The Universal Algorithm of Existence:
Empirical Anchors, Model Postulates, and a Testable Information-Physics Framework

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Abstract

The *Universal Algorithm of Existence* (UAE) is presented here as a testable information-physics research program in which physical reality is modeled as a self-resolving process on a non-empty informational substrate. To maintain scientific clarity, the framework is partitioned into three evidentiary layers: empirical anchors drawn from published experiments, theoretical precedents from established work in emergent gravity, holography, and spectral geometry, and new model postulates introduced here as hypotheses to be constrained or falsified. The UAE proposes that substrate connectivity may be characterized by an effective spectral dimension d_s, that physical organization may be described through a functional partition parameter p between global field tension and localized informational knots, and that gravity may be modeled phenomenologically as an emergent drag-like effect associated with constrained excitations propagating through a structured substrate. A bookkeeping functional called *Transformation Debt* is introduced to connect matter-sector dissipation to large-scale ledger evolution, while *Consciousness Drag* is defined conservatively as an observer-latency parameter associated with band-limited biological readout. This paper does not claim that these hypotheses are already established. Its narrower aim is to state them cleanly, distinguish them from what is already known, and identify concrete theoretical and experimental programs that could support or falsify them.

Keywords: information physics; spectral dimension; emergent gravity; quantum geometry; cosmological bookkeeping; falsifiable theory

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Conflict of Interest

The author is affiliated with Digital Dynamics AI and is involved in related theoretical and commercial research programs. The present manuscript is intended as a scientific framework paper. Proprietary implementation details of commercial systems are not disclosed here.

Data and Code Availability

This paper is a theory and methods manuscript. Public supporting materials, where applicable, are available through the author's publication archive and Zenodo records referenced in the bibliography.

1 Introduction

The search for a deeper physical framework continues to confront several unresolved tensions: the force-strength hierarchy, the relation between geometry and dynamics, the interpretation of nonlocal quantum structure, and the gap between microscopic information and macroscopic cosmological bookkeeping. Existing physics provides powerful partial descriptions, but many foundational questions remain open.

This paper introduces the *Universal Algorithm of Existence* (UAE) as a working framework intended to organize a family of hypotheses around a single question: can physical reality be modeled as a self-resolving informational process rather than as a merely static inventory of objects and forces?

The UAE is not presented here as a completed theory of everything. It is presented as a structured research program. Its purpose is to translate a broad conceptual model into a form that can be read, criticized, and tested. To do that responsibly, the paper sharply separates:

1. **Empirical anchors**: published experimental results that motivate parts of the framework but do not by themselves prove it.
2. **Theoretical precedents**: established ideas in emergent gravity, holography, quantum geometry, and scale-dependent spectral structure that define the neighborhood in which the UAE sits.
3. **Model postulates and operational definitions**: new hypotheses introduced here for explicit scrutiny.
4. **Speculative extensions**: broader recurrence or persistence ideas that are not required for evaluating the framework's core physical claims.

Within this structure, the UAE proposes that physical evolution occurs on a non-empty substrate whose connectivity may be captured by an effective spectral dimension; that observable matter can be modeled as localized constrained excitations or informational knots; that the global background behaves like a field-tension budget; and that some large-scale features of cosmic bookkeeping may be interpretable through an interacting transfer functional called *Transformation Debt*.

The central goal of this first paper is therefore foundational rather than triumphalist: to define the framework cleanly, identify what is already known, state what is merely hypothesized, make the notation internally consistent, and establish the first falsifiable roadmap for the broader program.

2 Why a Layered Evidence Framework Is Necessary

Large-scope theories often fail at the point of presentation rather than at the point of mathematics. When a framework mixes experimentally established results with untested ontological claims, readers cannot tell which parts are meant to be accepted, which parts are meant to be explored, and which parts are merely speculative. The UAE avoids that error by adopting a layered evidence architecture.

This architecture is essential for four reasons.

First, several of the motivating results for the UAE are real and important, but they do not imply the full framework. For example, temporal reflection at engineered time interfaces, measurable quantum geometric tensor structure in solids, and CP violation in baryon decays all show that boundary-sensitive dynamics, internal geometry, and deep asymmetry are experimentally real. But none of these independently establishes a 4.7D substrate, a 90/10 partition, or emergent substrate drag.

Second, the framework sits within a recognizable intellectual lineage. Emergent gravity, induced curvature response, holographic bounds, and scale-dependent spectral structure all provide precedent for considering geometry and information as dynamically meaningful rather than merely descriptive.

Third, some components of the UAE are best understood as research parameters, not final truths. For example, the effective spectral dimension and functional partition should be treated as quantities to estimate or constrain, not constants to announce.

Fourth, the theory includes ideas with very different maturity levels. The substrate-friction hypothesis and the transformation-debt bookkeeping model can be written as testable ansätze. By contrast, recurrence, holographic persistence, and closed-loop cycle-seeding remain speculative extensions and should be labeled that way.

Accordingly, this paper uses the following categories throughout:

- **Established / Anchored**: motivated by direct empirical literature.
- **Precedent / Conceptual**: supported by prior theory families but not confirming UAE-specific claims.
- **Postulated / To be tested**: introduced here as formal hypotheses.
- **Speculative extension**: conceptually related but not required for the core framework.

3 Empirical Anchors

The UAE is motivated in part by several experimental results that establish the physical relevance of time-boundary manipulation, internal state-space geometry, and deep asymmetry. These results should be read as anchors rather than confirmations.

3.1 Temporal Reflection at Photonic Time Interfaces

Abrupt time-boundary operations in engineered media have been shown to produce temporal reflection and broadband frequency translation. These experiments demonstrate that time-interface effects are not purely formal constructs but physically realizable operations [1]. Within the UAE, they motivate interest in boundary-sensitive update dynamics. They do not by themselves establish retrocausal or non-causal interpretations.

3.2 Quantum Geometric Tensor Measurements in Solids

Recent experimental reconstruction of the quantum geometric tensor in crystalline solids establishes that internal quantum geometry—specifically the quantum metric and Berry curvature—is experimentally accessible [2]. Within the UAE, this supports the general claim that internal geometry can be dynamically relevant and measurable. It does not establish the substrate-friction hypothesis directly, but it motivates a geometry-dependent transport program.

3.3 Baryon CP Violation

Observed charge–parity violation in baryon decays confirms that deep asymmetry is physically real at the particle level [3]. Within the UAE, this functions only as an anchor that nature contains irreducible asymmetry. It should not be overstated as direct evidence for the model's proposed functional partition or parity-gate structures.

3.4 Cosmological Ledger Constraints

Standard cosmological analyses continue to constrain the present matter–energy budget and late-time structure growth. Within the UAE, these serve as boundary conditions for any proposed interacting-sector mapping. The framework must therefore be judged not by rhetorical elegance, but by whether its bookkeeping ansatz can survive comparison with precision cosmology, including precision CMB and late-time large-scale structure constraints [9, 10].

4 Theoretical Precedents

The UAE is not developed in an intellectual vacuum. Several existing frameworks provide conceptual precedent for parts of its structure.

4.1 Induced or Emergent Gravity

The idea that gravitational behavior may emerge from deeper microscopic structure has notable precedent in Sakharov-style induced gravity [4] and later thermodynamic or entropic formulations [5, 6]. These frameworks do not prove UAE's substrate-friction model, but they establish that gravity need not be treated as primitive in every consistent description.

4.2 Thermodynamic and Informational Gravity

Jacobson's derivation of Einstein's equations as an equation of state, along with later entropic-gravity proposals, supports the broader research direction in which geometry, information, and thermodynamics are linked [5, 6]. UAE should therefore be read as part of this neighborhood, though with different specific postulates.

4.3 Holographic Principle

The holographic principle provides precedent for relating information content to boundary structure [7]. In this paper, holography is used only as a conservative precedent for information-bounding arguments. Stronger claims about memory persistence or recurrence are deferred to later speculative work.

4.4 Spectral Dimension as an Effective Observable

In several quantum-gravity and fractal-geometry programs, spectral dimension is treated as an operationally meaningful quantity that may differ from naive macroscopic dimensional counting and may run with scale [8]. This provides the conceptual basis for treating effective spectral dimension as a legitimate parameter in the UAE.

5 Core Model Definitions and Postulates

This section introduces the core language of the UAE. The following items are postulates or operational definitions, not established facts.

5.1 Informational Substrate

The *informational substrate* is defined as a non-empty dynamical medium supporting propagation, storage, and transformation of constrained states. Formally, it may be represented as a state over a graph- or manifold-like structure whose connectivity is encoded by an operator such as a Laplacian.

5.2 Informational Knot

An *informational knot* is a metastable, localized constrained excitation of the substrate. Observable matter is modeled not as a fundamentally separate substance, but as a family of such constrained configurations.

5.3 Substrate Tension

Substrate tension denotes the global stiffness or field-tension budget of the substrate. It sets propagation conditions and constrains the stability of localized excitations.

5.4 Effective Spectral Dimension

The *effective spectral dimension* is defined operationally via diffusion return-probability scaling on the substrate operator. In the UAE, the working hypothesis is that the relevant effective connectivity exponent lies near a non-integer value. The commonly used provisional value in the broader framework is approximately 4.7, but this paper treats it strictly as a parameter to be estimated or constrained, not as an already measured constant.

5.5 Functional Partition

The UAE introduces a *functional partition parameter* $p \in (0, 1)$, used to divide total system budget into a global field/tension sector and a localized knot sector. The working hypothesis often used in the broader framework is $p \approx 0.9$, but again this is treated here as a model parameter, not an established constant.

5.6 Substrate Friction

Substrate friction is the name given to the UAE hypothesis that gravity may be modeled as an emergent drag-like effect associated with knot propagation through a structured background. This is a research hypothesis introduced for testing.

5.7 Transformation Debt

Transformation Debt is a cumulative transfer functional that measures net flow from knot-sector organization into the tension/entropy ledger. It is introduced to connect an initial partitioned model to large-scale cosmological bookkeeping.

5.8 Consciousness Drag

Consciousness Drag is defined conservatively as an observer-latency ratio: the mismatch between a substrate transition scale and a band-limited biological or observer readout scale. In this paper it is not used as a mystical principle, but as a proposed phenomenological readout parameter.

6 Mathematical Skeleton of the Framework

6.1 Notation

To reduce ambiguity, the principal symbols used in this paper are fixed as follows:

- L: substrate connectivity operator.
- L_α: fractional coupling operator.
- d_s: effective spectral dimension.
- p: functional partition parameter.
- E_{total}: total system budget.
- E_{tension}: field/tension sector budget.
- E_{knot}: localized knot-sector budget.
- D_t: Transformation Debt.
- $\lambda_e(t)$: effective untying or entropy-production rate.
- $F(x)$: effective resolution functional.
- μ_0: PL-type relaxation constant.
- δ_c: Consciousness Drag, interpreted here as an observer-latency ratio.

The purpose of this section is not to deliver a complete derivation of the UAE, but to establish the minimum mathematical structure required for the research program.

6.2 Substrate Operator and Fractional Coupling

Let L denote a Laplacian-like connectivity operator. Nonlocal coupling is introduced by the fractional operator

$$L_\alpha = L^{\alpha/2}, \qquad \alpha \in (0, 2]. \tag{1}$$

This provides a standard way to model long-range or nonlocal connectivity in operator form.

6.3 Spectral Dimension

Define a diffusion process on the substrate. If the average return probability scales as

$$P_0(t) \sim t^{-d_s/2}, \tag{2}$$

then the effective spectral dimension is

$$d_s = -2\,\frac{d\ln P_0(t)}{d\ln t}. \tag{3}$$

This quantity is treated as operational and potentially scale-dependent, in line with the broader use of spectral dimension in other frameworks [8].

6.4 Functional Partition

Total system budget is partitioned as

$$E_{\text{tension}} = pE_{\text{total}}, \qquad E_{\text{knot}} = (1-p)E_{\text{total}}. \tag{4}$$

The central question is whether physically meaningful constraints can be derived or fit for p.

6.5 Transformation Debt

The proposed cumulative transfer functional is

$$D_t = \int_{\alpha}^{t_{\text{now}}} \lambda_e(t)E_{\text{knot}}(t)\,dt, \tag{5}$$

where $\lambda_e(t)$ is an effective untying or entropy-production rate, and α denotes an initial low-entropy boundary condition. This quantity is intended to connect microscopic dissipation to large-scale bookkeeping.

6.6 Relaxation Landscape

The UAE models substrate evolution as descent on an effective resolution functional $F(x)$, with structured regimes satisfying a Polyak–Łojasiewicz-type condition:

$$\frac{1}{2}\|\nabla F(x)\|^2 \geq \mu_0(F(x) - F(x^*)). \tag{6}$$

This is an explicit assumption in the framework. It is introduced because it allows structured exponential relaxation and avoids vague language about "self-resolution" without mathematical content.

6.7 A Conservative Master Functional

At the level of theory architecture, the UAE may be summarized by an effective functional of the form

$$\mathcal{I}[x] = F(x)+\chi_1(E_{\text{tension}}-pE_{\text{total}})^2+\chi_2(E_{\text{knot}}-(1-p)E_{\text{total}})^2+\chi_3\left(D_t - \int \lambda_e E_{\text{knot}}\,dt\right)^2+\cdots, \tag{7}$$

where the omitted terms denote additional phenomenological penalties associated with drag, observer latency, or stability conditions. In the present paper this should be read as a bookkeeping scaffold rather than a completed fundamental law.

7 Evidence-Status Map

To avoid ambiguity, the current evidence status of the UAE can be summarized as follows.

Anchored

- Temporal reflection at time interfaces.
- Quantum geometric tensor measurement in solids.
- Baryon CP violation.
- Precision cosmological bookkeeping constraints.
- Spectral dimension as a meaningful effective quantity in other frameworks.

Supported by precedent but not UAE-specific proof

- emergent or induced gravity,
- thermodynamic/informational links to geometry,
- holographic information bounds.

Postulated in the UAE and requiring validation

- effective substrate description as the correct ontological frame,
- non-integer effective spectral dimension in the relevant dynamical regime,
- functional partition between tension and knots,
- substrate friction as the source of gravitational weakness,
- transformation debt as a cosmological transfer quantity,
- consciousness drag as a useful observer-latency parameter.

Speculative extensions not required for core acceptance

- recurrence loops,
- cycle-seeded variance,
- holographic persistence as memory-like carryover.

8 Falsifiable Research Program

The UAE should stand or fall on its ability to generate discriminators. Several test programs emerge naturally from the framework.

8.1 Time-Interface Phase-Echo Test

A controlled time-interface experiment can test whether pre-interface signals carry statistically measurable structure correlated with later switching schedules. The null hypothesis is zero such dependence beyond noise and systematics. Temporal reflection experiments provide the physical anchor for such a proposal, but not yet the stronger effect itself [1].

8.2 QGT-Linked Geometry Transport Program

In materials with measurable quantum geometric tensor structure, one can search for transport residuals that correlate with geometric observables beyond what standard scattering or band models explain. The QGT measurements reported in solids motivate this line of inquiry [2].

8.3 Force-Hierarchy Ansatz Testing

Any substrate-friction proposal must be expressed through dimensionless ratios and shown to reproduce observed force hierarchies without unstable or arbitrary parameter choices. This paper does not claim that such a fit has already been definitively achieved; it establishes the requirement.

8.4 Cosmological Coupling Constraints

The transformation-debt model can be tested by fitting interacting-sector continuity equations against cosmological observables. A null or inconsistent coupling would strongly constrain the framework. In practice, this means confronting any nonzero transfer hypothesis with standard cosmological parameter pipelines and late-time structure measurements [9, 10].

9 Limits of the Present Paper

This paper does not claim that the UAE has already solved gravity, dark matter, dark energy, or time. It does not claim that a 4.7D substrate is experimentally established. It does not claim that all recent collider or condensed-matter anomalies confirm the theory.

Its narrower claim is that there now exists a coherent enough body of ideas, together with real empirical anchors and mathematically stateable postulates, to justify treating the UAE as a testable information-physics program rather than as a purely philosophical narrative.

10 Conclusion

The Universal Algorithm of Existence is best understood, at present, as a formal research program that seeks to model physical reality as a self-resolving informational process on a structured substrate. Its value does not lie in grand claims alone, but in the discipline with which it distinguishes what is known from what is merely proposed.

If the framework is to be taken seriously, it must succeed or fail on explicit tests: operator structure, spectral-dimension estimation, transport residuals, force-hierarchy fits, and cosmological coupling constraints. The role of this first paper is therefore foundational. It establishes the language, evidence structure, mathematical skeleton, and falsification pathways required for the rest of the program.

The next papers in the series will isolate the main technical claims individually: spectral dimension and fractional coupling, emergent drag and force hierarchy, transformation debt and cosmological bookkeeping, and time-interface/Phase-Echo proposals. In that sense, this paper is not the final word. It is the opening argument for why the framework deserves serious examination.

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