A Cyclical Cosmology Based on Pre-Spacetime Geometry and a Scalar Phase Transition

Abstract

This document proposes a novel cosmological model that addresses several fundamental problems in cosmology, including the matter-antimatter asymmetry, the nature of dark energy and dark matter, and the singularity problem of the Big Bang. The model posits a pre-spacetime structure with a fractal, "Calabi-Yau-like" geometry that guides the formation of separate matter and antimatter domains along intertwined, filamentary structures, metaphorically analogous to Birkeland currents. A new scalar field, the "strong-weak-darkforce," mediates a short-range repulsion between these domains, preventing annihilation, while also contributing to the long-range accelerated expansion of the universe. The model is inherently cyclical, with a deterministic collapse and "reshuffling" of matter and antimatter domains, driven by the dynamics of the pre-spacetime structure and the strong-weak-darkforce. This framework offers a unified explanation for several cosmological phenomena and presents a unique opportunity to test potential subtle differences in the gravitational behavior of matter and antimatter.

Furthermore, the model introduces the "Deception Formulation of Quantum Mechanics," which suggests that the quantum wavefunction is a reflection of the many possibilities that exist within the multiverse, but only one outcome manifests in our particular spacetime. This formulation challenges the conventional view of quantum mechanics and offers a unique perspective on the relationship between determinism and quantum possibilities. It suggests that quantum mechanics is not entirely random but rather a shadow of the superdeterministic potential, shaped by the leakage of the strong-weak-darkforce.

Introduction

The standard cosmological model, ΛCDM (Lambda-Cold Dark Matter), while remarkably successful in describing many observations, faces several fundamental challenges:

- **Matter-Antimatter Asymmetry:** The observed dominance of matter over antimatter in the universe is not adequately explained by the known laws of physics.
- **Dark Energy:** The accelerated expansion of the universe requires the introduction of a mysterious "dark energy," whose nature is unknown.
- **Dark Matter:** The rotation curves of galaxies and the dynamics of galaxy clusters necessitate the existence of "dark matter," which has not been directly detected.
- **Singularities:** General Relativity predicts singularities at the center of black holes and at the beginning of the universe (the Big Bang), where the theory breaks down.
- **Hubble Tension:** There is a growing discrepancy between different measurements of the Hubble constant, the rate of expansion of the universe.
- **Flatness Problem:** The universe is observed to be remarkably flat.
- **Horizon Problem:** The observed uniformity of the cosmic microwave background (CMB) is difficult to explain within the standard Big Bang model.

The model presented here offers a radical departure from ΛCDM, proposing a new framework that addresses these challenges in a unified and interconnected way.

Core Postulates

The model is based on the following core postulates:

2.1 **Pre-Spacetime Structure:**

There exists a fundamental, pre-spacetime structure that underlies the fabric of reality. This structure is:

- **Calabi-Yau-like:** It possesses a complex geometry analogous to Calabi-Yau manifolds, though not necessarily in the strict string theory sense. It is a metaphor for a complex, multi-connected space.
- **Fractal:** It exhibits self-similarity across different scales, meaning patterns repeat themselves in a nested fashion.
- **Chiral:** It possesses an intrinsic "handedness" or chirality that distinguishes between matter and antimatter.
- "Race Tracks": It contains preferred pathways or regions that guide the formation of matter and antimatter.
- "Chunky": It has a discrete structure at a fundamental scale, rather than being perfectly smooth and continuous.

2.2 **Universal Scalar Field (Φ):**

A single, universal scalar field (Φ) permeates the pre-spacetime structure. This field exists before the distinction between matter and antimatter. It is, in essence, the raw material from which matter and antimatter are formed.

2.3 **Strong-Weak-Darkforce (χ):**

A second scalar field (χ), the "strong-weak-darkforce," arises from the interaction between matter and antimatter domains. This field has the following key properties:

- **Origin:** It's generated by "leakage" between matter and antimatter domains at their boundaries (the firewall).
- **Non-Minimal Coupling to Gravity:** It couples directly to the curvature of spacetime, effectively modifying gravity.
- **Distance-Dependent Strength:** It mediates a strong, repulsive force at short distances (preventing matter-antimatter annihilation) and a weak, repulsive effect at long distances (driving the accelerated expansion of the universe).

2.4 **Filamentary Structure Analogy:**

Matter and antimatter domains are organized along intertwined, filamentary structures that are metaphorically analogous to Birkeland currents in plasma physics. These filaments are:

- **Guided by "Race Tracks":** Their formation and structure are dictated by the "race tracks" of the pre-spacetime structure.
- **Fractal:** They inherit the fractal geometry of the underlying structure.
- **Boundaries:** They form the boundaries (domain walls, or "firewall") between matter and antimatter domains.

2.5 **Eternal Infall and Cyclical Behavior:**

The universe undergoes cycles of expansion and contraction.

- **Expansion:** Driven by the "eternal infall" of matter and antimatter domains towards each other, guided by the pre-spacetime structure and the strong-weak-darkforce. This infall is perceived as the expansion of the universe.
- **Contraction:** Triggered by the deterministic failure of the firewall, caused by interactions at "nodes" along the filaments.
- **Reshuffling:** After the firewall collapses, the pre-spacetime structure guides the re-segregation of matter and antimatter, initiating a new cycle.

Key Mechanisms and Concepts

3.1 **Matter-Antimatter Asymmetry:**

The fundamental asymmetry between matter and antimatter is geometric. The chiral nature of the pre-spacetime structure, with its "race tracks," provides separate pathways for the formation of matter and antimatter. There was never a period of large-scale matter-antimatter annihilation.

3.2 **Phase Transition and Domain Formation:**

The universal scalar field, Φ, initially exists in a high-energy, undifferentiated state. A stress-induced phase transition of this field leads to the formation of distinct matter and antimatter domains.

- **Stress on Φ:** The "stress" on the Φ field is a combination of curvature of the pre-spacetime structure, the influence of the nascent strong-weak-darkforce (χ field), and potentially other fields.
- **Effective Potential (V(Φ)):** The behavior of Φ is governed by an effective potential, V(Φ), which changes shape as the "stress" changes.
- **Symmetry Breaking:** At a critical stress level, V(Φ) develops two distinct minima: Φ_M (favoring matter) and Φ_{AM} (favoring antimatter). This reflects the chirality of the pre-spacetime structure.
- **Race Track Guidance:** The "race tracks" guide Φ towards either Φ_M or Φ_{AM} in different regions, leading to spatial separation.

- **Domain Walls:** The boundaries between domains are domain walls ("firewall") where Φ transitions between Φ_M and Φ_{AM}.
- **CP Violation:** The different coupling of Φ to Standard Model fields in the two domains is the source of CP violation.

3.3 **The Strong-Weak-Darkforce (χ Field):**

This scalar field is central to the model.

3.3.1 **Origin:** Leakage between domains at the firewall: The χ field arises from quantum interactions across the domain walls.

3.3.2 **Non-Minimal Coupling:** $\xi R \chi^2$ term and its consequences: This term couples χ to the Ricci scalar (R), modifying gravity. The effective gravitational constant becomes dependent on χ.

3.3.3 **Potential:** $V(\chi) = (\lambda/4) (\chi^2 - \chi_0^2)^2 * \exp(-\alpha/R)$ and its implications: This potential, with its dependence on curvature (R), gives the χ field its distance-dependent behavior.

3.3.4 **Short-Range Repulsion:** Explanation of the firewall: The χ field condenses to a non-zero value near the domain walls (high curvature), creating a strong repulsive force that prevents annihilation.

3.3.5 **Long-Range Dark Energy Effect:** Explanation of accelerated expansion: Far from the walls (low curvature), the χ field has a small, non-zero value, contributing a positive energy density that drives accelerated expansion.

3.4 **Filamentary Structure Dynamics:**

3.4.1 **Formation:** Guided by the "race tracks" of the pre-spacetime structure: The filaments form along the boundaries between matter and antimatter domains, following the "race tracks."

3.4.2 **Fractal Structure:** Inheritance of the fractal geometry: The filaments inherit the fractal nature of the pre-spacetime structure, leading to a complex, self-similar network.

3.4.3 **"Current" Carriers:** What constitutes the "current" (likely not charged particles): The "current" is most likely carried by the quanta of the χ field itself, and potentially neutrinos/antineutrinos.

3.4.4 **Magnetic Fields:** The motion of the current carriers generate a fractal magnetic field.

3.4.5 **Helical Structure:** The filaments are not simply linear structures but exhibit helical configurations. This helical shape is a natural consequence of the dynamics of the system and has implications for various aspects of physics:

- **Classical Physics:** Helical motion is associated with angular momentum, suggesting a connection to the conservation of angular momentum in the universe. The helical shape could also be related to electromagnetic phenomena, similar to the magnetic field lines around a current-carrying wire.

- **General Relativity:** The helical spirals could be seen as manifestations of the curvature of spacetime, representing the geodesics followed by matter and antimatter domains. They could also be associated with gravitational waves.
- **Quantum Theory:** The helical structures might be related to quantum entanglement or give rise to unique quantum effects due to their topology.

3.5 **Node Formation and Firewall Weakening:**

3.5.1 **Eruptions from Φ:** Externalization of the pre-spacetime geometry: At specific points (nodes) along the filaments, the universal scalar field Φ "erupts," manifesting aspects of the underlying "Calabi-Yau-like" geometry. This is driven by a combination of filament instabilities, amplified quantum fluctuations, and resonance with the pre-spacetime structure.

3.5.2 **Fractal Mechanism:** Nodes as inherent features of the fractal geometry: The nodes are not random but are located at points determined by the fractal pattern of the filaments and the underlying pre-spacetime structure.

3.5.3 **Interaction with χ:** How eruptions weaken the firewall: The eruptions disrupt the χ field, reducing its repulsive effect and allowing for increased (but limited) interaction between matter and antimatter.

3.6 **The 'Clock':**

The interaction of the filaments with these nodes is rhythmic, due to the underlying geometry. This provides a natural clock. The clock is not perfectly regular, but has a quasi-regularity.

3.7 **The Collapse and Reshuffling:**

3.7.1 **Firewall Failure:** Deterministic collapse triggered by node interactions: Repeated interactions at the nodes gradually weaken the firewall until it reaches a critical point and collapses.

3.7.2 **Geometric Re-Separation:** Persistence of the pre-spacetime structure guiding the re-formation of domains: The underlying "Calabi-Yau-like" structure survives the collapse and guides the re-segregation of matter and antimatter, preventing complete annihilation.

3.7.3 **New Cycle Initiation:** Resetting of the Φ field and re-establishment of the strong-weak-darkforce: The collapse resets the Φ field, and a new cycle of domain formation, expansion, and eventual collapse begins.

3.8 **Quantum Mechanics:**

- **Superdeterminism with "Also-Rans"**:
    - The properties of particles are predetermined within the superdeterministic framework of the model, guided by the pre-spacetime structure and the scalar fields. There is only one set of values that you could ever get for a particular measurement.

    - However, there are other properties that you could measure, which are not predetermined. These properties are the "also-rans" - they exist as possibilities within the quantum wavefunction but do not manifest in our spacetime.
    - When you perform a measurement, there is no wave collapse in the traditional sense. Instead, you "collapse" the deception, revealing the predetermined properties and exposing the "also-rans" as mere possibilities.
- **Non-Locality:**
    - Even with the concept of predetermined properties and "also-rans," the framework can still accommodate non-locality due to the leakage of the strong-weak-darkforce.
    - This non-local leakage could influence the "also-rans," the non-predetermined properties that exist as possibilities within the quantum wavefunction. The leakage could alter the probabilities of these "also-rans" manifesting in different regions of spacetime, leading to non-local correlations.

3.9 **Bell's Theorem:**

- **Violation of Bell's Inequality:** The combination of superdeterminism and non-locality in this framework could explain the violation of Bell's inequality without resorting to retrocausality. The non-local correlations between entangled particles could be due to the influence of the leakage on the "also-rans."
- **No Measurement Problem:** This interpretation avoids the measurement problem, as there is no collapse of the wavefunction in the traditional sense. The act of measurement simply reveals the predetermined properties and the "also-rans."

3.10 **The Fractal Multiverse:**

- **Fractal Pervasiveness:** The fractal principle implies self-similarity across scales, meaning that the same patterns repeat themselves at different levels of magnification. This suggests that the pre-spacetime structure is not confined to a single scale but rather permeates all scales, from the sub-microscopic to the macroscopic.
- **Microscopic Manifestation:** At the microscopic level, the pre-spacetime structure could manifest as the "race tracks" and filaments woven into the fabric of spacetime at the Planck scale. These structures could be responsible for the properties of elementary particles and quantum phenomena.
- **Macroscopic Manifestation:** At the macroscopic level, the pre-spacetime structure could manifest as the "universal web" or "galactic web" connecting different universes. This web could be responsible for the large-scale structure of the multiverse and the exchange of matter and energy between universes.

3.11 Deception Formulation of Quantum Mechanics

- **Superdeterminism with "Also-Rans"**
    - The properties of particles are predetermined within the superdeterministic framework of the model, guided by the pre-spacetime structure and the scalar fields. There is only one set of values that you could ever get for a particular measurement.
    - However, there are other properties that you could measure, which are not predetermined. These properties are the "also-rans" - they exist as possibilities within the quantum wavefunction but do not manifest in our spacetime.
    - When you perform a measurement, there is no wave collapse in the traditional sense. Instead, you "collapse" the deception, revealing the predetermined properties and exposing the "also-rans" as mere possibilities.
- **Non-Locality**
    - Even with the concept of predetermined properties and "also-rans," the framework can still accommodate non-locality due to the leakage of the strong-weak-darkforce.
    - This non-local leakage could influence the "also-rans," the non-predetermined properties that exist as possibilities within the quantum wavefunction. The leakage could alter the probabilities of these "also-rans" manifesting in different regions of spacetime, leading to non-local correlations.
- **Measurement as Revelation**
    - In this interpretation, measurement is not about collapsing the wavefunction and selecting one outcome from many possibilities. Instead, measurement is about revealing the predetermined properties and exposing the "also-rans" as mere potentialities that were never destined to manifest in our spacetime.
    - The "deception waveform" represents the illusion of multiple possibilities, while the superdeterministic potential defines the single, actual outcome.
- **Superdeterministic Potential**
    - The "actual potential" is defined by the pre-spacetime structure and the scalar fields, guiding the overall evolution of the universe and determining the most likely outcomes for quantum events.
- **Leakage as Other Potentials**
    - The leakage of the strong-weak-darkforce creates "other potentials" that deviate from the superdeterministic potential, representing less probable outcomes for quantum events and creating the tails of the bell curve distribution.
- **Vast Deception**

  - The quantum wavefunction could be seen as a "vast deception" of could-have-happeneds that never actually happened in our spacetime.
  - These other potentials represent possibilities that exist in other spacetimes or as potentials within the pre-spacetime structure.

- **Quantum Mechanics as a Shadow**
  - Quantum mechanics, in this view, is a "shadow" of the superdeterministic potential, reflecting the many possibilities that could have happened but didn't in our particular universe.
- **Instability and Potential Shift**
  - Due to inherent instability, at times, those "potentials only" might become the "actively experienced potential," but not necessarily. The frequency and scope of such shifts are currently undetermined.

Mathematical Framework (Preliminary)

4.1 **Action:** $S = \int d^4x \sqrt{(-g)} [(R / 16\pi G) + L_\Phi + L_\chi + L_{matter} + L_{interaction}]$ where:

$L_\chi = (1/2) \partial\mu\chi \partial\mu\chi - V(\chi)$, $V(\chi) = (\lambda/4) (\chi^2 - \chi_0^2)^2 * \exp(-\alpha/R)$

$L_{interaction}$ includes $\xi R \chi^2$ and the Φ-χ interaction.

4.2 **Field Equations:**

- Modified Einstein Field Equations: $G\mu\nu = 8\pi G (T\mu\nu_\Phi + T\mu\nu_\chi + T\mu\nu_{matter})$
- Equation of Motion for Φ: (Complex equation, influenced by $V(\Phi)$, interaction with χ, and coupling to matter).
- Equation of Motion for χ: $\Box\chi + \partial V(\chi)/\partial\chi - \xi R\chi = 0$

4.3 **Domain Wall Solutions (Outline):** Numerical solutions are likely required to find the profiles of Φ and χ across the domain walls.

4.4 **Filamentary Structure Modeling (Outline):** Modified magnetohydrodynamics (MHD), incorporating the χ field and fractal geometry, might be needed.

4.5 **Fractal Geometry (Outline):** Characterization of the fractal dimension, use of iterated function systems (IFS), and calculation of correlation functions. The most challenging aspect is relating the fractal geometry to the field equations.

Solutions to Cosmological Problems

5.1 **Matter-Antimatter Asymmetry:** Geometric separation from the beginning, guided by the chiral pre-spacetime structure. No large-scale annihilation.

5.2 **Dark Energy:** Identified with the strong-weak-darkforce (χ field), providing a physical mechanism and linking it to matter-antimatter separation.

5.3 **Dark Matter:** Dark matter effects are explained by the modified gravity due to the χ field and the geometry of the filamentary structures. No new particles are required.

5.4 **Hubble Tension:** The "eternal infall" dynamic leads to a different expansion history than the standard model, potentially reconciling different H_0 measurements.

5.5 **Cosmological Constant Problem:** The observed dark energy is not vacuum energy, but the energy of the χ field, potentially explaining its small value.

5.6 **Singularity Problem (Big Bang):** The model is cyclical, with no Big Bang singularity.

5.7 **Flatness Problem:** Solved by the lack of a Big Bang singularity.

5.8 **Horizon Problem:** Solved by the lack of a Big Bang singularity.

Implications for Established Theories

6.1 **General Relativity:**

6.1.1 **Potential Violation of the Strong Equivalence Principle:** The non-minimal coupling of the χ field could lead to a subtle violation of the Strong Equivalence Principle, where matter and antimatter experience slightly different gravitational forces. This potential violation offers a unique opportunity for experimental testing and could provide insights into new physics beyond General Relativity.

6.1.2 **Modified Field Equations:** The presence of the χ field and its coupling to curvature modifies the relationship between matter/energy and spacetime geometry.

6.2 **Special Relativity:**

6.2.1 **Potential Violation of Lorentz Invariance:** The preferred frame defined by the pre-spacetime structure and the χ field could lead to a violation of Lorentz invariance. However, this violation is likely localized to the nodes, where the pre-symmetry breaking unary field (Φ) "erupts." In the vast majority of spacetime, where Φ is settled into its matter/antimatter minima, Lorentz invariance would still hold approximately. This means the violation is localized and potentially difficult to detect. This offers a unique opportunity to test for Lorentz violation and potentially discover new physics.

Sources and related content

6.3 **Standard Cosmology:**

6.3.1 No Big Bang

6.3.2 Cyclical Universe

Testable Predictions and Falsification

7.1 **Variations in the Gravitational Constant:** Search for time or spatial variations in G.

7.2 **Anomalies in Gravitational Lensing:** Look for deviations from GR predictions in strong and weak lensing, and galaxy rotation curves.

7.3 **CMB Anomalies:** Search for non-Gaussianity, specific features in the power spectrum, and polarization effects.

7.4 **Tests of Lorentz Invariance:** High-energy particle physics experiments, astrophysical observations, and clock comparison tests.

7.5 **Gravitational Waves:** Measure the speed, polarization, and waveforms of gravitational waves, and look for a unique stochastic background.

7.6 **Fractal Analysis of Large-Scale Structure:** Calculate the fractal dimension and correlation functions of the galaxy distribution.

7.7 **Matter-Antimatter Gravitational Differences:** Conduct high-precision experiments to test for any difference in the gravitational acceleration of matter and antimatter.

7.8 **Node-Specific Predictions:**

- **Variations in the speed of light:** Light might travel at slightly different speeds near nodes.
- **Energy-dependent effects:** Particles with different energies might be affected differently by the Lorentz violation near nodes.
- **Gravitational anomalies:** The gravitational field near nodes might exhibit unusual behavior.

These nodes, with their "eruptions" of pre-spacetime geometry, could be regions where new physics beyond GR and SR manifests.

Falsification: The model could be falsified by:

- Inconsistent results in the above tests.
- Definitive detection of particle dark matter.
- Strong evidence for a Big Bang singularity.
- No evidence for deviations from GR and SR, even with significantly improved precision.

Conclusion

This model offers a radical alternative to the standard cosmological model, proposing a geometrically driven, cyclical universe with a unified explanation for several fundamental puzzles, including matter-antimatter asymmetry, dark energy, and dark matter effects.

Strengths:

- **Unified Explanation:** Provides a unified explanation for multiple cosmological problems, including matter-antimatter asymmetry, dark energy, and dark matter.
- **Geometric Origin:** Offers a geometric origin for cosmic structure and asymmetry, rooted in the pre-spacetime structure.
- **Avoidance of Singularity:** Avoids the Big Bang singularity and proposes a cyclical cosmology.
- **Quantum Mechanics:** Introduces the Deception Formulation of Quantum Mechanics, offering a new perspective on the interplay between determinism and quantum possibilities.
- **Testable Predictions:** Provides testable predictions related to the gravitational behavior of matter and antimatter, variations in fundamental constants, and the structure of the cosmic web.

Weaknesses:

- **Violation of Principles:** Potential violation of the strong equivalence principle and Lorentz invariance.
- **Complexity:** High degree of complexity and many unknown parameters.
- **Mathematical Framework:** Challenging mathematical framework and the need for further development.
- **Testability:** Difficult to test directly, especially the pre-spacetime aspects and the Deception Formulation of Quantum Mechanics.

Future Research Directions

- **Develop the Mathematical Framework:** Formulate a more precise description of the pre-spacetime geometry, the scalar field potentials, and their interactions. Explore the mathematical implications of the "Deception Formulation of Quantum Mechanics," including the concept of "also-rans" and the absence of wavefunction collapse.
- **Solve the Field Equations:** Find numerical solutions for domain walls, cosmological evolution, and perturbation growth. Investigate the dynamics of the strong-weak-darkforce leakage and its influence on the "also-rans" and non-local correlations.
- **Make Testable Predictions:** Calculate specific, quantitative predictions for observable quantities (gravitational lensing, CMB anomalies, etc.). Develop experimental tests to distinguish the "Deception Formulation" from other interpretations of quantum mechanics.

- **Explore Connections to Particle Physics:** Investigate the implications for CP violation, neutrino masses, and other particle physics phenomena. Explore how the pre-spacetime structure and the strong-weak-darkforce might influence the properties of elementary particles and their interactions.
- **Numerical Simulations:** Develop simulations to model the formation and evolution of the filamentary structure and the collapse/reshuffling process. Simulate the dynamics of the "Deception Formulation," including the non-local leakage and its influence on the "also-rans."