

The Four-Sector Universe Model and the Tetrahedral Geometric Fingerprint in the CMB

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Abstract: The standard cosmological model is challenged by persistent large-scale anomalies, including the Cosmic Microwave Background (CMB) cold spot, baryon asymmetry, and the efficient early galaxy formation observed by the James Webb Space Telescope (JWST). This paper proposes a testable "Four-Sector Universe Model" based on a novel first principle of "physical information." The model posits that our universe is one of four constituent material universes (U1-U4) stabilized in a tetrahedral configuration within a higher-dimensional spacetime. It directly predicts that the CMB sky of our universe should exhibit two cold spots, caused by repulsion from negative-energy neighbouring universes, and one hot spot, caused by gravitational attraction from a positive-energy neighbouring universe, with angular separation relations reflecting the characteristic geometry of the tetrahedron. A preliminary analysis of Planck satellite data shows a qualitative agreement between the distribution of anomalous regions and this prediction. This model provides a unified origin framework for the aforementioned puzzles and suggests that the large-scale structure of the universe may originate from its macroscopic geometric architecture.

Keywords: cosmological model; cosmic microwave background; cosmological large-scale anomalies; tetrahedral geometry; physical information

1. Introduction

The Λ -CDM model, a cornerstone of modern cosmology, has successfully described many observational features of the universe with a concise parameter set, ushering cosmology into an era of "precision" science. However, advances in observational technology continue to reveal "large-scale anomalies" that are difficult to reconcile within this standard framework. These include the persistent CMB cold spot [1,2], multiple large-scale fluctuations confirmed by Planck data [3,4], the perplexing baryon asymmetry, and the efficient galaxy formation phenomenon in the very early universe discovered by JWST [5,6]. These seemingly disparate challenges may collectively point to a more profound, common origin related to the universe's initial conditions and macroscopic architecture.

Various hypotheses have been proposed to explain these anomalies, particularly the famous CMB cold spot (Fig. 1). The most representative is the "supervoid hypothesis" [7], which attributes it to a giant cosmological-scale underdensity via the (late-time) integrated Sachs-Wolfe effect. However, detailed galaxy surveys have not identified a single supervoid of sufficient scale and depth in the corresponding region to explain the observed temperature fluctuation. Other models, such as "cosmic texture collapse" or "early-universe features" [8], offer mechanisms distinct from the void but share two fundamental limitations: First, they are typically "isolated," aiming to explain a single, prominent cold spot without naturally accounting for other potential features on the CMB sky that might share a specific geometric relationship with it. Second, they are largely

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"phenomenological descriptions" that fail to reveal a deeper "cosmological origin" and a unified physical mechanism behind these phenomena.

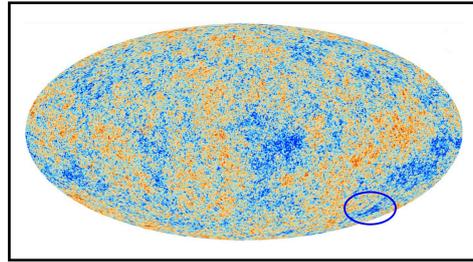


Fig. 1 Map of the Cosmic Microwave Background (CMB) temperature fluctuations, indicating the famous cold spot location. The base map shows the full-sky CMB temperature fluctuations measured by the Planck satellite (Planck Collaboration, 2013). The blue circle marks the famous anomalous cold spot region, centered at approximately Galactic coordinates $(l, b) \sim (209^\circ, -57^\circ)$ (the Eridanus cold spot), located based on its original discovery references [1,2] and subsequent confirmation by Planck data (Planck Collaboration, 2016)

To fundamentally overcome these limitations, this paper introduces a testable "Four-Sector Universe Model" based on the novel first principle of "physical information." The model's innovativeness is threefold: First, it provides a clear physical picture, positing that our universe (U1) is part of a system of four material universes (U1-U4). These universes are generated through a two-stage recursive transition and symmetry branching of physical information and are stabilized in a tetrahedral geometric configuration within a higher-dimensional spacetime. Second, it makes a unique observational prediction—although strict light-speed causal isolation prevents direct detection of U2-U4, this macroscopic tetrahedral architecture must imprint its unique two-dimensional projection onto the CMB of our universe (U1) via gravitational/repulsive interactions with the neighbouring universes. This projection manifests as a "fingerprint" pattern of two cold spots and one hot spot, whose angular separation reflects the characteristic tetrahedral geometry (Fig. 2). Third, it demonstrates powerful unifying explanatory power, providing a common origin framework for the CMB anomalies, baryon asymmetry, and the JWST early galaxy crisis.

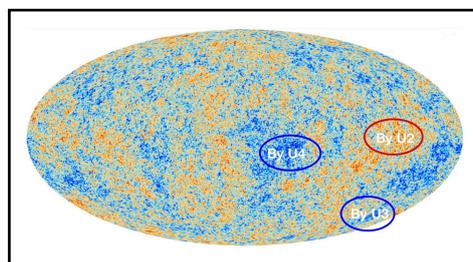


Fig. 2 Comparison between the CMB geometric fingerprint predicted by the Four-gSector Universe Model and Planck observations. This figure is based on the cosmic microwave background (CMB) temperature fluctuation map released by the Planck satellite, annotated with the three characteristic spatial configurations predicted by our model. (a) The red elliptical region indicates the predicted hot spot caused by gravitational attraction from the neighbouring universe U2 (positive energy), leading to matter overdensity. (b) The two blue elliptical regions indicate the predicted cold spots caused by repulsion from the neighbouring universes U3 and U4 (negative energy), leading to matter underdensity (cosmic voids). The spatial distribution of these three

features qualitatively matches the predicted tetrahedral geometry (see Fig. 4), constituting strong observational evidence supporting the Four-Sector Universe Model

The structure of this paper is as follows: Section 2 will elaborate the theoretical framework from physical information to the Four-Sector Universe Model and its causal isolation mechanism. Section 3 will present the tetrahedral geometric fingerprint in the CMB and its qualitative comparison with Planck satellite observational data. Section 4 will discuss the model's testability, unified explanatory power, and the resulting paradigm shift. Section 5 offers conclusions and future prospects.

2. Theoretical Framework: From Physical Information to the Four-Sector Universe and Its Causal Isolation Mechanism

2.0 Foundational Basis: Physical Information Cosmology as a Natural Extension of the Existing Paradigm

Modern cosmology, while highly successful in describing the universe's evolution from a hot, dense state, faces profound theoretical gaps beneath its established consensus. The mainstream framework posits our material universe (U1) originated from a singularity via the Big Bang, preceded by a vacuum with quantum fluctuations. This framework, however, encounters fundamental challenges: the Primordial Information Problem, the Symmetry-to-Asymmetry Conundrum, and the Incompleteness of the Single-Stage Fluctuation Model.

Physical Information Cosmology (PIC) addresses these challenges not by overturning established physics, but by refining the ontology of the quantum vacuum and proposing a more complete, two-stage genesis narrative. We propose that the state traditionally termed the "quantum vacuum" is more fundamentally described as a "primordial ocean of physical information in a free state." The subsequent genesis is not a single, ill-defined event but a two-stage, recursive process of generalized condensation, where each stage is driven by the information potential (Φ_{info}) and strictly adheres to fundamental conservation laws.

(1) First-Stage Transition: Establishing the Energy Foundation and Symmetry Reservoir

The information potential reaching a first critical threshold triggered a fundamental transition, branching physical information into positive and negative energy foundations.

- **Addressing Energy Conservation:** This process is inherently energy-conserving, producing a universe with zero net energy from the outset.
- **Addressing Primordial Symmetry:** It establishes a symmetry reservoir. While the emergence of positive and negative energy represents a local symmetry breaking, they are co-born and remain correlated, preserving a higher-order global symmetry. The observed asymmetries in our universe (U1) can thus be naturally explained as local observational effects within this grander symmetric architecture.

(2) Second-Stage Transition: Resolving Matter Genesis and Baryon Asymmetry

Within the newly formed positive and negative energy sectors, the information potential reached new critical points, triggering a second fundamental transition and branching:

- Positive Energy \rightarrow Positive Matter (U1) & Antimatter (U2)

- Negative Energy → Negative Matter (U3) & Negative Antimatter (U4)
- **Resolving Baryon Asymmetry:** This step perfectly conserves baryon number across the entire four-universe system. Our observed matter-dominated universe arises simply because we are confined within U1. The "missing" antimatter predominantly resides in U2. This provides a clear, geometric solution without requiring exponential fine-tuning via CP-violation parameters alone.
- **Optimizing the Fluctuation Paradigm:** PIC subsumes the standard model's single fluctuation into a deterministic, two-stage process with a definite end state. Within this framework, the "particle-antiparticle pair production" picture no longer diverges due to vacuum fluctuations nor requires ad-hoc renormalization techniques. It is no longer an isolated, problematic random event but the final step in a structured, information-driven phase transition.

In summary, PIC provides a more self-consistent, complete, and elegant foundation for cosmology, constructed directly to address recognized shortcomings of the current paradigm. By introducing physical information as the fundamental entity and a two-stage transition as the dynamical mechanism, it achieves key advancements in self-consistency, physical plausibility, and conceptual elegance, unifying multiple seemingly unrelated puzzles.

2.1 Core Concepts: Physical Information, Information Potential, and Recursive Hierarchical Emergence

We introduce the following set of core concepts to form the basis of the theory:

- **Physical Information:** Regarded as the sole primary fundamental entity of the universe. It is ontologically prior to energy and matter.
- **Information Potential (Φ_{info}):** The fundamental dynamical quantity driving the evolution of the physical information system. Its role is analogous to the chemical potential in thermodynamics, serving as the root cause triggering phase transitions.
- **Free State and Bound State:** These are two fundamental states universally present within each level of existence (physical information, energy, matter). The free state represents an unstructured state of high potentiality within its level; the bound state represents a stable, structured state. The information potential drives the gradual transition from the free state to bound states within each level.
- **Transition Phase Change and Symmetry Branching:** When the information potential of a system at any level reaches a critical threshold, a fundamental transition occurs—a discontinuous structural change or phase transition. The transition, via the mechanism of symmetry branching, generates multiple foundational states at the subsidiary level from a single state at the parent level, strictly adhering to overall conservation laws.

Based on these concepts, the theory depicts a recursive universe genesis:

(1) From Information to Energy: Primary Generalized Condensation

At the physical information level, the free state undergoes a fundamental transition phase change, symmetrically branching into the two foundational energy types of the universe—positive and negative energy. This process can be viewed as the initial "condensation" or "structuring" of physical information from its most primordial free state into entities with definite energy attributes. Thus, energy is the "primary generalized condensate" of physical information.

(2) From Energy to Matter: Secondary Generalized Condensation

Within the nascent energy level, free and bound states also exist. When the internal information potential within the energy sectors reaches a new critical point, their free states undergo a second transition phase change, branching into the foundational states of the matter level: positive energy branches into positive matter and antimatter; negative energy branches into negative matter and negative antimatter. This process further structures the energy states into particles with rest mass, charge, and other complex attributes. Thus, matter is the "secondary generalized condensate" of physical information, mediated through energy.

(3) Recursive Hierarchical Structure

Therefore, energy and matter are not coequal with physical information but are secondary realities that emerge from it through recursive phase transitions. The emergence of each new level provides the stage for more complex free-bound state dynamics and subsequent transitions within it. The concept of "generalized condensation" accurately captures the progressive solidification from informational potentiality to material reality.

2.2 Physical Information and the Recursive Transition Phase Change

Our theoretical framework, based on the above core concepts, involves the following specific cosmic generation mechanism:

(1) First-Stage Transition: From Information to Energy Foundations

The primordial physical information state (free state) underwent a fundamental transition phase change, symmetrically branching into a positive energy sector and a negative energy sector. To ensure the stable existence of these energy foundations after their birth and prevent mutual annihilation, they established a recession from each other at the speed of light (c), thereby realizing the first level of causal isolation. At this stage, spacetime structure was not fully solidified; these positive and negative energy sectors, as "primary generalized condensates," constituted the energy foundation for subsequent universe creation.

(2) Second-Stage Transition: From Energy to Material Universes

Subsequently, the nascent positive and negative energy sectors, as independent causally isolated systems, reached critical points in their internal information potentials, triggering a second transition phase change and branching:

- The Positive Energy Sector branched into: Our material universe (U1) & an Antimatter universe (U2). Though opposite in matter composition, both belong to the positive energy domain.
- The Negative Energy Sector branched into: a Negative Matter universe (U3) & a Negative Antimatter universe (U4). Both belong to the negative energy domain.

These four material universes, as secondary generalized condensates, constitute the basic architecture of the observable cosmos. Based on interaction balance and symmetry, the most stable configuration for these four resulting material universes is a regular tetrahedron in a higher-dimensional spacetime. They inherit the inherent recession at speed c , constituting a second-level causal isolation mechanism that ensures the stability of the four universes as independent systems. This "dual causal isolation" architecture—the two-level light-speed recession between energy sectors and between material universes—is the foundation of the entire model (schematic diagram in Fig. 3).

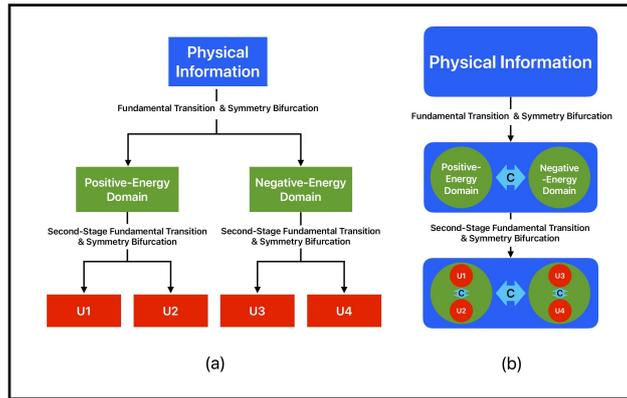


Fig. 3 The recursive transition of physical information and the dual causal isolation mechanism.

(a) The two-stage recursive transition of physical information and the generation sequence of the four-sector universe.

(b) The corresponding dual causal isolation dynamical mechanism for the transition process. These two schematics jointly illustrate the complete process from physical information to a stable material universe architecture: the first-stage transition generates positive and negative energy sectors, establishing the first-level light-speed (c) recession isolation; the second-stage transition generates matter-antimatter universe pairs within each energy sector, establishing the second-level light-speed (c) recession isolation, ultimately forming the four-universe tetrahedral configuration shown in Fig. 4

Based on interaction balance and symmetry, the most stable configuration for these four resulting material universes is a regular tetrahedron in a higher-dimensional spacetime(its spatial configuration is illustrated in Fig. 4).

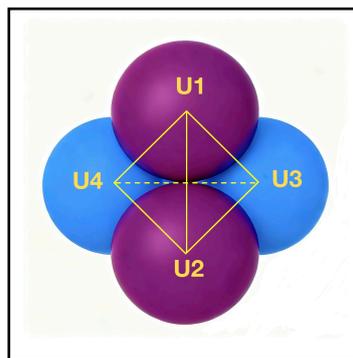


Fig. 4 This figure illustrates the stable tetrahedral configuration of the four material universes (U1-U4) in a higher-dimensional spacetime. The yellow solid and dashed lines clearly connect the centers of the four universes, forming the geometric skeleton of a regular tetrahedron. (a) The two red spheres in the foreground (longitudinally distributed) represent U1 (our resident universe) and U2, originating from the positive energy sector. (b) The two blue spheres in the background (transversely distributed) represent U3 and U4, originating from the negative energy sector. The colors distinguish their energy attributes, which determine their gravitational (from U2's positive energy) or repulsive (from U3, U4's negative energy) influence on U1

In this configuration, the equivalent repulsive force generated by the inherent light-speed recession between universes (originating from the two-stage transition) achieves perfect dynamic balance with the gravitational/repulsive interactions between universes of different energy attributes. This aligns with the principle of minimum energy prevalent in physical systems (e.g., the tetrahedral structure of the CH₄ methane molecule is the most stable configuration resulting from balanced electron cloud repulsions). This makes the tetrahedron the natural and inevitable geometric architecture ensuring the long-term stability of this multi-universe system.

2.3 Causal Isolation and the Cosmological Origin of the Speed of Light

A profound implication of this model is that these four universes recede from each other at speed c while simultaneously expanding. This inherent recession velocity constitutes the dynamic stabilization and causal isolation mechanism of the Four-Sector Universe structure. This allows for a natural cosmological origin explanation for local physical laws:

- **Speed of Light as the Substrate Velocity:** Within our universe (U1), any motion of objects or information occurs superimposed upon this inherent "light-speed substrate." Therefore, the speed of light c is not an ordinary velocity but a local manifestation of the inherent recession velocity of the cosmic spatial structure itself.
- **Necessity of the Speed Limit:** Since no motion within our universe can cancel out or exceed the inherent recession velocity of the universe's architecture itself, the speed of light c becomes the absolute speed limit for all motion and information transfer within our universe.
- **Deep Origin of Lorentz Transformations:** The constant c appearing in the Lorentz transformations, independent of the motion of the source and observer, is no longer an accidental, empirical postulate in this view. It precisely reflects that the local physical laws of our universe are grounded and constrained by the geometry and dynamics of the larger-scale cosmic structure (i.e., the light-speed recession of the Four-Sector Universe).

Mechanism for Imprinting the Early-Time Signatures

The model reveals a fundamental physical picture: the four universes recede from each other at light speed, ensuring that for most of cosmic evolution, no causal connection can be established between them via interactions propagating at light speed. However, as discussed in Section 3, the gravitational and repulsive forces from neighbouring universes have left imprints on our universe's CMB from the very early epochs. This guides us to investigate the imprinting mechanism. We posit that the seeds of these large-scale imprints were sown during the universe's extreme infancy (e.g., around the end of the inflationary epoch). At that time, the particle horizon scale of our universe was much smaller than the present observable universe, and the inherent recession distances between the four universes were relatively smaller. During this brief period of "causal contact," the gravitational and repulsive potential fields of the neighbouring universes (U2, U3, U4) could effectively influence the density distribution of the primordial plasma in our universe (U1), imprinting their geometric configuration onto the CMB. Subsequently, as the universe expanded, causal isolation became complete, but these gravitational potential imprints, set as initial conditions, were frozen in and amplified, ultimately manifesting as the observed cold and hot spots on the CMB last scattering surface. This picture naturally resolves the apparent paradox of "imprints under causal isolation" and incorporates the effects of the four-sector architecture into the standard early-universe evolutionary scenario.

3. The Tetrahedral Geometric Fingerprint in the CMB and Existing Evidence

3.1 Mechanism, Quantitative Prediction, and Observational Comparison

Our model not only permits inter-universe interaction but necessitates it. As shown in Fig. 4, the neighbouring universe U2 (positive energy-antimatter) exerts a gravitational influence on the primordial plasma of our universe (U1), while the neighbouring universes U3 and U4 (negative energy) exert repulsive influences. This inevitably leads to the geometric fingerprint in the CMB, as embodied in Fig. 2:

- U2 direction forms a matter overdensity \rightarrow CMB hot spot (red elliptical region in Fig. 2).
- U3 and U4 directions form matter underdensities (cosmic voids) \rightarrow two CMB cold spots (two blue elliptical regions in Fig. 2).

These cold/hot spots qualitatively match the tetrahedral geometry shown in Fig. 4, constituting strong observational evidence supporting the Four-Sector Universe Model. It is crucial to emphasize that the observed CMB sky is a two-dimensional projection of the celestial sphere. In our model, the four universes form a tetrahedral structure in a four-dimensional spacetime. When observed from within our universe (U1), the central directions of the other three universes (U2, U3, U4), which exert gravitational or repulsive forces, project onto the CMB celestial sphere. The angle between the lines connecting these projections, under ideal static conditions, is the angle between the center and vertices of a regular tetrahedron, namely $\sim 70.53^\circ$ (the geometric relationship is sketched in Fig. 4). Therefore, our model predicts that the two cold spots and one hot spot caused by the interaction of these three neighbouring universes form a specific spatial configuration on the CMB sky. Their angular separation will have $\sim 70.53^\circ$ as the ideal benchmark and is expected to show a trend of increase due to perturbations from early-universe dynamics—particularly the net repulsive effect of U3 and U4. This is a unique, quantitatively testable joint prediction of the model's geometry and dynamics.

3.2 A Unifying Explanation for Existing Observations

Current observations (like the famous CMB cold spot) already hint at the existence of such anomalies. Our model provides a unique theoretical framework that not only offers a physical origin for this known cold spot (interpretable as the U3 repulsive fingerprint) but, more importantly, uniquely predicts the existence of two other related features on the CMB sky: a hot spot caused by U2's gravitational attraction and another cold spot caused by U4's repulsion, with the three constituting a specific spatial configuration. Encouragingly, a preliminary analysis of the Planck satellite's CMB sky map shows anomalous structures in the directions predicted by the model that qualitatively match the above prediction. Initial observation suggests that the angular separation between these three characteristic points is slightly larger than 70.53° , consistent in direction with the dynamical perturbation predicted by our model from the net repulsive force of the negative-energy universes (U3, U4) on the primordial plasma distribution. Furthermore, the residual large-scale temperature asymmetry on the right side of the CMB sky (i.e., the direction of the U2, U3, U4 sector) after subtracting the dipole anisotropy due to the solar system's motion can be directly explained as resulting from the net positive energy background from these three neighbouring universes (see discussion in Section 4.4). Final validation of the model awaits rigorous, quantitative statistical significance analysis of these features.

4. Discussion

4.1 Testability of the Theory: The Tetrahedral Geometric Fingerprint under Causal Isolation

Before assessing the explanatory power of the model, a fundamental question must be addressed: how can the Four-Sector Universe Model be confirmed under causal isolation? The model's scientific value lies precisely here: it is not a metaphysical construct but a physical theory capable of verifying itself through indirect yet decisive predictions. The four-universe tetrahedral configuration, derived from first principles, is its most core, quantifiable geometric property. Although a light-speed recession mechanism maintains causal isolation between U1 and U2-U4, preventing direct detection, this inherent macroscopic geometric architecture imprints its unique two-dimensional projection onto the early history of universe U1 via gravitational/repulsive interactions with neighbouring universes. Therefore, the large-scale CMB features reported in this paper—the hot spot caused by U2's gravity and the two cold spots caused by U3 and U4's repulsion, along with their specific spatial configuration—should be regarded as the unique geometric fingerprint of this tetrahedral architecture under causal isolation. The model's verification does not rely on direct peering into invisible worlds but on the precise identification of this quantifiable spatial pattern, uniquely predicted by the deep geometry of our cosmos.

4.2 Core Logic and Re-examination of Observational Evidence

The model's argument is built upon a traceable, theory-driven logical chain:

- (1) **Theoretical Derivation:** Starting from the "physical information" first principle necessarily leads to the existence of four material universes (U1-U4) and their tetrahedral configuration.
- (2) **Interaction Mechanism:** U1 experiences non-local interactions with U2 (attraction) and U3, U4 (repulsion).
- (3) **Spatial Prediction:** This mechanism necessarily imprints one hot spot (U2) and two cold spots (U3, U4) on the CMB sky of U1, with angular separations reflecting the tetrahedral geometry (ideal value $\sim 70.53^\circ$), and an expected significant increase from this ideal value due to the net repulsive effect of U3/U4 negative energy.
- (4) **Observational Discovery:** Existing data show a qualitative 吻合 between a known cold spot, another newly predicted cold spot, and a newly predicted hot spot in their spatial configuration.
- (5) **Dynamical Evidence:** The systematic deviation of the observed angular separation from the ideal value is not a falsification but instead reveals early-universe dynamical processes, providing richer clues for the model's interaction mechanism.

This suggests that the CMB anomalies may not be isolated, random statistical fluctuations but a systematic phenomenon with a common physical origin and geometric architecture.

4.3 Quantitative Comparison with Independent Observations and Interpretation

The agreement of the model's predictions with observations is strongly supported by an independent study. The Planck Collaboration [9], in a systematic analysis of the CMB's most extreme large-scale features, identified five most significant temperature anomaly regions (Fig. 5), where #1 and #5 are cold anomalies and #3 is a hot anomaly, perfectly matching our model's predictions for U4/U3 (cold) and U2 (hot) in property. Encouragingly, the regions numbered 1, 3, and 5 correspond almost precisely in both location and thermal property to the features predicted by our model to be caused by U4, U2, and U3, respectively. Crucially, while that study confirmed the existence and statistical significance of these anomalies, it provided no unified explanation for their physical origin. Our

model is the first to posit that these three features are not independent statistical fluctuations but necessary manifestations of a common underlying physical mechanism—the "four-sector" geometric architecture of our universe—in different directions.

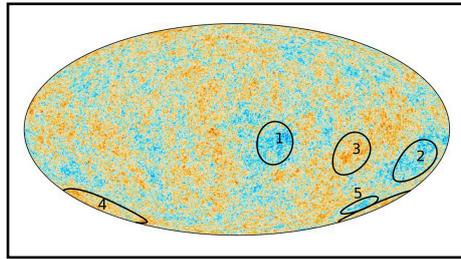


Fig. 5 The five large-scale temperature anomaly regions identified by the Planck Collaboration. This figure is reproduced from [9] (their Fig.29). The regions numbered 1, 3, and 5 largely correspond in position and property to the features predicted by our model (see Fig. 2 and the main text)

Furthermore, the distribution of the other two anomaly regions (2 and 4) in that figure is also compatible with the physical picture of our model. Cold region #2, adjacent to the hot spot (#3) caused by U2's gravitational attraction, might result from relative matter rarefaction in the flanking regions due to the same gravitational pull that concentrates matter into the hot spot (a gravitational halo effect). Similarly, hot region #4, adjacent to the cold spot (#5) caused by U3's repulsion, could be explained by the pile-up of matter pushed away by U3's repulsive force (a repulsive stacking effect). Although these are secondary effects, they collectively paint a dynamic picture of the primordial matter distribution being "sculpted" by the combined gravitational and repulsive forces of neighbouring universes, demonstrating the considerable potential and physical richness of our theoretical framework in unifying the explanation of a series of large-scale observational features.

4.4 Unifying Explanatory Power: From CMB Anomalies to a Network of Cosmological Puzzles

The value of the model lies not only in its prediction of CMB geometric features but also in the unifying power of its architecture, providing a common origin for a series of hitherto isolated puzzles in cosmology, constituting strong supporting evidence:

- **Ultimate Resolution of Baryon Asymmetry and Parity Violation:** These fundamental puzzles within the standard model framework are naturally resolved in the four-universe system. Antimatter predominantly resides in the antimatter universe U2, and parity symmetry is perfectly restored in the ensemble of the four universes. The observed asymmetries are not inherent violations of physical laws but an "observer effect" arising from our confinement within the horizon of a single universe (U1).
- **Natural Resolution of the JWST Early Galaxy Crisis:** The abundance of mature galaxies discovered by JWST at very high redshifts poses a severe challenge to traditional, slow gravitational growth models. In our model, the persistent gravitational and repulsive forces from neighbouring universes in the extreme early universe provide a set of powerful, non-random, directed initial perturbations for matter aggregation. This effectively pre-sets clear "gravitational potential wells" and "repulsive potential hills" from the cosmic beginning, drastically accelerating and front-loading the structure formation process, providing a perfect dynamical origin for the JWST observations.

- **A New Paradigm for the Origin of Large-Scale Structure:** The observed cosmic web may not be shaped solely by random fluctuations and dark matter gravity. The fixed-direction forces from U2, U3, and U4 provide a persistent "driving field from an external geometric architecture" for structure formation. This non-random "cosmic stirring" can very efficiently guide material flows, significantly shaping and enhancing the formation of the cosmic web.

4.5 Paradigm Shift: From Isolated Patches to a Unified Architecture

The value of the model lies in its paradigmatic breakthrough. Existing theories (e.g., supervoids, cosmic textures) seek isolated, post-hoc explanatory causes for single phenomena. They are, in essence, "patches" applied to the Λ -CDM model. In contrast, our model provides an a priori, unified physical architecture. Within this framework, the CMB anomalies, baryon asymmetry, JWST observations, and large-scale structure are no longer isolated "unsolved mysteries" but necessary manifestations of the same deep cosmic geometric architecture in different aspects. Therefore, the model's advantage is not in providing another "explanation," but in using a more fundamental "architecture" to unify the "puzzles" that are isolated under the current paradigm, steering cosmology from the paradigm of "patching models" towards that of "exploring architecture."

5. Conclusions and Outlook

This paper proposes the "Four-Sector Universe Model," reinterpreting CMB large-scale anomalies as probes of the universe's ultimate architecture. The study suggests these anomalies need not invoke multiple ad hoc assumptions but can be uniformly attributed to a grander, multi-universe system with a specific geometric form. Future work will focus on:

- (1) **Quantitative Verification:** Performing rigorous statistical analysis of the tetrahedral angular separation features in the CMB.
- (2) **Theoretical Formalization:** Developing a complete interaction potential model to simulate its impact on the primordial power spectrum and structure formation.
- (3) **Extended Application:** Expanding the framework to address core puzzles like dark matter and dark energy, and deriving new, testable secondary predictions.

Declarations

Author Contributions: The author confirms sole responsibility for the conception of the theory, all analyses, and the preparation of the manuscript.

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