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Article

The Multiverse as the Source of Anisotropy: Explaining Three Fermion Generations and Early Galaxies

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Abstract

This paper explores the cosmological implications of anisotropic boundary conditions arising from a multiverse composed of multiple Big Bounce domains. We propose that our universe is one such domain within a larger hyper-universe, where interactions with adjacent universes induce anisotropic stiffness along three primary axes. This anisotropy provides a mechanical explanation for the three fermion generations, with the electron, muon, and tauon representing excitations along axes of varying stiffness. Neutrino oscillations emerge naturally as a geometric interference effect within this anisotropic framework, aligning with established phenomena [2,3]. Additionally, we address anomalies observed by the James Webb Space Telescope (JWST) [4,5], suggesting that some distant, mature galaxies may belong to adjacent universes with different evolutionary timelines. This model extends the Diffusive Universe framework [1] by incorporating multiverse dynamics. Crucially, it proposes a novel mechanism for triggering the cosmological bounce, based on multiverse-induced anisotropic phase transitions. This offers unified solutions to particle physics and cosmological puzzles without invoking dark components or singularities, while providing a potential pathway to avoid the need for primordial inflation.

Keywords: Cyclical cosmology; multiverse; anisotropy; fermion generations; neutrino oscillation; JWST anomalies; big bounce; boundary conditions

1. Introduction

The Standard Model of particle physics successfully describes three generations of fermions but lacks a fundamental explanation for their mass hierarchy and the phenomenon of neutrino oscillation [2,3]. Similarly, cosmological observations of unexpected early galaxy formations detected by JWST [4,5], challenge the standard Λ CDM model.

In this paper, we propose a paradigm where our universe is a finite domain within a larger hyper-universe, born from a local Big Bounce event. Interactions with adjacent universes impose anisotropic boundary conditions, breaking the isotropy of space and defining three distinct stiffness axes. This anisotropy elegantly explains: - The three-generation structure of fermions. - Neutrino oscillations as a geometric effect. - JWST observations of mature galaxies as glimpses into adjacent universes.

This work extends the Diffusive Universe model [1], which unified galactic dynamics and cosmic expansion through energy diffusion and a bounce driven by exotic matter collapse. Here, we introduce multiverse dynamics and anisotropic boundary conditions, which provide a complementary and novel mechanism for triggering the cosmological rebound. This mechanism operates through phase transitions induced by the evolving anisotropic structure of space itself, potentially offering an alternative to, or unification with, the exotic matter collapse scenario.

2. Theoretical Framework

2.1. Multiverse and Anisotropic Boundary Conditions

We posit that the hyper-universe comprises multiple universe-domains, each undergoing cyclical expansions and contractions via Big Bounce events. The boundary of our universe-domain is not isolated; it interacts with adjacent domains through energy-momentum exchange.

These interactions impose anisotropic boundary conditions, breaking the intrinsic isotropy of space and defining three principal, orthogonal eigenvectors – the natural axes of the system. The energy required to excite vibrations differs along each eigenvector, characterized by three stiffness parameters $k_1 > k_2 > k_3$.

The resulting anisotropy is modeled as:

$$\nabla^2 \rho_{\text{eff}} + \sum_{i=1}^3 k_i \frac{\partial^2 \rho_{\text{eff}}}{\partial x_i^2} = S(\mathbf{r}, t),$$

where ρ_{eff} is the effective energy density and S represents sources from adjacent universes.

The eigenvectors represent the fundamental vibration modes of the anisotropic medium, with eigenfrequencies ω_i proportional to $\sqrt{k_i}$.

2.2. Fermion Generations from Anisotropic Excitations

The fermion mass hierarchy does not arise from excitations along arbitrary axes, but along the fundamental eigenmodes of vibration of the anisotropic lattice. The mass of a particle is interpreted as the energy of its localized, resonant vibration. For example, for the leptons:

- **Electron (e)**: The fundamental excitation of the mode with the lowest eigenfrequency (ω_3). - **Muon (μ)**: The fundamental excitation of the mode with the intermediate eigenfrequency (ω_2). - **Tauon (τ)**: The fundamental excitation of the mode with the highest eigenfrequency (ω_1).

Particle decay ($\tau \rightarrow \mu \rightarrow e$) is recast as a natural relaxation process: a high-energy, meta-stable excitation of a high-frequency mode interacts with the lattice background and cascades down to the lowest-energy, most stable mode, radiating away excess energy (photons, neutrinos). The charged lepton hierarchy is therefore a direct manifestation of the spectrum of eigenfrequencies of the spatial medium.

2.3. Neutrino Oscillations As Geometric Interference

Neutrinos are ultra-relativistic perturbations that propagate as a superposition of the three fundamental eigenmodes of the anisotropic lattice. A neutrino's flavor eigenstate (ν_e, ν_μ, ν_τ) is defined at creation by the specific interaction that projects it onto this eigenmode basis. However, during propagation, each eigenmode component evolves with its own phase factor $e^{-i\omega_i t}$. The probability of detecting a specific flavor oscillates due to the interference between these phase-shifted eigenmode components, governed by the differences in eigenfrequency $\Delta\omega_{ij} \propto \Delta m_{ij}^2$, providing a natural explanation for the observed solar and atmospheric oscillation regimes [2,3].

2.4. JWST Anomalies and Multiverse Glimpses

JWST observations of mature galaxies at high redshifts [4,5] may indicate light from adjacent universes. These universes could have different ages or physical constants due to varying bounce timelines, explaining their advanced evolution.

3. Implications and Predictions

3.1. Static Predictions

- **Lepton Mass Ratios**: Predictable from stiffness ratios $k_1 : k_2 : k_3$. - **JWST Observations**: Further surveys may reveal correlations between galaxy distributions and anisotropic directions [5]. - **JWST Observations**: Further deep-field surveys may reveal correlations between the spatial distribution, apparent maturity, and size of high-redshift galaxies and the proposed anisotropic directions [5]. A

statistically significant alignment of anomalously mature or massive galaxies along a specific axis would constitute strong evidence for the multiverse-induced anisotropy proposed in this model.

3.2. Temporal Evolution of Stiffness Axes and a Second Bounce Scenario

A profound implication of this model is that the boundary conditions, and thus the stiffness parameters k_1, k_2, k_3 , are not static. They evolve over cosmological timescales, driven by the expansion/contraction dynamics of adjacent universes in the hyper-universe.

This provides a potential solution to a key question left open in our previous work on the Diffusive Universe [1]. There, we proposed that a gravitational collapse culminates in the formation of exotic matter, and the precise trigger for its subsequent rebound was explored through several scenarios (e.g., energy saturation, source exhaustion). But the multiverse-induced evolution of stiffness axes constitutes a new candidate for this trigger, with a highly speculative yet fascinating scenario: what occurs when two stiffness values converge? If, for instance, k_2 increases and k_1 decreases due to the evolving multiverse geometry until $k_1 = k_2$, the fundamental anisotropy of space would be reduced from three distinct axes to two. This degeneracy would have catastrophic consequences for the stability of matter:

The three generations of leptons (and by extension, likely quarks) are tied to the existence of three distinct axes. The disappearance of this distinction could trigger a universal matter instability. Particles whose stability is defined by the degeneracy between these axes (τ and μ) might undergo synchronized decay or transformation. This could catalyze a chain reaction, effectively dissolving the baryonic matter of the universe into a uniform plasma of energy.

This process constitutes a second type of Big Bounce: not a gravitational collapse to an exotic state, but a phase transition induced by a change in the fundamental geometric properties of space itself. Crucially, this novel bounce scenario could eliminate the need for a primordial hyper-inflation epoch if the matter-instability phase transition is triggered while the universe is still sufficiently contracted. In this case, the subsequent re-creation of matter (baryogenesis) would occur within a hot, dense, and *finite* volume, naturally yielding a homogeneous and flat universe without requiring a separate inflationary phase. Conversely, if this transition occurred in a highly dilated universe, the result would be a cold, radiated and matter-empty space that would rapidly dissipate its energy into adjacent domains, leading to a cosmological dead-end. This conditional outcome underscores the critical link between the multiverse dynamics, the contraction phase, and viable cosmology.

The speed at which these stiffness changes propagate through the hyper-universe remains an open question. If governed by relativistic constraints, variations would propagate at light-speed, potentially creating complex interference patterns across cosmological distances. Alternatively, if stiffness represents a more fundamental property of the space lattice, changes might propagate at superluminal speeds. This fundamental uncertainty underscores the need for a deeper theory of multiverse interactions.

3.3. Gamma-Ray Decay and Anisotropic Energy Dissipation

The anisotropic framework naturally extends to explaining high-energy astrophysical phenomena, particularly the observed behavior of cosmic gamma rays. Within this model, gamma rays are interpreted as ultra-high-energy excitations of the fundamental vibrational mode with the highest eigenfrequency, ω_1 , which is governed by the stiffest axis parameter (k_1).

These excitations are inherently metastable due to the intense energy concentration in the highest-frequency mode. The decay process of gamma rays is therefore a cascading relaxation through the hierarchical spectrum of eigenmodes toward more stable, lower-energy modes, accompanied by electromagnetic radiation. This mechanism provides a physical basis for several observed phenomena:

1. **Pair production** ($\gamma \rightarrow e^+ + e^-$): This is not a direct energy transfer between axes, but a resonant energy transfer from the high-frequency ω_1 mode to the specific lower-frequency modes that constitute the electron and positron wave-packets.

2. **Gamma-ray burst spectra:** The characteristic energy distributions and cut-offs reflect the discrete eigenfrequency spectrum ($\omega_1, \omega_2, \omega_3$) of the anisotropic lattice and the efficiency of energy transfer between these modes.

3. **Extended air showers:** The spatial development patterns of showers in the atmosphere may encode information about the underlying anisotropy, as the relaxation cascade of the initial high-energy excitation could have a directional dependence relative to the lattice's principal axes.

The model predicts specific, testable correlations between: - The energy spectra of gamma-ray sources and the local orientation of our galaxy relative to the universal stiffness axes. - The temporal profiles (e.g., rise and decay times) of gamma-ray events and the characteristic relaxation timescales between the lattice's eigenmodes. - Large-scale anisotropies in the diffuse gamma-ray background and the orientation of the local supercluster structure, which may be influenced by the large-scale anisotropic potential.

4. Conclusions

By integrating anisotropic boundary conditions from a multiverse framework, we provide mechanical explanations for key particle physics and cosmological phenomena. While speculative, this model is built upon several foundational arguments that address open questions across quantum physics and cosmology:

- It provides a physical foundation for the three-generation structure of leptons, offering a mechanistic cause for their mass hierarchy and decay patterns, rather than treating them as arbitrary parameters of the Standard Model.
- It investigates the critical role of boundary conditions in a Big Bounce scenario, exploring its potential non-uniqueness across time and space within a larger hyper-universe.
- It proposes a second, complementary rebound trigger based on multiverse-induced phase transitions, alongside the exotic matter collapse mechanism previously suggested.
- This novel and complementary bounce scenario could eliminate the need for a primordial hyper-inflation epoch. This occurs only if the matter-instability phase transition is triggered while the universe is still sufficiently contracted. In this case, the subsequent re-creation of matter (baryogenesis) would occur within a hot, dense, and *finite* volume, naturally yielding a homogeneous and flat universe without requiring a separate inflationary phase. Conversely, if this transition occurred in a highly dilated universe, the result would be a cold, radiated and matter-empty space that would rapidly dissipate its energy into adjacent domains, leading to a cosmological dead-end. This conditional outcome underscores the critical link between the multiverse dynamics, the contraction phase, and viable cosmology.

This work extends the Diffusive Universe theory, offering testable predictions while eliminating the need for dark matter and dark energy. The multiverse paradigm thus offers a dual pathway to avoiding a singular endpoint: either through the internal dynamics of exotic matter or through external, boundary-induced phase transitions, paving the way for a more complete cosmological narrative.

Author's Note

This work builds upon the Diffusive Universe model [1], which established energy diffusion as the mechanism for galactic dynamics and cosmic expansion. Here, we explore cosmological implications of multiverse-induced anisotropy. For foundational details, readers are referred to [1].

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