler observers accelerating toward the future. Cant judge the age of the universe.

ACKNOWLEDGEMENTS

Thank you Manny Gonzales, Emily Marie Hancock, Seung Soon Jang and Jean Bellissard for invaluable discussions. Thank you to Naresh Thadhani and Ignacio Taboada for funding while this research was conducted. To Georgia Tech for funding this research with the Presidential Fellowship. Thank you to my mother, Helene Gutfreund, for everything else.

---

[1] A. D. Dolgov, Physics of Atomic Nuclei **71**, 651 (2008).

[2] L. de Broglie, Ph.D. thesis, Sorbonne (1924).

[3] D. Bigatti and L. Susskind, *M-Theory and Quantum Geometry* (Kluwer Academic publishers., 2000), chap. The Holographic Principle, pp. 179–225.

[4] T. Kuhn, *The Structure of Scientific Revolutions* (Univeristy of Chicago Press, 1962).

[5] M. Bojowald, Physical Review Letters **86**, 5227 (2001).

[6] M. Bojowald, Physical Review Letters **89**, 261301 (2002).

[7] Ashtekar et al., Physical Review D **75**, 024035 (2007).

[8] A. Ashtekar, in *Invisible Universe: Proceedings of the Conference* (2010).

[9] M. Bojowald, Class Quant Grav **17**, 1489 (2000).

[10] M. Bojowald, Class Quant Grav **17**, 1509 (2000).

[11] M. Bojowald, Class Quant Grav **18**, 1055 (2001).

[12] M. Bojowald, Class Quant Grav **18**, 1071 (2001).

[13] A. Ashtekar and P. Singh, Class Quant Grav **28** (2011).

[14] Arnowitt et al., Annals of Physics **1960**, 116 (11).

[15] E. Witten, arXiv:hep-th/03121717v2.

[16] G. 't Hooft, Class Quant Grav **16**, 3263 (1999).

[17] G. 't Hooft, in *Frontiers of Fundamental and Computational Physics - Proceedings of the 10th International symposium* (2010).

[18] I. Bars, Phys Rev D **54**, 5203 (1996).

[19] M. Duff and M. P. Blencowe, Nuclear Physics B **310**, 387 (1988).

[20] C. Vafa, Nuclear Physics B **469**, 403 (1996).

[21] I. Bars, Phys Rev D **55** (1997).

[22] D. Kutasov and E. Matrinec, Nuclear Physics B **477**, 652 (1996).

[23] H. Nishino and E. Sezgin, Physics Letters B **388**, 569 (1996).

[24] I. Bars, Phys Rev D **55**, 3633 (1997).

[25] I. Bars and C. Kounnas, Phys Rev D **56**, 3664 (1997).

[26] I. Bars and C. Deliduman, Phys Rev D **56**, 6579 (1997).

[27] I. Rudychev and E. Sezgin, hep-th/9711128.

[28] C. Misner, Physical Review Letters **22**, 1071 (1969).

[29] Spergel et al., Astrophysical Journal Supplement Series **170**, 377 (2007).

[30] C. Rocchini, http://en.wikipedia.org/wiki/3-sphere.

[31] S. Brendle, *Ricci Flow and the Sphere Theorem* (American Mathematical Society, 2010).

[32] J. Maldacena, International Journal of Theoretical Physics **38** (1999).

[33] M.S. El Naschie, Chaos, Solitons and Fractals **11**, 2397 (2000).

[34] M.S. El Naschie, Chaos, Solitons and Fractals **29**, 871 (2006).

[35] M.S. El Naschie, International Journal of Nonlinear Sciences and Numerical Simulation **8**, 11 (2007).

[36] M.S. El Naschie, Chaos, Solitons and Fractals **29**, 23 (2006).

[37] M.S. El Naschie, Chaos, Solitons and Fractals **19**, 209 (2004).

[38] M.S. El Naschie, Chaos, Solitons and Fractals **30**, 622 (2006).

[39] M.S. El Naschie, Chaos, Solitons and Fractals **41**, 232635 (2009).

[40] M.S. El Naschie, Chaos, Solitons and Fractals **29**, 816 (2006).

[41] M.S. El Naschie, Chaos, Solitons and Fractals **41**, 2725 (2009).

[42] Y. B. Zeldovich, Soviet Physics Uspekhi **11** (1968).

[43] J. M. Jenkins, *Maya Cosmogenesis 2012: The True Meaning of the Maya Calendar End-Date* (Bear & Company, 1998).