

# TONLEE

Theory of Nothingness, Leading to Everything Else

*Geometric and Number-Theoretic Foundations  
From Pure Mathematics to the Speed of Light*

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*“The universe is not an object but a phenomenon—a causality-minimizing process whose ground state is nullity. All physical law emerges from the causal structure of spacetime, and dissolves where that structure ceases.”*

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# Part I: Pure Mathematical Foundations

## 1 The Axiom of Nullity

We begin with the most minimal possible mathematical assumption: nothing.

**Axiom 1** (Nullity). The fundamental state of totality is the empty set  $\emptyset$ . Equivalently, the net content of the universe, summed over all configurations and all scales, is identically zero:

$$\boxed{\sum_{\text{all}} \equiv 0} \quad (1)$$

This is not a physical assumption—it is the statement that “there is nothing to explain” at the level of totality. Everything that exists is a *mismatch*: a local departure from nullity that is compensated elsewhere.

**Definition 1.1** (Mismatch). A **mismatch**  $\mathcal{M}$  is any local configuration  $\omega$  in a space  $\Omega$  such that  $\omega \neq 0$  locally, but the global integral vanishes:

$$\int_{\Omega} \omega d\mu = 0, \quad \text{yet} \quad \omega(p) \neq 0 \text{ for some } p \in \Omega. \quad (2)$$

*Remark 1.1.* The Axiom of Nullity is the only axiom of TONLEE. Everything else—geometry, dynamics, quantum mechanics, the speed of light—must be *derived* as consequences of mismatch configurations living on structures that emerge from nullity. Every postulate we introduce below will eventually be shown to reduce to this single axiom.

### 1.1 Nullity in Number Theory: The Zeta Function

The Axiom of Nullity has a precise number-theoretic realization. Consider the Riemann zeta function:

$$\zeta(s) = \sum_{n=1}^{\infty} n^{-s}, \quad \text{Re}(s) > 1. \quad (3)$$

The analytic continuation to  $s = 0$  yields

$$\zeta(0) = -\frac{1}{2}, \quad (4)$$

which, via the functional equation, encodes the fact that the “sum of all unity” ( $1 + 1 + 1 + \dots$ ) is regularized to  $-1/2$ . More precisely, the functional equation of  $\zeta$  connects  $s$  and  $1 - s$ :

$$\zeta(s) = 2^s \pi^{s-1} \sin\left(\frac{\pi s}{2}\right) \Gamma(1-s) \zeta(1-s). \quad (5)$$

This symmetry  $s \leftrightarrow 1 - s$  centered at  $s = 1/2$  is the **number-theoretic expression of nullity**: the structure of the natural numbers, when summed over all scales (all values of  $s$ ), possesses a mirror symmetry that enforces a net cancellation.

**Proposition 1.1** (Arithmetic Nullity). *The completed zeta function*

$$\xi(s) = \frac{1}{2} s(s-1) \pi^{-s/2} \Gamma\left(\frac{s}{2}\right) \zeta(s) \quad (6)$$

*satisfies  $\xi(s) = \xi(1-s)$ . The sum of residues of  $\zeta$  at its unique pole  $s = 1$  is exactly compensated by the zero at  $s = 0$  inherited from the prefactor, yielding a net “content” of zero when integrated over the critical strip.*

*Remark 1.2.* The divergent series  $1 + 2 + 3 + \dots = \zeta(-1) = -1/12$  (via analytic continuation) and Abel/Cesàro summation methods are *not* mathematical pathologies but are manifestations of the Axiom of Nullity: the naive “infinity” obtained by direct summation is an artifact of counting from a prejudiced starting point. The regularized value  $-1/12$  encodes the mismatch between the counting process and the underlying nullity.

## 1.2 Nullity from Set Theory: The Empty Set Generates Structure

From  $\emptyset$  alone, we construct the von Neumann ordinals:

$$0 := \emptyset, \quad 1 := \{\emptyset\}, \quad 2 := \{\emptyset, \{\emptyset\}\}, \quad \dots \quad (7)$$

The natural numbers  $\mathbb{N} = \{0, 1, 2, \dots\}$  emerge from *nothing* by the operation of self-reference:  $n + 1 = n \cup \{n\}$ . Each number is a mismatch—a departure from  $\emptyset$ —that carries within it the memory of every prior mismatch.

**Proposition 1.2** (Conservation of Cardinality Mismatch). *For every finite ordinal  $n$ , define  $\bar{n} := -n$  (the formal additive inverse). Then  $n + \bar{n} = 0$ . The integers  $\mathbb{Z} = \mathbb{N} \cup \{-n : n \in \mathbb{N}\}$  are the minimal mismatch-compensated extension of  $\mathbb{N}$ , and  $\sum_{n \in \mathbb{Z}} n = 0$  (as a principal value or Cesàro sum).*

This is the first instance of a recurring pattern: *every mismatch generates its own compensation, and the net sum is always nullity.*

## 2 Emergent Geometry from Causal Order

With nullity established as the ground state, we now ask: what structure emerges from mismatch? The answer is *geometry*, and specifically *causal geometry*.

### 2.1 The Partial Order of Precedence

**Definition 2.1** (Precedence Relation). Let  $\Omega$  be a set of mismatches (“events”). A **precedence relation**  $\preceq$  on  $\Omega$  is a partial order satisfying:

- (i) **Reflexivity**:  $p \preceq p$  for all  $p \in \Omega$ .
- (ii) **Antisymmetry**:  $p \preceq q$  and  $q \preceq p$  implies  $p = q$ .
- (iii) **Transitivity**:  $p \preceq q$  and  $q \preceq r$  implies  $p \preceq r$ .

We write  $p \prec q$  if  $p \preceq q$  and  $p \neq q$  (strict precedence, or “ $p$  causally precedes  $q$ ”).

**Definition 2.2** (Causal and Acausal Pairs). Two events  $p, q \in \Omega$  are:

- **Causally related** if  $p \preceq q$  or  $q \preceq p$ .
- **Causally disconnected** (acausal) if neither  $p \preceq q$  nor  $q \preceq p$ .

**Postulate 2.1** (Causal Geometry Emergence). The precedence relation  $\preceq$  on  $\Omega$ , together with a measure  $\mu$  counting the number of elements in causal intervals  $[p, q] = \{r : p \preceq r \preceq q\}$ , determines a **conformal Lorentzian geometry** on  $\Omega$  in the continuum limit.

This postulate is supported by two deep results:

**Theorem 2.1** (Malament, 1977). *Let  $(M, g)$  be a time-oriented, distinguishing spacetime. The causal relation  $J^+$  determines the topology, differential structure, and conformal class  $[g]$  of the metric. That is, the causal order encodes all of spacetime geometry up to a local volume factor.*

**Theorem 2.2** (Hawking–King–McCarthy, 1976). *The causal structure of a strongly causal spacetime determines its topology.*

The message is: *causal order is geometry*. A Lorentzian manifold  $(M, g)$  is nothing more than a continuum of mismatches equipped with a precedence relation.

## 2.2 The Light Cone as Boundary of Causal Influence

Given a point  $p \in M$ , the **causal future**  $J^+(p)$  and **causal past**  $J^-(p)$  are:

$$J^+(p) = \{q \in M : p \preceq q\}, \quad (8)$$

$$J^-(p) = \{q \in M : q \preceq p\}. \quad (9)$$

The boundary  $\partial J^+(p)$  is the **future light cone** of  $p$ . In coordinates, for a Lorentzian metric  $g_{\mu\nu}$  with signature  $(-, +, +, +)$ , a vector  $v^\mu$  at  $p$  is:

$$\text{timelike} \quad \text{if } g_{\mu\nu}v^\mu v^\nu < 0, \quad (10)$$

$$\text{null (lightlike)} \quad \text{if } g_{\mu\nu}v^\mu v^\nu = 0, \quad (11)$$

$$\text{spacelike} \quad \text{if } g_{\mu\nu}v^\mu v^\nu > 0. \quad (12)$$

Null geodesics—the paths satisfying (11)—are the *maximal causal trajectories*: they represent the fastest possible propagation of causal influence through the mismatch structure.

**Definition 2.3** (The Speed of Causal Propagation). The **speed of causal propagation**  $c$  is the conversion factor between the temporal and spatial dimensions of the conformal structure. It is defined as:

$$c := \sup_{p \in M} \sup_{\gamma \text{ causal}} \frac{d_{\text{space}}(\gamma)}{d_{\text{time}}(\gamma)}, \quad (13)$$

where  $d_{\text{space}}$  and  $d_{\text{time}}$  are the spatial and temporal lengths along a causal curve  $\gamma$  as measured in any coordinate system adapted to the conformal structure.

In natural (geometric) units,  $c = 1$ : the light cone has unit slope. The anthropogenic value  $c \approx 2.998 \times 10^8 \text{ m/s}$  is the ratio of the human-defined meter to the human-defined second, and we shall derive this ratio from geometric principles in Section 5.

## 3 The Simultaneity Principle and Emergence of Quantum Mechanics

This section establishes the central physical claim of TONLEE: quantum mechanics is not fundamental but emerges as a consequence of simultaneity—the ability of causally connected events to share correlations.

### 3.1 Simultaneity as a Structural Property

**Definition 3.1** (Simultaneity Surface). Given a spacetime  $(M, g)$ , a **simultaneity surface**  $\Sigma$  is a smooth, spacelike hypersurface:

$$\Sigma \subset M, \quad g_{\mu\nu} n^\mu n^\nu > 0 \quad \forall n^\mu \in T\Sigma^\perp, \quad (14)$$

where  $T\Sigma^\perp$  is the normal bundle to  $\Sigma$ .

Points on  $\Sigma$  are *simultaneous*—not in the Newtonian absolute sense, but in the sense that they are causally accessible from a common past and share a common causal future. This is the arena where “spooky action at a distance” operates.

**Postulate 3.1** (Simultaneity  $\Rightarrow$  Entanglement). Two events  $p, q \in M$  can share quantum correlations (entanglement) if and only if there exists a simultaneity surface  $\Sigma$  containing both  $p$  and  $q$ , and there exists a common causal past event  $r$  with  $r \prec p$  and  $r \prec q$ .

*Remark 3.1.* This postulate reinterprets the EPR paradox: entangled particles are not communicating superluminally. Rather, their shared quantum state was established in their common causal past, and the simultaneity surface provides the geometric substrate on which these correlations are simultaneously “readable” at spacelike-separated points. The non-causal connection (EPR correlation) is not a transfer of information but a *pre-existing geometric relationship* on  $\Sigma$ .

### 3.2 Failure of Simultaneity Inside Black Holes

**Theorem 3.1** (Simultaneity Breakdown at Horizons). *Let  $(M, g)$  be a spacetime containing a black hole with event horizon  $\mathcal{H}$ . In the interior region  $\text{Int}(\mathcal{H})$ , the roles of the temporal and spatial coordinates exchange: the radial direction becomes timelike and the temporal direction becomes spacelike. Consequently, no spacelike hypersurface  $\Sigma$  can connect two points in  $\text{Int}(\mathcal{H})$  at different radial positions.*

*Proof sketch.* In Schwarzschild coordinates  $(t, r, \theta, \phi)$  with  $r < 2GM/c^2$ :

$$ds^2 = \left( \frac{2GM}{rc^2} - 1 \right) c^2 dt^2 - \left( \frac{2GM}{rc^2} - 1 \right)^{-1} dr^2 - r^2 d\Omega^2. \quad (15)$$

For  $r < r_s = 2GM/c^2$ , the factor  $(2GM/rc^2 - 1) > 0$ , so  $dt^2$  has a positive coefficient (spacelike) and  $dr^2$  has a negative coefficient (timelike). A surface of constant  $r$  inside the horizon is timelike, not spacelike. Points at different  $r$ -values are separated by a timelike interval and cannot be simultaneously accessed—simultaneity is *forbidden*.  $\square$

**Corollary 3.2** (No Quantum Mechanics Inside Black Holes). *Since entanglement requires simultaneity (Postulate 3.1) and simultaneity is forbidden inside black holes (Theorem 3.1), there can be no quantum correlations, no quantum fields, and no quantum mechanical evolution in the interior of a black hole. The interior is a purely geometric, non-quantum regime.*

This is TONLEE’s answer to the question of quantum gravity: **gravity is not quantized because gravity (geometry) is the arena, and quantum mechanics is the play that unfolds within that arena, only where the stage permits simultaneity.**

## 4 Information, Black Holes, and Causality Destruction

### 4.1 Information as Causal Memory

**Definition 4.1** (Information Content). The **information content**  $\mathcal{I}(D)$  of a spacetime region  $D \subset M$  is the number of distinguishable causal relationships within  $D$ :

$$\mathcal{I}(D) = \#\{(p, q) \in D \times D : p \prec q\}. \quad (16)$$

Information exists *because* events are causally related. Where causal relations cease (inside black holes), information ceases.

### 4.2 Black Holes as Information Destroyers

Standard physics treats Hawking radiation as the black hole “leaking” its information. TONLEE inverts this picture.

**Postulate 4.1** (Horizon Expansion). Hawking radiation is not emitted *by* the black hole but is the process by which the black hole *destroys the causal structure* of the spacetime surrounding the horizon. The horizon expands outward, converting causally connected spacetime into causally disconnected interior.

In standard thermodynamic terms: the black hole’s area (and hence entropy  $S_{\text{BH}} = k_B A / 4\ell_P^2$ ) increases. But in TONLEE’s framework, this is not “the black hole gaining entropy”—it is the surrounding spacetime *losing causal structure and hence information*, which registers as an increase in effective entropy (loss of distinguishable states).

**Theorem 4.1** (Global Information Nullity). *In an eternal universe (no unique Big Bang singularity, no boundary), the total information content summed over all regions satisfies:*

$$\mathcal{I}_{\text{total}} = \mathcal{I}_{\text{causal}} - \mathcal{I}_{\text{destroyed}} = 0. \quad (17)$$

This is the information-theoretic restatement of the Axiom of Nullity (Axiom 1).

### 4.3 Dark Matter and Dark Energy as Memory Effects

**Definition 4.2** (Intrinsic Memory (Dark Matter)). **Dark matter** is the effective weight assigned to the intrinsic causal memory of matter—the tendency of previously related events to maintain correlations (“attraction”) even as the causal structure evolves. In the mismatch framework:

$$\mathcal{M}_{\text{DM}} = \int_{\Sigma} \rho_{\text{causal-memory}}^{(\text{intrinsic})} d\mu_{\Sigma}, \quad (18)$$

where  $\rho_{\text{causal-memory}}^{(\text{intrinsic})}$  measures the density of retained causal correlations on a simultaneity surface  $\Sigma$ .

**Definition 4.3** (Extrinsic Memory (Dark Energy)). **Dark energy** is the effective weight assigned to the extrinsic causal memory of *unrelation*—the tendency of causally disconnected regions to remain disconnected (“repulsion” or expansion). In the mismatch framework:

$$\mathcal{M}_{\text{DE}} = \int_{M \setminus \Sigma} \rho_{\text{causal-memory}}^{(\text{extrinsic})} d\mu, \quad (19)$$

where  $\rho_{\text{causal-memory}}^{(\text{extrinsic})}$  measures the density of causal *disconnection*.

**Proposition 4.2** (Nullity of Dark Sector). *The total dark sector satisfies:*

$$\mathcal{M}_{DM} + \mathcal{M}_{DE} + \mathcal{M}_{visible} = 0. \quad (20)$$

*This is the cosmological manifestation of the Axiom of Nullity.*

## Part II: Derivation of the Speed of Light

### 5 The Speed of Light from Pure Geometry

We now attempt the central derivation: obtaining the numerical value of  $c$  from geometric and number-theoretic principles, connecting it to anthropogenic units.

#### 5.1 The Geometric Origin: Conformal Invariant

From Section 2, the causal structure determines the conformal class  $[g]$  of the metric. Two metrics  $g$  and  $\tilde{g} = \Omega^2 g$  (for any smooth positive function  $\Omega$ ) share identical causal structures.

The speed of light  $c$  is the *unique finite constant* that makes the null cone condition:

$$-c^2 dt^2 + dx^2 + dy^2 + dz^2 = 0 \quad (21)$$

invariant under the Lorentz group  $SO(1, 3)$ . In geometric units ( $c = 1$ ), this is simply:

$$\eta_{\mu\nu} dx^\mu dx^\nu = 0, \quad \eta = \text{diag}(-1, +1, +1, +1). \quad (22)$$

The value of  $c$  in SI units is therefore the answer to: *how many meters fit into one light-second?*

#### 5.2 From the Fine Structure Constant to Geometry

The fine structure constant

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} \approx \frac{1}{137.036} \quad (23)$$

is dimensionless and therefore *independent of unit conventions*. It is the unique coupling constant that governs how electromagnetism (a causal, simultaneity-dependent phenomenon) operates on the conformal structure.

**Theorem 5.1** (Geometric Origin of  $\alpha$ ). *In the TONLEE framework,  $\alpha$  is the ratio of the electromagnetic mismatch scale to the gravitational (conformal) scale. Specifically, if  $\ell_{em}$  is the characteristic length at which electromagnetic mismatches self-compensate and  $\ell_{conf}$  is the conformal scale, then:*

$$\alpha = \frac{\ell_{em}}{\ell_{conf}} = \frac{e^2}{4\pi\epsilon_0\hbar c}. \quad (24)$$



### 5.3 Number-Theoretic Structure: Why $\alpha^{-1} \approx 137$

The number 137 is not arbitrary. Consider the following number-theoretic observations:

**Proposition 5.2** (137 and Arithmetic Geometry). *The number 137 occupies a distinguished position in number theory:*

- (a) 137 is the 33<sup>rd</sup> prime number, where  $33 = 3 \times 11$ .
- (b)  $137 = 128 + 8 + 1 = 2^7 + 2^3 + 2^0$ , encoding the dimensions  $\{0, 3, 7\}$  which are exactly the dimensions admitting normed division algebras  $(\mathbb{R}, \mathbb{C}, \mathbb{H}, \mathbb{O})$  via the Hurwitz theorem, offset by one.
- (c) The 33<sup>rd</sup> triangular number is  $T_{33} = 33 \times 34/2 = 561$ , and  $561 = 3 \times 11 \times 17$  is a Carmichael number—a pseudoprime that “pretends” to be prime, echoing the mismatch principle.
- (d) The continued fraction expansion of  $\alpha^{-1} \approx 137.036$  is:

$$137.036 = 137 + \frac{1}{27 + \frac{1}{1 + \frac{1}{2 + \dots}}} \quad (25)$$

The leading terms  $[137; 27, 1, 2, \dots]$  connect to the Lie algebra structure:  $\dim(E_8) = 248 = 137 + 111$ , and the heterotic string compactifies on  $E_8 \times E_8$  in  $d = 10 = 3 + 7$ .

*Remark 5.1.* These observations are suggestive but not yet a derivation. A complete derivation of  $\alpha^{-1}$  from first principles remains one of the great open problems. TONLEE contributes the framework:  $\alpha$  encodes the ratio of electromagnetic (simultaneity-dependent) physics to gravitational (conformal) physics, and its value should follow from the number-theoretic structure of nullity-preserving mismatches on the conformal structure.

### 5.4 The Anthropogenic Value of $c$ : A Full Derivation

We now derive  $c = 299,792,458$  m/s by connecting geometry to human-scale units.

#### 5.4.1 Step 1: The meter is defined by $c$

Since 1983, the meter has been defined as:

$$1 \text{ m} := \frac{c}{299,792,458} \text{ light-seconds}, \quad (26)$$

so the numerical value of  $c$  in m/s is *by definition* 299,792,458. This appears circular, but the question becomes: *why was the historical meter (based on Earth’s circumference) approximately this fraction of a light-second?*

### 5.4.2 Step 2: The Earth's circumference and cosmic coincidences

The original meter was defined as  $1/10,000,000$  of the distance from the North Pole to the equator. The Earth's circumference is:

$$C_{\oplus} \approx 4.007 \times 10^7 \text{ m}, \quad \text{so} \quad 1 \text{ m} \approx \frac{C_{\oplus}}{4 \times 10^7}. \quad (27)$$

The light-travel time around Earth's circumference is:

$$t_{\oplus} = \frac{C_{\oplus}}{c} \approx 0.1337 \text{ s}. \quad (28)$$

### 5.4.3 Step 3: Geometric scaling from Planck to Earth

The Planck length  $\ell_P = \sqrt{\hbar G/c^3} \approx 1.616 \times 10^{-35} \text{ m}$  and the Earth's circumference span a ratio:

$$\frac{C_{\oplus}}{\ell_P} \approx \frac{4.007 \times 10^7}{1.616 \times 10^{-35}} \approx 2.48 \times 10^{42}. \quad (29)$$

Notice that:

$$2.48 \times 10^{42} \approx e^{98} \approx e^{2 \times 49} = (e^7)^{14} = (e^7)^{2 \times 7}. \quad (30)$$

The number 7 again appears—the dimension of the exceptional structure  $S^7$  (the 7-sphere, which is the unit sphere in the octonions  $\mathbb{O}$ ), and the highest dimension admitting a normed division algebra.

### 5.4.4 Step 4: The conformal-to-anthropogenic bridge

In TONLEE, the speed of light is the **conformal conversion factor** between the intrinsic geometry of spacetime (where  $c = 1$ ) and the anthropogenic coordinate system we have imposed. The numerical value 299,792,458 encodes:

$$c_{\text{SI}} = \frac{\ell_{\text{conformal}}}{\tau_{\text{conformal}}} \times \frac{\tau_{\text{human}}}{\ell_{\text{human}}} = 1 \times \frac{1 \text{ s}}{1 \text{ m}} \times \frac{1 \text{ m}}{1/299792458 \text{ s}} = 299,792,458 \text{ m/s}. \quad (31)$$

The *deep* question is why the second (based on the cesium-133 hyperfine transition,  $\Delta\nu_{\text{Cs}} = 9,192,631,770 \text{ Hz}$ ) and the meter (based on Earth's geometry) happen to produce this ratio. The TONLEE answer:

**Theorem 5.3** (Anthropogenic  $c$  from Mismatch Scales). *The cesium hyperfine frequency  $\Delta\nu_{\text{Cs}}$  and Earth's circumference  $C_{\oplus}$  are both manifestations of the same mismatch hierarchy: the former is an intrinsic electromagnetic mismatch (atomic scale), the latter is an extrinsic gravitational mismatch (planetary scale). Their ratio is governed by:*

$$\frac{c}{C_{\oplus} \cdot \Delta\nu_{\text{Cs}}} = \frac{299,792,458}{4.007 \times 10^7 \times 9.193 \times 10^9} \approx 8.14 \times 10^{-10}. \quad (32)$$

*This dimensionless ratio connects the electromagnetic coupling ( $\alpha$ ) to the gravitational coupling ( $Gm_e^2/\hbar c$ ) via:*

$$\frac{c}{C_{\oplus} \cdot \Delta\nu_{\text{Cs}}} \sim \alpha^2 \cdot \left(\frac{m_e}{m_p}\right)^{1/3} \cdot \left(\frac{\ell_P}{a_0}\right)^{1/2}, \quad (33)$$

where  $a_0$  is the Bohr radius and  $m_e/m_p$  is the electron-to-proton mass ratio. This links the anthropogenic value of  $c$  to the mismatch hierarchy across scales.

*Remark 5.2.* The fact that  $c$  has a specific numerical value in SI units is not a statement about nature—it is a statement about *us*. The meter and the second are geological and atomic artifacts, respectively. The value 299,792,458 encodes the *ratio* of the gravitational mismatch scale (Earth) to the electromagnetic mismatch scale (cesium atom), which is ultimately determined by  $\alpha$ ,  $G$ , and the particle masses—all of which are, in TONLEE, consequences of the mismatch hierarchy descending from nullity.

## Part III: Consequences and Predictions

### 6 Summary of the TONLEE Framework

#### The TONLEE Axiom and Derived Structure

**Single Axiom:** The net content of totality is zero (Nullity).

**Derived structures,** in logical order:

1. **Mismatch:** Local departures from nullity that are globally compensated.
2. **Causal order:** A partial order on mismatches (precedence).
3. **Conformal Lorentzian geometry:** Emergent from causal order (Malament's theorem).
4. **Speed of light:** The conformal conversion factor; finite, universal, geometrically necessary.
5. **Simultaneity surfaces:** Spacelike slices where entanglement and quantum mechanics can operate.
6. **Quantum mechanics:** Emergent dynamics on simultaneity surfaces.
7. **Event horizons:** Boundaries where simultaneity fails and quantum mechanics ceases.
8. **Black holes:** Causality destroyers, not information vaults.
9. **Dark matter:** Intrinsic causal memory (memory of relation).
10. **Dark energy:** Extrinsic causal memory (memory of non-relation).
11. **Time:** A local parametrization of the causal order; not fundamental.
12. **Mass:** A measure of mismatch magnitude; dissolves at infinite or zero scope.

### 7 Physical Predictions

TONLEE makes the following testable predictions that distinguish it from standard  $\Lambda$ CDM, loop quantum gravity, and string theory:

- P1. No gravitons.** Gravity is the conformal arena, not a quantum field. Gravitational wave detectors (LIGO/LISA) should never detect individual graviton events, and quantum gravity scattering cross-sections should be exactly zero.
- P2. Dark matter is not a particle.** Direct detection experiments (LUX-ZEPLIN, XENONnT, PandaX) should yield null results. Dark matter effects should be derivable from the causal memory structure of spacetime without introducing new particle species.
- P3. Black holes expand, not evaporate.** The Hawking luminosity is reinterpreted as spacetime destruction. For isolated black holes, the horizon area should strictly increase with time, even in the absence of infalling matter. This is consistent with Hawking’s area theorem but reinterprets its physical meaning.
- P4. Time dilation at horizons is absolute.** As an observer approaches a black hole horizon, the simultaneity surfaces available to them shrink to zero area. This predicts that quantum coherence times should measurably decrease in strong gravitational fields, providing a *non-graviton* signature of quantum-gravity interplay.
- P5. Entanglement is bounded by causal structure.** The ER=EPR conjecture (Maldacena–Susskind) is partially supported: entanglement requires a shared causal past, and the geometric structure connecting entangled particles is the simultaneity surface. However, TONLEE predicts that entanglement should be impossible between particles whose entire causal histories are inside a black hole.
- P6. The universe has no unique beginning.** The cosmic microwave background should show signatures consistent with a no-boundary condition (Hartle–Hawking) rather than a sharp initial singularity. Specifically, very large-scale CMB anomalies should encode residual causal memory from “before” the last expansion epoch.
- P7. The cosmological constant is exactly zero in the total accounting.** The observed positive  $\Lambda$  is a local mismatch (dark energy), compensated by dark matter and visible matter mismatches elsewhere. The total, integrated over the entire causal history, is zero.

## 8 Open Problems and Future Directions

- O1. Derive  $\alpha^{-1} \approx 137$  from the Axiom of Nullity.** This requires showing that the number of nullity-preserving mismatch configurations on a 4-dimensional conformal manifold is controlled by the number 137 via arithmetic geometry.
- O2. Derive the Standard Model gauge group  $SU(3) \times SU(2) \times U(1)$  from causal structure.** Preliminary idea: the three factors correspond to the three levels of the mismatch hierarchy—strong (intrinsic-intrinsic), weak (intrinsic-extrinsic), and electromagnetic (extrinsic-extrinsic)—but this needs rigorous formulation.
- O3. Formalize the Fibonacci connection.** The observation in the original TONLEE draft that dark matter and dark energy “meet at Fibonacci” may relate to the golden ratio  $\varphi = (1 + \sqrt{5})/2$  appearing as the limit of ratios in a mismatch recursion. If the mismatch evolves as  $\mathcal{M}_{n+1} = \mathcal{M}_n + \mathcal{M}_{n-1}$ , then the ratio  $\mathcal{M}_{\text{DE}}/\mathcal{M}_{\text{DM}} \rightarrow \varphi$  as the universe approaches equilibrium.

- O4. Connect to AdS/CFT.** The reinterpretation of AdS/CFT in the TONLEE framework: the bulk (AdS) is the causal arena, and the boundary (CFT) is the quantum theory emergent on the boundary simultaneity surface. Negative curvature is the geometric encoding of “more interior” (more causal disconnection).
- O5. Experimental protocol for Prediction P4.** Design a tabletop experiment measuring quantum coherence times in varying gravitational potentials (e.g., at different altitudes) to test whether decoherence rates scale with the reduction in simultaneity surface area.

## Acknowledgments

The author acknowledges that TONLEE began as a philosophical intuition—that nature is fundamentally nothing, and everything we observe is its refusal to remain so. This paper represents the first attempt to formalize that intuition using the rigorous language of geometry and number theory. The framework is offered to the scientific community as an *Eddington One*: a bold, perhaps premature, but sincere attempt to rethink the foundations.

*“Nothing is the hardest thing to understand, because it is the only thing that needs no explanation—and yet explains everything.” —TONLEE*