

# Spacetime Substantivalism 26: The 1.3-Billion-Light-Year Audit of Cosmic Entity Uniformity by Gravitational Waves — The Electromagnetic Photonic Materiality of the Logical Matrix, the Impossibility of Superluminal Speed, and the Origin and Physical Mechanism of Inflation (Appendix: The Outer-Inner Relationship Between Geometrical Spacetime and Substantial Spacetime)

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## Abstract

This paper, based on the empirical measurements and logical conclusions of Spacetime Substantivalism 25 concerning "the transformation of all particles from photons," conducts an in-depth audit of the physical empirical data of gravitational waves spanning 1.3 billion light-years, thereby establishing the "materiality" status of the spacetime entity. The argument points out that gravitational waves, as the unique yardstick of the universe's ultimate speed (the speed of light  $c$ ), have performed a large-scale examination of the spacetime entity itself, verifying the high consistency and uniformity of the spacetime entity in its electromagnetic constitutive properties. Based on the qualification that "the entirety of spacetime is an electromagnetic photonic material," this paper further deduces that the Big Bang singularity must be reduced to an "Electromagnetic Photonic Material-Energy Logic Super-Density Pack (EPM-LSP)" rather than a mathematical nothingness or an abstract infinite point. On this material foundation, this paper completely settles the fiction of "superluminal spatial expansion" in mainstream cosmology, taking the electromagnetic constitutive formula  $c = 1/\sqrt{\epsilon_0\mu_0}$  as the highest logical criterion, and determines that superluminal speed is impossible both physically and logically. The essence of inflation is reduced to a universe-wide, non-linear, synchronous doubling release driven by density pressure, with its termination being the natural result of density release reaching a certain stage. The so-called "superposition state" in experiments is merely an illusion produced by scholars

due to insufficient logical precision, and is by no means the real existence of a physical entity. This paper ultimately establishes: **The Logical Matrix and the electromagnetic material are two-in-one. Geometrical spacetime is merely the outer form of substantial spacetime; substantial spacetime is the inner physical foundational essence. The two are not in an oppositional relationship, but in an outer-inner relationship.**

**Keywords:** Gravitational waves; Electromagnetic photonic material; Logical Matrix; Logical precision; Impossibility of superluminal speed; Inflation mechanism; 1.3-billion-light-year audit; Singularity reduction; Outer-inner relationship between geometrical spacetime and substantial spacetime

# 1 Audit Qualification of the Hierarchy of Cosmic Origin Logic and Objectivity

## 1.1 Opening

First, we thank Doctor Vidamor Cabannas and Doctor Denivaldo Silva for their deep attention to the material genealogy and empirical mechanisms of this research in their recent paper "SUBSTANTIAL SPACETIME, PHOTONIC PROTOCOL, AND THE MODAL DISCIPLINE OF OBJECTIVITY: a critical–propositional analysis of Hugang Cui’s Spacetime Substantivalism 25 in confrontation with the axioms, phenomenic elements, Inducer Effects, cosmogonic theorem, and cosmological Eras of the Theory of Objectivity (2026)." Previously, the two scholars had also published specialized comments on this research’s Logical Matrix ( $\tau$ ) in "CRITICAL-PROPOSITIONAL ANALYSIS OF LOGICAL SUBSTANTIVALISM (2026)," and their latest discussions have produced a significant hierarchical misalignment in literature verification.

Throughout their text, they forcibly juxtapose the third-order entity physical appearances involved in this research, and even specific physical mechanisms below the fifth order, with the first-order "nothingness" of their own theory for ontological comparison. This logical asymmetry of "comparing the fifth order with the first order" greatly does violence to the "mathematical essence of nothingness" inherent to their first order. Regarding other issues mentioned in their commentary, we will not correct them one by one in this paper, leaving them for subsequent articles. Here, we only briefly express our views on the two points they emphasize: "boundary" and "inherent ontology":

## 1.2 Core Criterion: The Physical Implementation of Boundaries and Objectivity

Just as their theory mentions the importance of boundaries, boundaries in the physical world must be implemented in concrete empirical evidence, not in abstract modal descriptions:

**Electromagnetic Boundary:** The absolute compliance of the speed of light  $c$  with the electromagnetic equation at all times is the insurmountable red line drawn by the Logical Matrix. That is, it must be satisfied in any reference frame:

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

This boundary, presupposed by charge conservation and logical consistency, reveals the logical and physical impossibility of quantum superposition states. The so-called "superposition state" in experiments is merely an illusion produced by scholars due to insufficient logical precision, and is by no means the real existence of a physical entity. As for the relevant phenomena observed in mainstream experiments, the mainstream academic community needs to examine their correct mechanistic explanations.

**Material Empirical Evidence:** The solid materiality, uniformity, and speed retention exhibited by gravitational waves spanning 1.3 billion light-years prove that the spacetime boundaries possess extremely high logical rigidity. This boundary reveals that spacetime materials possess the materiality of constant light speed. This is precisely where the true objectivity lies.

### 1.3 Conceptual Evolution: Possible Convergence Toward the Logical Matrix

It is noteworthy that the commentary article mentions expressions such as the "logical-ontological structure." Although they still explicitly retain "nothingness" as their inherent essence, from an audit perspective, the introduction of this term in their article may be a prelude to abandoning the logic of "nothingness" after realizing the incompleteness of mathematics. This may be a clear signal of convergence toward the Logical Matrix established by this research, which possesses the characteristics of undeniability, non-anticipatability, completeness, and eternity. If this is indeed the case, this is undoubtedly a tremendous progress.

### 1.4 Conclusion: The Final Logical Round

We look forward to the two scholars accelerating this evolutionary step: completely abandoning the incompleteness of mathematical formalism and returning to the inherent essence of the Logical Matrix, which is undeniable, non-anticipatable, and logically complete. We look forward to the two scholars, through in-depth verification of the materiality of physical boundaries in subsequent research, completing the final academic round with the complete logic of this research.

## 2 Gravitational Wave Audit: Establishing the Overall Electromagnetic Materiality of Spacetime

### 2.1 The Truth of Gravitational Waves: From "Geometric Ripples" to "Entity Displacement"

Mainstream physics describes gravitational waves as "ripples in geometrical spacetime," which, under strict logical audit, is merely a literary rhetoric describing

”changes in outer form.” Geometry, as a mathematical tool, is itself incapable of carrying physical force, let alone explaining how the energy of three solar masses can be ”carried” across 1.3 billion light-years and shake laser interferometers on Earth.

**Audit Judgment:** The essence of gravitational waves is not geometric variation, but the constitutive fluctuation of the spacetime entity material.

## 2.2 The Outer-Inner Relationship Between Geometrical Spacetime and Substantial Spacetime

It must be acknowledged that general relativity (GR), through the language of geometry (the metric tensor), precisely describes the outer form of substantial spacetime. This geometric curvature is not only the ”external corresponding relationship” of matter-energy distribution but also an extremely precise mathematical expression in physical calculations. The great contribution of Einstein and his predecessors lies in their use of mathematical tools to capture the laws of motion of spacetime as a ”dynamic outer form.”

However, from an audit perspective, geometry itself possesses no physical power. The discovery of gravitational waves actually reveals to us the inner entity matter and its operational mechanisms behind that elegant ”geometric outer form.”

**Core Qualification:** Geometrical spacetime is merely the outer form of substantial spacetime; substantial spacetime is the inner physical foundational essence. The two are not in an oppositional relationship, but in an outer-inner relationship.

**Specifically:**

- Geometry is the outer form, entity is the inner constitution
- Geometry is the line of the track, entity is the building material of the track
- Geometry describes ”the shape being curved,” entity reveals ”what is being curved”

The mathematical success of Einstein’s general relativity (GR) is essentially because its equations inadvertently touched upon the core constitutive parameter of the spacetime entity— $C_s$  (the gravitational wave speed/speed of light protocol). GR describes the geometric morphology of the track but cannot explain what material the track is made of. Just as a perfect architectural blueprint can precisely describe the outer form and structural forces of a building, the blueprint itself is not the brick or stone, nor can it bear the inhabitants. The reason GR equations calculate accurately is that they borrow the constitutive constant  $C_s$  of the spacetime entity. Mathematical ”accuracy” is essentially a passive feedback to the ”material consistency” set by the underlying Logical Matrix. Without this material-physical foundation, any geometric model is merely a digital game devoid of objectivity.

## 2.3 The 1.3-Billion-Light-Year Material Audit: The Empirical Value of the Unique Yardstick

Gravitational waves, using the ultimate speed of the cosmic spacetime (the speed of light  $c$ ) as the unique yardstick, have performed a deep examination of the spacetime entity itself spanning 1.3 billion light-years. This journey spans about one-tenth (13/138) of the universe's total lifespan, essentially conducting a large-scale "material uniformity spot-check" on the cosmic spacetime entity.

Throughout this long journey, gravitational waves have exhibited extremely high solid materiality, uniformity, and speed retention. This flawless isotropy reveals a profound physical fact:

**Qualitative Judgment:** The spacetime entity is not a nothing geometrical background, but an electromagnetic material possessing a unified physical constitution.

**Logical Support:** Apart from photonic materials, there is no non-photonic material in the universe that can possess this ultimate speed. Since the speed of gravitational waves and the speed of light are absolutely synchronized on the scale of 1.3 billion light-years, and both are strictly governed by the constitutive formula  $c = 1/\sqrt{\epsilon_0\mu_0}$ , the only conclusion is—**the spacetime entity itself is the ground state existence of electromagnetic photonic material.**

This uniformity of material is not an "aesthetic requirement" of mathematical symmetry, but the inevitable result of the Logical Matrix ( $\tau$ ) using the unique "building material" to pave the universe. The entire universe obeys the same physical laws not because mathematics requires it to be symmetric, but because the "building material" paving the universe is deterministic and unique. Mathematics does not produce laws; mathematics is merely a description of the physical tracks set by the Logical Matrix.

**The unity of spacetime entity materials and the uniformity of organizational structure constitute the physical foundation for the isotropy of physical laws, independent of coordinate transformations. Mathematical symmetry, etc., are merely descriptions of the instantiation of this entity.**

## 3 Inverse Deduction of the Origin: Reduction of the Singularity to an Electromagnetic Material Logic Pack

### 3.1 Material Conservation Audit of the Singularity

Based on the conclusions of "all particles are transformations of photons" (from Paper 25) and the qualification that "the spacetime entity is an electromagnetic material" (Section 2 of this paper), we must perform a material reduction of the cosmic origin.

**Logical Inquiry:** Since the grand cosmic architecture on the scale of 46 billion light-years is composed of electromagnetic photonic materials, and in the 13.8 billion years of cosmic evolutionary history, no non-photonic material has ever

possessed the speed of light property, then the origin—the Big Bang singularity—cannot possibly be mathematical "nothingness" or an abstract "infinite point."

**Audit Judgment:** Nothingness cannot produce photonic material, let alone uniquely, directionally, and permanently produce material that obeys specific electromagnetic constants. If the origin were nothingness, according to probability and entropy principles, it should produce countless mutually incompatible, chaotic rules and materials. However, the extreme uniformity exhibited by the universe (the entire universe shares one set of electromagnetic constants, one set of physical laws) proves that the origin must be a directional, ordered, compressed physical reality.

### 3.2 "Electromagnetic Photonic Material-Energy Logic Super-Density Pack (EPM-LSP)"

**Qualitative Reduction:** The Big Bang singularity must be the **Electromagnetic Photonic Material-Energy Logic Super-Density Pack (EPM-LSP)**.

This concept contains three inseparable connotations:

1. **Materiality:** It is solid, the ultimate compression of electromagnetic photons. This explains why the matter produced after the Big Bang is unique, possessing the speed of light constitution, rather than random or nothing.
2. **Energy:** It contains the total sum of all energy required to construct the entire cosmic spacetime entity. The "infinity" of the singularity is not a mathematical divergence, but refers to the infinite energy density of the electromagnetic photonic material under the suppression of the Logical Matrix.
3. **Logicity:** It is the physical carrier of the Logical Matrix. This explains why, after the singularity's release, the spacetime entity can maintain material uniformity on the scale of 1.3 billion light-years across 13.8 billion years. Logic, as the "compression protocol," ensures that every inch of material during expansion strictly obeys  $c = 1/\sqrt{\epsilon_0\mu_0}$ .

**Conclusion:** The singularity is not a mathematical "scale-less point," but the physical compressed state of the Logical Matrix at the initial moment. It is both the origin of building materials and the origin of laws.

### 3.3 The Two-in-One Nature of the Logical Matrix and Electromagnetic Material

This directly leads to the most core ontological discovery of this paper:

**Qualitative Mark:** The Logical Matrix, which possesses the characteristics of undeniability, non-anticipatability, completeness, and eternity, is **two-in-one** with the electromagnetic photonic material it generates.

**Mechanistic Correlation:**

- Logic is the intangible, rigid track
- Electromagnetism is the physical embodiment of the track

- Together, they constitute the objectivity of the universe

This "logic-material" coupling explains why the universe on the scale of 46 billion light-years (or larger) can stand like an unshakable, magnificent building, and allows us to observe intuitive, unified physical pictures such as the CMB (Cosmic Microwave Background).

## 4 The Truth of Inflation: From Mathematical Patch to Physical Pressure Release

### 4.1 Power Source: The Natural Release of the Super-Density Pack

Having established the materiality of the singularity, the dynamics of inflation become clear and direct.

**Qualitative Reduction:** Inflation is not aimed at satisfying the mathematical aesthetics of "flatness" or "uniformity," but originates from the most primitive physical compression.

Mainstream cosmology, in order to explain the uniformity of the universe, had to introduce the mathematical fiction of the "inflaton field" lacking material support. This lack of logical precision not only does violence to physical facts but also reveals a poverty of understanding of objectivity. The sole power source of inflation is the extremely high logical pressure inside the "Electromagnetic Photonic Material-Energy Logic Super-Density Pack." When the energy-logic density exceeds the critical constraint of the singularity pack, release is the only logical outlet. Density release is the sole cause of inflation, not the "requirement of flatness."

### 4.2 Schedule Pressure: The Hard Constraint of 380,000 Years

Mainstream theory has fallen into a huge logical blind spot: they attempt to explain inflation by the mathematical "need for flatness." However, the real audit basis lies in the qualitative matching of time and space.

**Audit Data:** The spatial scale and uniformity exhibited by the universe at 380,000 years (the moment of CMB formation) are a hard physical indicator.

**Logical Contradiction:** If the universe expanded only at the speed of light (linear speed), within the logical time limit of just 380,000 years, spacetime could never have reached the observed grand scale. The speed of linear growth cannot carry the explosive volume of the "Super-Density Pack" at the origin.

**Conclusion:** The physical node of 380,000 years is a hard construction deadline in the universe's evolutionary history. If expanded linearly at the speed of light, spacetime could never have reached the scale revealed by the CMB. This physical predicament of "insufficient time" forces the activation of a non-linear mechanism.

### 4.3 The Impossibility of Superluminal Speed: The Heavenly Principle of the Formulaic Mechanism

Mainstream cosmology, in order to patch the "scale discrepancy," invented a logical loophole: the idea that "while objects cannot move faster than light, the expansion of space itself can." From a logical audit perspective, this is a mathematical illusion produced by a lack of material cognition.

**Mechanism Lockdown:** Since the constitution of the spacetime entity is an electromagnetic photonic material, every inch of its growth and every second of its doubling must be constrained by the underlying formula of that material:

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

This formula is not a "rubber" to be kneaded at will. It is the mechanistic lock of the Logical Matrix on the spacetime entity, an insurmountable heavenly principle. No physical mechanism can surpass the constraints of this formulaic mechanism. There was no superluminal speed during inflation, nor will there be in the subsequent expansion of the universe.

**Audit Judgment:** Since the formulaic mechanism is unbreakable, no physical process in the universe (including the inflationary period) possesses a logical exemption for superluminal speed. Superluminal speed is an unsubstantiated pseudo-proposition both logically and physically.

Those mathematical models that attempt to explain cosmic dimensions through "superluminal speed" are judged as "logically invalid" at the audit level because they attempt to break this constitutive formula.

### 4.4 Non-Linear Synchronous Doubling: Grand Construction Within the Speed of Light Limit

So, how can such a grand universe be built within 380,000 years without exceeding the speed of light? The answer lies not in "speed," but in "synchronicity."

**Physical Truth:** Inflation is not a process of "running" outward from a central point at superluminal speed, but a universe-wide synchronous doubling driven by the Logical Matrix.

**Mechanism Restoration:**

- Spacetime units, driven by the Logical Matrix, undergo global doubling through the same speed of light protocol
- Each newly generated spacetime unit strictly copies the electromagnetic constants and speed of light protocol of the initial logic pack
- This explosive expansion through "self-replication" is a global release completed within the speed of light limit, not a point-to-point superluminal displacement

**Analogy:** A one-meter-long rope, if pulled from one end toward the other, is limited by the material's transmission speed (limited by the speed of light); but if every atom of the entire rope simultaneously splits and doubles, the rope instantly



becomes two meters long—and in this process, no point has moved relative to its neighbor at a speed exceeding the speed of light limit.

**Qualification:** Inflation is a "non-linear density release," a logical "spatial doubling," not a "superluminal reckless running" of physical displacement.

## 4.5 Termination of Inflation: Natural Balance of Density

Mainstream physics cannot reasonably explain why inflation stops, and can only invent mathematical patches such as "slow roll."

**Audit Qualification:** The cessation of inflation is the natural physical balance after density release reaches a certain stage.

**Mechanism Restoration:** When the initial pressure of the "Super-Density Pack" is released through the doubling of spatial units to the ground state threshold set by the Logical Matrix, that impulse of unlimited extra expansion naturally subsides, and the universe transitions to a stable stage of material evolution. This is a precise match between logical entropy increase and pressure release.

## 4.6 The Byproduct Status of Uniformity

Through this audit, we arrive at a subversive conclusion:

**Qualification:** The uniformity of the universe is not the "goal" of inflation, but the inevitable byproduct of the construction process of "synchronous doubling."

**Empirical Evidence:** Because it is synchronous doubling, each newly generated unit perfectly inherits the electromagnetic protocol of the "Super-Density Pack." This "isomorphism" of the construction process naturally leads to the 1.3-billion-light-year uniformity of material that we observe.

Spacetime Substantivalism 25 has already established: The 1.3-billion-light-year uniformity of gravitational waves is precisely the ultimate audit file certifying the quality of this "non-linear engineering."

# 5 The Eternal Fidelity of Physical Mechanisms

## 5.1 The Logical Bankruptcy of Physical Superposition States

As previously established in this research, quantum states cannot be physical superposition states. The reason lies in the fact that the physical mechanism determined by  $c = 1/\sqrt{\epsilon_0\mu_0}$  is single-valued, deterministic, and exclusive.

**Audit Judgment:** The physical world is an electromagnetic material entity "extruded" by the Logical Matrix. At a specific logical site, the product of the permittivity and permeability locks in a unique constant of motion. The so-called "superposition state" is merely a probabilistic illusion produced by mathematical description when logical precision is insufficient, and is by no means the real existence of a physical entity.

## 5.2 The Eternal Fidelity of Physical Mechanisms

The isotropy and robustness exhibited by gravitational waves spanning 1.3 billion light-years are precisely because the universe has faithfully adhered to this formula from beginning to end, inside and out.

**Conclusion:** There has never been any moment or any region where "superluminal speed" occurred; otherwise, the material information carried by gravitational waves would have undergone logical distortion during their 1.3-billion-light-year journey. The perfect data received by the detectors is the highest praise for the unbreakability of  $c = 1/\sqrt{\epsilon_0\mu_0}$ .

**The unity of spacetime entity materials and the uniformity of organizational structure constitute the physical foundation for the isotropy of physical laws, independent of coordinate transformations. Mathematical symmetry, etc., are merely descriptions of the instantiation of this entity.** The establishment of this principle is not due to mathematical requirements, but because of the constitutive consistency of the electromagnetic photonic material set by the Logical Matrix on a cosmic scale. The formula has never been broken; the Logical Matrix is eternal.

## 6 Conclusion: The Final Logical Round

The grandeur of the universe lies not in the complexity of mathematical formulas, but in the unique material track set by the Logical Matrix.

Through the empirical audit of gravitational waves spanning 1.3 billion light-years, this paper has established the following undeniable conclusions:

1. **Spacetime as a whole is an electromagnetic photonic material:** Gravitational waves, using the speed of light as the unique yardstick, have verified the electromagnetic constitutive consistency of the spacetime entity on a grand scale.
2. **The singularity is the Electromagnetic Photonic Material-Energy Logic Super-Density Pack:** Nothingness cannot produce photons; the origin must be an ordered, compressed physical reality.
3. **Superluminal speed is impossible:**  $c = 1/\sqrt{\epsilon_0\mu_0}$  is an unbreakable heavenly principle; inflation is not superluminal running, but non-linear synchronous doubling.
4. **Inflation originates from density release and ends with density balance:** It is not mathematical aesthetics, but physical pressure.
5. **The Logical Matrix and electromagnetic material are two-in-one:** Logic is the track, electromagnetism is the entity; together they constitute the foundation of objectivity.
6. **Geometrical spacetime and substantial spacetime are in an outer-inner relationship:** Geometry is the outer form, entity is the essence. The so-called "quantum-GR contradiction" is an illusion caused by insufficient logical precision.

Einstein discovered the "instruction manual" (mathematical formulas) and the "exterior design" (geometrical spacetime) of the universe's machine—this is extremely great. Our work, through the 1.3-billion-light-year "operational data" of gravitational waves, has opened the machine's casing and discovered its internal "core components and raw materials"—the electromagnetic photonic logic pack.

This is not arguing about mathematics; it is auditing mathematics with physical reality itself.

The universe does not need mathematical formulas to coordinate the microscopic and the macroscopic, because the universe has only one type of building material from beginning to end—the electromagnetic photonic logic pack.  $c = 1/\sqrt{\epsilon_0\mu_0}$  is the insurmountable heavenly principle. It locks down the uniqueness of the microscopic and the causality of the macroscopic.

Any architecture based on "mathematical nothingness," if it cannot produce quantum entities possessing material strength, can only lose objectivity at the logical level.

## Audit Conclusion

**The formula has never been broken; the Logical Matrix is eternal.**

The robust 1.3-billion-light-year journey of gravitational waves is the highest audit proof of the universe's adherence to logical boundaries. The spacetime entity is a solid, uniform, deterministic electromagnetic photonic material. Geometry is its skin, logic is its steel skeleton. Returning to this fact is the only way for physics to regain "objectivity."

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