

Preliminary Investigation into the Construction of a 10-Dimensional Discrete Spacetime Basis Based on Ramanujan Modular Formulas

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Abstract

Aiming at the "continuous-discrete" contradiction between general relativity and quantum theory at the Planck scale, as well as the defects of existing unified theories, this paper takes Ramanujan modular formulas as the mathematical core to construct a 10-dimensional discrete spacetime basis with a fractal fiber topological network. The basis is formed by the topological tensor product coupling of 3-simplices, elliptically deformed Calabi-Yau-like manifolds and fractal fibers, and the spacetime evolution is regulated by modular parameters. This study clarifies the intrinsic origin mechanism of time, initially constructs a correlation framework for 60 typical topological real particles, provides topological interpretations for the Higgs signal and the origin of photons, proposes a cyclic universe model, and predicts candidate particles for dark matter. This research offers a new research path for the unification of quantum and classical theories, and also provides a basic framework for the interdisciplinary research of high-dimensional spacetime and number-theoretic geometry.

Key words: nature of time; discrete spacetime; cyclic universe; dark matter; spacetime basis

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1 Introduction

The origin of spacetime and the unification of quantum and classical theories are core propositions of theoretical physics, as well as major unsolved scientific problems. General relativity describes spacetime with continuous Riemannian manifolds and depicts geometric evolution through metric tensors, which successfully explains macroscopic gravitational phenomena but cannot accommodate quantum

discreteness at the Planck scale. Quantum mechanics is rooted in discrete quantization rules and accurately describes the behavior of microscopic particles, yet it lacks an underlying explanation for the nature of spacetime. This "continuous-discrete" contradiction leads to a complete separation of the two theories at the Planck scale [1-3].

All mainstream candidates for existing unified theories have inherent defects: although M-theory provides a potential path for the unification of the four fundamental forces, it lacks a complete core mathematical equation and has a multiplicity problem of 10^{500} vacuum solutions, and key predictions such as supersymmetric particles have not been experimentally verified [4-6]; loop quantum gravity successfully avoids the zero-distance divergence problem, but it is difficult to naturally accommodate gauge invariance, unable to incorporate electromagnetic and nuclear forces into its framework, and the connection mechanism with quantum field theory at low-energy approximation remains unclear [7-9]. In addition, the fundamental contradictions between the two theories in terms of spacetime dimensions, particle nature and mathematical foundations further exacerbate the difficulty of unification exploration [11,12].

Unlike M-theory which relies on unobserved supersymmetry or loop quantum gravity which is hard to incorporate gauge fields, this framework for the first time couples Ramanujan modular forms, fractal fiber topology and discrete geometry, realizing the intrinsic generation of the time dimension, topological coding of the particle spectrum and unified description of cosmic expansion dynamics, and providing a new paradigm for quantum gravity that does not depend on additional symmetry assumptions.

1.1 Research Scope and Boundaries

The core research object of this paper is the existence, core composition and evolutionary nature of the 10-dimensional discrete spacetime basis, with the specific boundaries as follows:

The core research content includes the topological composition of the spacetime basis, the intrinsic origin mechanism of time, the evolutionary stages of cosmic expansion regulated by the σ parameter, and the core mathematical logic under the constraint of modular invariance; the follow-up research content involves the specific splicing mechanism of 3-simplex complexes, the complete quantitative coding of the 60 particle spectra, the coupling dynamics of conformal fields and the spacetime basis, the microscopic model of vacuum superfluid, and the derivation of the unified equations of the four fundamental forces; the expressions related to particles only briefly explain the correlation logic between particles and spacetime topology, without involving the quantitative derivation and experimental fitting of the complete particle spectrum.

2 Composition and Action Mechanism of the 10-Dimensional Discrete Spacetime Basis

The construction of the 10-dimensional spacetime basis is derived from the optimization of the 11-dimensional spacetime setting of M-theory: the intrinsic correlation between fractal fibers and time can naturally derive the time dimension, and finally the 10 dimensions are determined as the core basis (3-dimensional 3-simplices + 6-dimensional CY_3^{ellip} manifold + 1-dimensional fractal fibers). The three components form a whole through topological tensor product coupling with distinct and non-interfering functional divisions. The 3-simplices serve as the spatial topological skeleton; the CY_3^{ellip} manifold acts as the excitation carrier and topological anchoring carrier; the fractal fibers are responsible for evolutionary driving and the generation of the origin of time.

The coupling logic of the topological tensor product is as follows: the endpoints of the fractal fibers are anchored at the 27 fixed points C_{ijk} of the CY_3^{ellip} manifold, the entire CY_3^{ellip} manifold is embedded in the internal cavity of the 3-simplex, and the base points of the fractal fibers fall at the geometric center of the 3-simplex, forming an integrated topological structure of "skeleton-carrier-driver". This splicing method ensures that the $\Gamma(3)$ modular symmetry acts on each component simultaneously, and the modular transformation of the fractal fibers is transmitted to the 3-simplices and the CY_3^{ellip} manifold through the tensor product, realizing the global modular invariance constraint.

2.2 Core Characteristics and Excitation Mechanism of Spacetime Units

The basic spacetime unit is a deformable 3-simplex (tetrahedron) in appearance, uniquely characterized by 4 vertex coordinates or 6 edge lengths, with a six-dimensional compact space CY_3^{ellip} embedded inside. A trifurcated fractal fiber with a depth of 3 is embedded in the space, whose nodes are in one-to-one correspondence with the 27 special points in CY_3^{ellip} and divided into 9 fibers.

The 3-simplex units move freely in the macroscopic three-dimensional space in the form of fluid-like molecules and form a "soft-spliced" continuous spacetime fluid through coupling via non-rigid potential fields—presenting a continuous vacuum without an independent background macroscopically (similar to still water) and a collection of Planck-scale units microscopically, and the whole approximately conforms to the continuous spacetime picture of general relativity. In the unexcited state, the unit topology is smooth and featureless, and the units are soft-connected and flow freely with each other; the excitation is triggered when the dual conditions of "internal topological instruction + external energy matching" are satisfied: the internal instruction is generated by the paired combination of 10 discrete t-sites (0-9, topological fixed points of the CY_3^{ellip} manifold) and 12 cosets of the $\Gamma(3)$ modular group in a fixed order, outputting a $\tau=t+i\sigma$ instruction to determine the topological excitation configuration, and the external energy needs to match the threshold of this configuration; after excitation, a single or double fractal fiber inside breaks, triggering the characteristic deformation of the unit. The deformation mode directly determines the type and physical properties of microscopic particles, forming "real units" in the

spacetime fluid (corresponding to elementary particles and the matter composed of them).

2.3 Conformal Field Correlation

The set of infinite points of the 4-elliptic torus can naturally form a conformal field, and its coupling logic with the spacetime basis is as follows: the boundary conditions of the conformal field are determined by the topological invariants of the CY_3^{ellip} manifold, and the conformal symmetry is self-consistently compatible with the $\Gamma(3)$ modular invariance. The specific coupling dynamics and quantitative derivation are left for follow-up research.

3 Fractal Fibers and Elliptically Deformed Calabi-Yau Manifolds

3.1 Physical Motivation and Group-Theoretic Correlation of Ramanujan's Cubic Continued Fraction

Ramanujan's cubic continued fraction $G(q)$ is selected as the core modular function, whose recursive hierarchical structure is naturally matched with the three-layer trifurcated topological characteristics of fractal fibers, and it is a weight-0 modular function on the modular group $\Gamma(3)$ that strictly satisfies modular invariance, which can be used as the core mathematical characterization of spacetime topological evolution. $G(q)$ is defined as:

$$G(q) = \frac{q^{1/3}}{1 + \frac{q + q^2}{1 + \frac{q^2 + q^4}{1 + \frac{q^4 + q^6}{1 + \frac{q^6 + q^8}{1 + \dots}}}}}, \quad q = e^{2\pi i \tau} \quad (1)$$

where the modular parameter $\tau = t + i\sigma$, $t \in \mathbb{Z}$ is the cyclic index of the $\Gamma(3)$ cosets, characterizing the discrete evolution of topological sites; $\sigma > 0$ is a positive integer, serving as the continuous scale parameter of spacetime topological evolution, corresponding to the intrinsic time unit of the universe.

For any modular transformation element $\gamma = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma(3)$, $G(q)$ satisfies the modular transformation relation:

$$G(\gamma\tau) = \chi(\gamma) G(\tau) \quad (2)$$

where $\chi(\gamma)$ is the root-of-unity character of $\Gamma(3)$. This relation indicates that $G(q)$ maintains modular invariance under the $\Gamma(3)$ modular transformation, ensuring that the evolutionary process of spacetime topology maintains structural self-similarity in different modular transformation reference frames, and providing a strict mathematical foundation for the symmetry constraint of spacetime evolution.

3.2 Cubic Continued Fraction and Fractal Fibers

The hierarchical recursive structure of Ramanujan's cubic continued fraction is in one-to-one correspondence with the trifurcated evolution of fractal fibers, and its finite truncation in physics can completely describe the topological generation process of fractal fibers. The specific coupling relations are as follows:

- The first layer $q^{1/3}/(1 + \dots)$: corresponding to the core topological node and the first trifurcation of the fractal fiber, serving as the basic generator of the topological structure;
- The second layer $(q + q^2)/(1 + \dots)$: corresponding to the second trifurcation of the fractal fiber, realizing the hierarchical expansion of the topological structure;
- The third layer $(q^2 + q^4)/(1 + \dots)$: corresponding to the third trifurcation of the fractal fiber, finally generating 27 topological endpoints and completing the construction of the fractal fiber topology at the finite physical scale.

The infinite form of the continued fraction provides mathematical potential for the self-similar evolution of fractal fibers, while the three-layer truncation at the physical scale can already satisfy the complete description of the topological structure.

3.3 Elliptically Deformed Calabi-Yau Manifold (CY_3^{ellip} , 6-dimensional)

To adapt to modular symmetry regulation and topological excitation bearing, the traditional CY_3 manifold is elliptically deformed, with the mathematical definition:

$$CY_3^{ellip} = (E_{\tau_1} \times E_{\tau_2} \times E_{\tau_3})/\mathbb{Z}_3 \quad (3)$$

where E_τ is a 2-dimensional elliptic torus characterized by Ramanujan's Jacobi θ function $\theta_3(q)$ ($q = e^{\pi i \tau}$, $Im(\tau) > 0$, $\tau \in \mathbb{H}$). When $\tau = e^{2\pi i/3}$, E_τ has a \mathbb{Z}_3 automorphism group. Ignoring the infinite points for the time being, let $O \in E_\tau$ be the identity element of group operation, and $p_1, p_2, p_3 \in E_\tau$ be non-trivial 2-torsion points ($2p_i = O$). A real six-dimensional product space $X = E_\tau \times E_\tau \times E_\tau$ is defined, and any point of it is expressed as (x_1, x_2, x_3) ($x_i \in E_\tau$).

X contains two types of surface special point sets: first, 27 spatial fixed points $C_{ijk} = (p_i, p_j, p_k)$ ($i, j, k = 1, 2, 3$), where the 27 fixed points are not freely set but derived from the Cartesian product structure of the 2-torsion points of the three elliptic factors, and their number is uniquely determined by discrete symmetry; second, the 3rd-layer leaf nodes c_{ijk} of the fractal tree, which are coupled one-to-one with the fixed points and serve as the anchoring sites for the endpoints of fractal fibers.

The elliptical deformation is a differentiated optimization of traditional Calabi-Yau geometry: τ satisfying $\partial\tau = 0$ ensures that E_τ is a Kähler manifold. Combined with the model-specific geometric constraints, when τ takes an algebraic number in the upper half-plane, the product manifold maintains structural stability adapted to topological excitation under the \mathbb{Z}_3 quotient action, without following the requirements of Ricci flatness and supersymmetry of traditional Calabi-Yau manifolds. Its core necessity

lies in: realizing the deep binding of modular symmetry and topological structure mathematically, enabling the sites to have dynamic excitation bearing capacity topologically, and realizing the distinction of spacetime states and the regulation of double-splicing dynamics through the evolution of τ theoretically, ensuring the energy conservation and structural consistency of the excitation process.

4 Topological Coding Mechanism of the Particle Spectrum

4.1 Core Coding Logic

The core carrier of particle topological coding in this paper is the 12 basic cosets of the principal congruence subgroup of $\Gamma(3)$. First, their mathematical forms and coupling correspondence with the modular parameter $\tau = t + i\sigma$ are clarified. Based on the structural characteristics of CY_3^{ellip} , $t = 0 - 9$ is taken to complete the zonal coding of real particles with 6 cycles, initially constructing a topological correlation framework for 60 real particle states. The complete coding and quantitative matching are left for follow-up research.

4.2 Corresponding between the 12 Basic Cosets of the $\Gamma(3)$ Modular Group and 60 Particles

$\Gamma(3)$ adopts the standard simplified matrix form of group theory and is numbered $C_1 - C_{12}$ in sequence. The 12 basic cosets are fully covered through the cycle of t , with 10 values in each cycle and a total of 6 cycles forming 60 groups of codes. Each t value corresponds to 6 cosets without redundancy or omission. In the absence of external energy triggering, these 60 particle states form a superposition state, and the docking mode between fractal fibers and CY_3^{ellip} can be regarded as the vacuum fluctuation phenomenon. The detailed corresponding relations are shown in Table 1. It should be specially noted that $\Gamma(3)$ itself does not directly correspond to particle states; the coset structure of $SL(2, \mathbb{Z})/\Gamma(3)$ is used for particle topological coding; the discrete parameter t is only a physical index for coset cycling, which is independent of the cosets themselves at the mathematical level. The following uses a schematic way to demonstrate the feasibility of this correspondence, which does not represent the real correspondence, and the real correspondence needs further research.

Table 1 Virtual Particle Encoding Based on $\Gamma(3)$ Coset Traversal

t Value	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6
0	c1	c11	c9	c7	c5	c3
1	c2	c12	c10	c8	c6	c4

2	c3	c1	c11	c9	c7	c5
3	c4	c2	c12	c10	c8	c6
4	c5	c3	c1	c11	c9	c7
5	c6	c4	c2	c12	c10	c8
6	c7	c5	c3	c1	c11	c9
7	c8	c6	c4	c2	c12	c10
8	c9	c7	c5	c3	c1	c11
9	c10	c8	c6	c4	c2	c12

4.3 Excitation Mechanism of Real Particles

CY_3^{ellip} is formed by the 120° rotationally symmetric splicing of three complex toroidal ellipses according to the \mathbb{Z}_3 modular group, with a concentric structure and the endpoints of the major axes anchored at the peripheral edge nodes of the 3-simplex, forming a "concentric, equal-modular, 120° uniformly distributed" topology, which is consistent with the characteristics of the Jacobi θ function complex torus. Based on the above characteristics, the model sets that: every 3 of the 27 leaf nodes form 9 fractal fiber chains, each zone has 3 chains including 1 main chain and 2 branch chains. The tension of the main chain is significantly higher than that of the branch chains, and the tension of the branch chains at the sites beside the minor axis is slightly higher than that at the sites beside the oblique poles; when the fibers break, the deformation of the three zones shows a three-level gradient differentiation of high, medium and weak. The fracture of the main chain and different branch chains in the same zone correspond to significant differences in physical performance, which are directly related to the topological coding of particle properties, as shown in Table 2.

Table 2 Real Particle Encoding Formed via $\Gamma(3)$ Coset Topological Breaking

t	Topological Breaking Mode	Particle Type
0	Breaking one branch chain in a single zone	6 gluons
1	Breaking one main chain / Breaking two main chains across zones	3 gluons / W^+ W^- Z bosons

2	Weak symmetric breaking of two branch chains across zones	6 neutrinos
3	Asymmetric breaking of two branch chains across zones	The remaining 6 leptons
4	Breaking one main chain and one branch chain across zones	6 states of up quarks
5	Breaking one main chain and one branch chain across zones	6 states of down quarks
6	Breaking one main chain and one branch chain across zones	6 states of charm quarks
7	Breaking one main chain and one branch chain across zones	6 states of strange quarks
8	Breaking one main chain and one branch chain across zones	6 states of top quarks
9	Breaking one main chain and one branch chain across zones	6 states of bottom quarks

4.4 Special Notes on the Higgs Boson and Photon

It should be specially pointed out that the 60 particle topological coding framework constructed in this paper is aimed at the typical topological real particles directly excited by the core mechanism of fractal fiber breaking-binding collapse. The Higgs boson is not such a typical real particle in this theory, and its essence is the macroscopic manifestation carrier of energy tension in the spacetime basis during topological deformation. The Higgs signal observed in experiments has a clear correlation with the mass generation of particles, which can be classified into the category of "particles" in appearance; however, in the spacetime topological framework of this theory, it is not a typical topological real particle formed by fractal fiber breaking-binding collapse, but essentially an energy effect carrier when the

spacetime topological basis undergoes topological deformation, and a macroscopic manifestation of the topological tension and energy absorption of the vacuum fluid basis.

In this theory, the mass of particles is not endowed by the traditional Higgs coupling, but originates from the unit deformation caused by fractal fiber breaking and the energy absorption in the topological breaking process: when two main fractal fiber chains break, the energy absorption increases significantly, and the particles exhibit large mass; when one branch chain breaks, the energy absorption is extremely small, and the particles exhibit light mass. This rule has an indirect correlation with the energy characteristics of the Higgs signal. As a carrier of topological binding energy released by the rebound after fractal fiber breaking, the photon is a propagator of pure energy excitation. After the fractal fiber breaks and collapses, it rebounds and releases the stored topological binding energy, which is emitted in the form of photons. Photons are not included in the 60 particle spectra, but a special energy carrier with essential differences from real particles, so they are also not in these 60 particle spectra. Together with the 60 real particles, the two constitute the complete topological interpretation of the standard model particle panorama in this theory.

5 The Nature of Time and Its Generation Mechanism

5.1 The Essence of Time: Intrinsic Rhythm

The core essence of time is the periodic coupling rhythm of fractal fibers and the CY_3^{ellip} manifold—the discrete symmetric cycling of the $\Gamma(3)$ cosets and the ordered iteration of the t cycle form a constant cosmic intrinsic clock σ that is not disturbed by the external environment.

5.2 Intrinsic Time Unit T_0 and the Invariance of the Speed of Light

The theoretical intrinsic basic time is defined: each completion of a coupling closed loop between fractal fibers and the CY_3^{ellip} manifold (i.e., T_0) triggers an integer jump of σ ($\sigma + 1$), that is, the evolutionary quantity of σ is in one-to-one correspondence with the cumulative quantity of T_0 :

$$\Delta T = (\sigma_2 - \sigma_1) \times T_0$$

where ΔT is the time span corresponding to the evolution of σ from σ_1 to σ_2 , and $T_0 \approx k \cdot t_p$ (t_p is the Planck time, k is an undetermined coefficient). It should be clearly stated that T_0 will increase with the cosmic expansion. This evolutionary characteristic originates from the extension of the topological path of the coupling closed loop caused by the volume expansion of the CY_3^{ellip} manifold, making the period of the unit time closed loop increase synchronously with the cosmic scale. σ is the embodiment of the cosmic intrinsic clock and its frequency will not change with expansion and contraction.

It can be derived from the model that both the propagation distance and propagation time of light are affected by cosmic expansion, but their ratio (i.e., the speed of light) remains fixed. This characteristic is directly related to the topological structure of the 10-dimensional unit. Due to modular invariance, the speed of light is independent of the evolution of σ . Light propagates in the form of waves, and the light wave transmits one spacetime unit for each jump of σ .

6 Cosmic Evolution and the Theories of Big Bang and Inflation

6.1 Basic Definitions and Cyclic Universe Framework

Assumption: We assume that the upper limit of the cosmic age ≈ 16.8 billion years, corresponding to $\sigma_{max} = 10^{61}$ as the theoretical calibration anchor for calculating the approximate time of cosmic evolution (this assumption is only a self-consistent verification tool for the theory and observations and does not affect the core logic of the model, which can be updated according to more accurate observation data in the follow-up).

This paper constructs a cyclic universe model based on the evolution of the complex modular field $\tau = t + i\sigma$. The evolution of σ dominates the changes of cosmic phases: $\sigma_{min} = 1$ is the minimum value at the quantum gravity scale, corresponding to the "hot boundary". When contracting to this scale, the phase reverses, matter and antimatter are produced and annihilated, triggering the Big Bang (without classical singularity). According to the characteristics of modular functions, σ must be greater than 0, and 1 is already the smallest integer value; $\sigma_{max} = 10^{61}$ is the evolutionary upper limit, corresponding to the "cold boundary". When the universe expands to the edge of heat death, a global big reversal is triggered. The selection of the value 10^{61} is estimated according to the current cosmic age. If 10^{62} is taken, the universe needs to expand 10 times more, which is inconsistent with the currently observed cosmic expansion rate.

The cyclic mechanism is as follows: when σ increases from 1 to 10^{61} , the universe is in an expansion phase dominated by matter; after reaching the upper limit, a reversal is triggered, entering a contraction phase dominated by antimatter, and σ decreases to 1, forming an eternal oscillating picture of "Big Bang/Inflation \rightarrow matter-dominated cosmic expansion \rightarrow heat death and big reversal \rightarrow antimatter-dominated cosmic contraction \rightarrow Big Bang/Inflation".

The total cosmic lifetime $T_{total} \approx 16.8$ billion years $= 5.3 \times 10^{17}$ seconds. Combined with $N = \sigma_{max} - \sigma_{min} \approx 10^{61}$, the average value of T_0 is deduced:

$$T_{0,avg} = \frac{T_{total}}{\sigma_{max} - \sigma_{min}} \approx 5.3 \times 10^{-44} \text{ seconds} \quad (4)$$

6.2 Microscopic Implications for Cosmic Expansion

This model provides a completely new microscopic perspective for understanding cosmic expansion. The evolution of the discrete parameter σ drives the changes of spacetime topology, and the triple bifurcated structure of fractal fibers and the number 3 in the $\Gamma(3)$ modular symmetry strongly suggest that the spacetime scale may grow discretely with 3 as the base.

A noteworthy numerical correspondence: the ratio of the current observable cosmic radius (≈ 46.5 billion light-years) to the cosmic age (≈ 13.8 billion years) is about $3.37c$, which is of the same order of magnitude as 3. If there is a linear correspondence between σ and the cosmic age in this model, the discrete growth mode may explain this macroscopic observation.

Important note: This paper only points out the inspiration of this numerical correspondence and does not take it as a strict conclusion. Deriving the expansion dynamics of continuous spacetime from discrete topological structures requires constructing a complete action and equation of motion, which is beyond the scope of this paper. Follow-up research will specially explore whether this correspondence can naturally emerge in the dynamical framework.

6.3 Cosmic Evolution Stages

The cosmic stages corresponding to the evolution of σ are shown in Table 3.

Table 3 Cosmic Stages Corresponding to σ Evolution

σ Range	Matter-dominated Universe	Antimatter-dominated Universe	Time
$\sigma = 1$	Big Bang initiation point	End of the antimatter-dominated universe	/
$1 \sim 10^{30}$	Cosmic inflation period	Rapid cosmic contraction period	$\approx 5 \times 10^{-14}$ seconds
$10^{30} \sim 10^{59}$	Early steady expansion period	Late contraction period	≈ 171 million years
$10^{59} \sim 10^{60}$	Middle steady expansion period	Middle contraction period	≈ 1.54 billion years
$10^{60} \sim 10^{61}$	Mature expansion period / Life development	Early contraction period / Life development	≈ 15.26 billion years

7 Core Differences from Existing Spacetime Theories

The core differences between this theory and existing spacetime theories are compared in Table 4. The core breakthrough of this theory is: with Ramanujan modular formulas as the unified constraint, realizing the integration of fractal structures, high-dimensional discrete spacetime and the intrinsic origin of time, avoiding the multiple vacuum problem of superstring theory and the gauge invariance compatibility problem of loop quantum gravity, and being able to explain cosmic expansion observations without dark energy.

Table 4 Comparison of Core Differences Between the Present Theory and Existing Spacetime Theories

Theory Type	Spacetime Structure	Nature of Time	Core Regulating Quantity	Particle Origin	Dark Energy Requirement
Present theory	10-dimensional discrete topological basis	Intrinsic rhythm of topological closed loops	Modular parameter $\tau = t + i\sigma$	Excited by spacetime topological breaking	Not required
Superstring/M-theory	11-dimensional continuous spacetime (string/membrane vibration)	Independent background parameter	String vibration mode	Excited by string vibration	Required in some models
Loop quantum gravity	3+1-dimensional discrete spin network	Spin foam evolution	Spin variable	Excited by spin network nodes	Not required
General relativity	4-dimensional continuous Riemannian manifold	Independent background parameter	Metric tensor	Underlying origin not involved	Required in the standard model

8 Testable Predictions of This Theory

Based on the core derivation of the spacetime topological evolution of this model, the

$\Gamma(3)$ modular group coset particle coding and the topological characteristics of the spacetime basis, combined with the observable/verifiable conditions achievable by current high-energy physics experiments, two theoretical predictions with strong falsifiability are proposed.

8.1 Prediction 1: Existence of the Ninth Gluon, Modification of the Gluon Color Charge Structure and Candidate Particles for Dark Matter

This model deduces a complete gauge boson spectrum including nine gluons. This not only predicts the ninth gluon beyond the standard model, but more importantly, this theory proposes a modification to the foundation of gluon color charges. The modified color charge structure is as follows: the color charge matrix of the 8th gluon is modified to $g_8 = \frac{bb-gg}{\sqrt{2}}$, the color charge matrix of the 9th gluon is $g_9 = \frac{rr-bb}{\sqrt{2}}$. This means that the observed behavior of the "8th gluon" in the standard model may originate from the effective action of the modified g_8 and g_9 together. This modification is inferred from the topological excitation mode of fractal fiber main chain breaking.

According to the reasoning of this model, gluons with "color confinement" are virtual gluons triggered by the $\Gamma(3)$ modular group, while real gluons formed by breaking one fiber have a tiny mass between electrons and neutrinos, whose mass may be in the eV-keV range. Two gluons are coupled together through two broken fibers to form stable gluon dimers with the potential characteristics of warm dark matter, which may explain the observational challenges encountered by the cold dark matter model at smaller scales.

In addition, W/Z bosons also have this property. Based on the characteristic that their topological excitation originates from main chain breaking with the maximum energy absorption, the mass of bound states formed by W/Z bosons is expected to be in the GeV-TeV range. They are more likely to form stable trimer states like protons, and may also be dimers or mixed multimers coupled with gluons, which conform to the basic characteristics of cold dark matter and can be used as candidates for cold dark matter.

8.2 Prediction 2: The Production of Antimatter is Negatively Correlated with the Evolution of the Modular Parameter σ

In this model, the imaginary part σ of the modular parameter $\tau = t + i\sigma$ is the core parameter of spacetime topological evolution, and the tendency of σ is directly related to the production of matter and antimatter: when σ increases, the universe is in an expansion state, and the topological probability of matter production is much higher than that of antimatter; when σ decreases, the universe is in a contraction state (reverse evolution), which is the core topological condition for antimatter

production. The theoretical extension is: in the laboratory, antimatter-biased particles can be prepared by constructing a vacuum contraction state environment while ensuring the right-handed rotation of spacetime.

9 Conclusions and Prospects

This paper establishes a 10-dimensional discrete spacetime theory with Ramanujan modular formulas as the unified mathematical constraint. By performing topological tensor product on fractal fibers, elliptically deformed Calabi-Yau manifolds and 3-simplex complexes, the microscopic basis of spacetime quantization is successfully constructed. This model clarifies that the intrinsic origin of time is the intrinsic rhythm of the coupling between fractal fibers and the CY_3^{ellip} manifold, and the inherent cosmic clock is determined by the change of σ . The derived basic time unit T_0 increases with cosmic expansion; the modular parameter $\tau = t + i\sigma$ as the core regulating quantity, its evolution can completely describe the expansion history of the universe from the Big Bang to the present, and can be compatible with cosmic expansion observations without introducing the dark energy hypothesis; using the 12 cosets of the $\Gamma(3)$ modular group and the cycle of the parameter t , a preliminary topological correlation framework for 60 typical topological real particles is constructed, and a completely new topological interpretation is provided for the origin of the Higgs signal and photons.

This paper only initially constructs the basic framework of the theory, and there are still several important issues to be further studied, which constitute the clear direction of follow-up research: 1) Detailed derivation of the specific splicing dynamics of 3-simplex complexes; 2) Completion of the complete matrix and quantum number mapping of the 60 particle topological coding; 3) Deduction of the dynamical equations of the strong, weak, electromagnetic and gravitational forces in a unified topological framework according to the hierarchical structure of the units; 4) Research on conformal fields based on this model.

The work of this paper is to construct and clarify the mathematical foundation and physical picture of this theoretical framework, and the detailed dynamical equations and quantitative calculations are natural extensions and future core work under this framework.

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