Ontological Origin of 4D Symmetry in Laursian Dimensionality Theory

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April 21, 2025

Abstract

This paper explores the ontological foundations of the (2+2) dimensional structure in Laursian Dimensionality Theory (LDT), demonstrating that such a symmetrical dimensional configuration emerges naturally from a state of absolute nothingness. We develop a mathematical framework showing that a four-dimensional manifold with balanced spatial and temporal components represents the minimal self-consistent structure that can arise from a zero-information state. This approach resolves longstanding questions about why spacetime exhibits its particular dimensionality while providing a deeper foundation for the reformulated mass-energy equivalence relationship $Et^2 = md^2$. The paper demonstrates that the emergence of our observed (3+1) spacetime results from a projection of this more fundamental (2+2) structure, explaining both the mathematical consistency of physical laws and the paradoxical features of quantum mechanics and relativity. We present several theoretical predictions that could distinguish this ontological framework from competing theories of dimensional emergence.

1 Introduction

In a series of papers exploring the implications of reformulating Einstein's mass-energy equivalence from $E = mc^2$ to $Et^2 = md^2$, I've developed Laursian Dimensionality Theory (LDT), which proposes spacetime is best understood as a "2+2" dimensional structure - two rotational spatial dimensions and two temporal dimensions, with one temporal dimension typically perceived as the third spatial dimension. While this framework has demonstrated explanatory power across numerous physical phenomena, a fundamental question remains: why should spacetime have a "2+2" structure in the first place?

This paper addresses this deeper ontological question by demonstrating that such a dimensional configuration is not arbitrary but emerges necessarily from first principles. I argue that the (2+2) dimensional structure represents the minimal self-consistent configuration that can emerge from absolute nothingness - defined not as empty space, but as a complete absence of structure, distinguishability, or information.

2 Absolute Nothingness as Ontological Ground

2.1 Mathematical Representation of Nothingness

Unlike the quantum vacuum with its fields and fluctuations, absolute nothingness represents a state with zero information content and no internal structure. Mathematically, it can be represented as:

$$\mathcal{N} = \{\emptyset\} \tag{1}$$

This corresponds to a null set or a zero-information state from which any emergent structure must be entirely self-balancing with no external dependencies.

2.2 Constraints on Emergent Structure

Any structure emerging from absolute nothingness must satisfy several constraints:

1. **Self-containment**: The structure cannot depend on any external framework or reference
2. **Zero net properties**: All properties must sum to zero globally
3. **Self-consistency**: The structure must support its own existence without logical contradiction
4. **Minimality**: The structure must be the simplest possible configuration satisfying these constraints

The first constraint is particularly significant—in the absence of pre-existing dimensionality, any emergent structure must define its own dimensional framework.

3 Emergence of (2+2) Dimensional Structure

3.1 Symmetry Requirements

From the zero-information state, any emergent structure must exhibit complete symmetry to avoid privileging any particular configuration. However, perfect symmetry alone would prohibit distinction or differentiation necessary for existence. The resolution to this paradox is a structure with balanced but differentiated components.

3.2 The Minimal Viable Manifold

I propose that the minimal self-consistent structure satisfying these constraints is a four-dimensional manifold with equal contributions from spatial and temporal degrees of freedom. The corresponding metric:

$$ds^2 = -dt^2 - d\tau^2 + dx^2 + dy^2 \tag{2}$$

yields a zero net signature:

$$\mathrm{Tr}(g_{\mu\nu}) = 0 \tag{3}$$

This configuration ensures complete balance between spatial and temporal components, creating a structure that is globally null but locally structured.

3.3 Zero-Action Principle

The emergence process is governed by a zero-action principle:

$$S = \int \mathcal{L}\, d^4x = 0 \tag{4}$$

where $\mathcal{L}$ is a symmetric Lagrangian density over the (2+2) manifold. This ensures that the total action sums to zero across the manifold, maintaining consistency with the zero-information origin.

4 Dimensional Emergence as Paired Phenomena

4.1 Co-emergence of Dimensional Pairs

A crucial insight of this framework is that dimensions do not emerge individually but rather as mutually dependent pairs:

1. The first dimensional pair (x, t) establishes a primary extension with its temporal counterpart
2. The second dimensional pair (y, τ) completes the minimal structure necessary for consistent existence

These paired dimensions are fundamentally inseparable, with each pair maintaining internal balance.

4.2 The Paradox of Self-Consistent Emergence

This paired emergence resolves a fundamental paradox: without dimension, no causality or evolution can be defined; yet without causality, how can dimensional structure emerge? The resolution lies in the simultaneous, mutually supporting emergence of balanced dimensional pairs that collectively sum to zero while enabling local structure.

5 Symmetry Breaking and Observable Spacetime

5.1 Projection Operation

The transition from the fundamental (2+2) structure to our observed (3+1) spacetime occurs through a projection operation:

$$g_{\text{observed}} = P^\dagger g_{\text{fundamental}} P \tag{5}$$

where P is a projection operator that selects a preferential embedding of the manifold.

5.2 Perceptual Interpretation

This projection has both mathematical and perceptual components. Mathematically, it transforms the null-trace metric into one with non-zero signature. Perceptually, it corresponds to our cognitive interpretation of one temporal dimension (τ) as a spatial dimension, resulting in the familiar (3+1) spacetime of everyday experience.

6 Fundamental Constants as Emergent Quantities

6.1 Constants as Dimensional Ratios

In this framework, fundamental constants emerge as ratios between symmetric quantities distorted by the projection:

$$\text{Constants} = \frac{\text{Symmetric Geometry}}{\text{Broken Projection}} \tag{6}$$

This explains why constants like c, $\hbar$, G, and α have their particular values—they reflect the geometric relationships inherent in the projection from (2+2) to (3+1) dimensions.

6.2 The Speed of Light as a Projection Artifact

The speed of light c, traditionally viewed as a fundamental constant, emerges in this framework as the ratio between distance and time created by the projection:

$$c = \frac{d}{t} \tag{7}$$

This directly relates to the reformulated mass-energy equivalence $Et^2 = md^2$ and explains why c appears constant in all reference frames—it's a fundamental property of the projection operation itself.

7 Theoretical Predictions

This ontological framework makes several distinctive predictions:

7.1 Quantum-Gravitational Predictions

1. **Signature fluctuations**: At Planck scales, there should be detectable fluctuations in the effective spacetime signature

2. **Dimensional phase transitions**: Extreme energy concentrations could trigger localized reversions to a more symmetric (2+2) structure

3. **Non-local correlations**: Quantum entanglement arises from connections through the underlying (2+2) structure, with specific mathematical patterns

7.2 Cosmological Predictions

1. **Early universe symmetry**: The very early universe should show evidence of greater (2+2) symmetry
2. **Inflationary mechanism**: Cosmic inflation can be explained as the rapid projection from (2+2) to (3+1) structure
3. **Vacuum energy structure**: The cosmological constant arises from incomplete cancellation in the projection process

8 Philosophical Implications

8.1 Ex Nihilo Creation

This framework provides a mathematical foundation for the philosophical concept of creation ex nihilo (from nothing). The emergence of structured reality from absolute nothingness becomes not just philosophically plausible but mathematically necessary, given the constraints of self-consistency.

8.2 Information Conservation

The framework implies a fundamental conservation of information at the deepest level:

$$I_{\text{total}} = 0 \tag{8}$$

All information content in the universe must sum to zero when accounting for both temporal dimensions, resolving paradoxes in black hole thermodynamics and quantum information theory.

9 Comparison with Other Approaches

9.1 String Theory and Extra Dimensions

Unlike string theory, which postulates additional spatial dimensions, this approach reinterprets existing dimensions while maintaining a total dimensionality of four. This provides a more parsimonious explanation that makes directly testable predictions.

9.2 Quantum Cosmological Models

In comparison to quantum cosmological models that require a pre-existing framework for quantum fluctuations, this approach derives both the dimensional structure and quantum properties from the same ontological foundation.

10 Conclusion

The (2+2) dimensional structure foundational to Laursian Dimensionality Theory is not assumed but emerges necessarily as the minimal self-consistent configuration from absolute nothingness. This ontological grounding provides a deeper foundation for the math-

ematical framework of LDT while answering the fundamental question of why spacetime has its particular dimensionality.

This approach transforms our understanding of reality's origin—rather than beginning with unexplained dimensions or constants, it derives the fundamental structure of spacetime from pure logical necessity. The universe, in this view, represents the unique, minimal solution to the paradox of existence emerging from non-existence, with the (2+2) dimensional structure serving as the critical bridge between nothing and something.

Future work will focus on developing more detailed mathematical models of the projection mechanism and exploring observational tests that could provide evidence for the underlying (2+2) structure beneath our perceived (3+1) spacetime.