Universe Creation from a UNNS Substrate: A Detailed Hypothesis Linking Recursive Substrates to Cosmology, Dark Matter and Dark Energy

UNNS Research Notes

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Abstract

We develop a formal hypothesis that the large-scale structure and dynamics of our universe may be understood as emergent phenomena of an underlying *Unbounded Nested Number Sequence* (UNNS) substrate. In this view, primordial recursive seeds ("inletting") ignite nested lattices ("inlaying"), repair and normalization rules enforce stability, and *trans–sentifying* residues of recursion produce effective contributions to gravitational observables. We propose that dark matter corresponds to gravitational effects of *hidden inlayings* (UNNS coefficients that do not couple to electromagnetic processes), while dark energy is an emergent global renormalization/UPI-driven expansive residue. We present formal definitions, toy models linking discrete UNNS lattices to effective mass density and cosmological acceleration, a list of falsifiable predictions, numerical experiment protocols, and a discussion of compatibility with major cosmological constraints. This document is intended as a research hypothesis: mathematically precise where possible, speculative (where the physics is open), and designed to be directly testable with simulations and observations.

Contents

1 Introduction and motivation

Modern cosmology is dominated by two empirical puzzles: the dynamical evidence for *dark matter* and the accelerating expansion attributed to *dark energy*. Traditional solutions posit new particle species, fields, or modifications of gravity. We propose a different angle: view the universe as an emergent product of a recursive, number-theoretic substrate (UNNS). Within this substrate, nested recurrence rules, discrete lattice embeddings, and stability/repair processes generate effective contributions that behave gravitationally like unseen mass or like a small positive cosmological constant.

The UNNS viewpoint is motivated by: (1) the ubiquity of recurrence-generated invariants in number theory (e.g. Pisano periods, algebraic integers), (2) the successful use of nested lattices to produce discrete field structures in FEEC/DEC-inspired numerical math, and (3) the analogy between DNA repair and the need for stabilization in unbounded recursion. This work attempts to translate those insights into explicit cosmological hypotheses and concrete tests.

2 Preliminaries: UNNS substrate and notation

We briefly summarize the minimal formalism for UNNS used in this paper.

Definition 2.1 (UNNS substrate)**.** *A* UNNS substrate $\mathcal{U}$ *is an abstract, scale-hierarchical structure supporting:*

- *finite-order linear recurrences producing sequences* $\{u_n\}$ *and nested coefficient arrays* $\{c^{(\ell)}\}$ *at scale level* $\ell \geq 0$*;*
- *discrete spatial embeddings (lattices) at each level:* $\Lambda_\ell \subset \mathbb{R}^d$ *(typically* $d = 3$ *for spatial models);*
- *local diagnostics: residues* $r(x)$*, local spectral radii* ρ*, and a global UNNS Paradox Index (UPI).*

Definition 2.2 (Local recurrence)**.** *A local UNNS recurrence on* Λ_ℓ *is written*

$$u_{n+r}(x) = \sum_{j=1}^{r} c_j^{(\ell)}(x)\; u_{n+r-j}(x) + s^{(\ell)}(x),$$

for lattice site $x \in \Lambda_\ell$*, where* $s^{(\ell)}$ *denotes local sources (possibly from lower or higher levels).*

Definition 2.3 (Hidden (inlayed) coefficients)**.** *A coefficient* $c_j^{(\ell)}(x)$ *is* hidden *if it contributes to the dynamical evolution of* $\mathcal{U}$ *but does not directly couple to electromagnetic-like observables (i.e., is invisible to photon-mediated interactions). We denote hidden coefficient fields by* $h^{(\ell)}(x)$*.*

2.1 The UNNS Paradox Index (UPI)

We adopt an operational scalar index $\mathcal{P}(\mathcal{R})$ on a region $\mathcal{R}$ measuring the propensity of recursion self-reference to drive divergence:

$$\mathcal{P}(\mathcal{R}) \;=\; \frac{D(\mathcal{R}) \cdot R(\mathcal{R})}{M(\mathcal{R}) + S(\mathcal{R})},$$

where D is recursion depth, R is local self-reference rate, M is morphism divergence, and S is memory saturation. Precise definitions of these scalars can be adapted to application; for cosmology we will propose coarse-grained proxies (see Section 5).

3 Summary of the core conjectures

We state the primary conjectural identifications that will be examined in this paper.

Hypothesis 3.1 (UNNS Cosmogenesis – skeletal form)**.** *The observable universe emerges from a UNNS substrate via (i) a primordial inletting (seed recurrence), (ii) nested inlayings producing hierarchical lattices that realize spacetime and fields, and (iii) repair/renormalization processes that enforce stability while generating effective large-scale contributions that appear as dark matter and dark energy.*

Hypothesis 3.2 (Dark matter as hidden inlaying)**.** *The effective gravitational contribution attributed to dark matter is primarily the macroscopic manifestation of* hidden inlayed *UNNS coefficients* $h^{(\ell)}(x)$ *distributed across nested lattices* $\{\Lambda_\ell\}$*. These coefficients produce additional terms in the effective Poisson/Einstein equations without coupling to electromagnetic observables.*

Hypothesis 3.3 (Dark energy as global renormalization residue)**.** *The observed cosmic acceleration (dark energy) is an emergent, large-scale effect of UNNS global renormalization and UPI-driven expansive residues. In coarse-grained cosmological dynamics, this appears as an effective positive cosmological term* Λ_{UNNS} *proportional to a suitable spatial average of* $\mathcal{P}(\mathcal{R})$*.*

4 Formal toy model: from UNNS lattices to effective mass density

We now present a concrete toy model showing how hidden inlayings can appear as an effective mass density in Newtonian gravity. This is an intentionally simple, illustrative model designed to yield testable consequences.

4.1 Discrete lattice embedding and weighted mass kernel

Consider a nested family of cubic lattices Λ_ℓ of spacing $a_\ell = a_0\,\alpha^{-\ell}$ for $\ell = 0, 1, \ldots, L$ filling spatial domain $\Omega \subset \mathbb{R}^3$. On each Λ_ℓ define a coefficient field $h^{(\ell)}(x)$ (hidden coefficient) associated to local recurrence stencils. We define the *UNNS effective mass density* at point $x \in \Omega$ by

$$\rho_{\mathrm{UNNS}}(x) \;=\; \sum_{\ell=0}^{L} \gamma_\ell \sum_{y \in \Lambda_\ell} h^{(\ell)}(y)\; W_\ell(x-y), \tag{1}$$

where W_ℓ is a compactly supported smoothing kernel at scale a_ℓ (e.g. a mollifier), and γ_ℓ are level-dependent coupling coefficients (dimensionful constants converting UNNS units to mass density units).

Remark: Conventional baryonic mass $\rho_b(x)$ is assumed to arise from UNNS coefficients that couple directly to electromagnetic sectors and are therefore separately modeled and measured; ρ_{UNNS} complements ρ_b.

4.2 Effective Poisson equation

Assume Newtonian gravity at galactic scales is a valid approximation. The gravitational potential $\Phi(x)$ then satisfies

$$\nabla^2\Phi(x) = 4\pi G\big(\rho_b(x) + \rho_{\mathrm{UNNS}}(x)\big).$$

Plugging (1) gives an explicit dependence of Φ on the hidden coefficient fields $h^{(\ell)}$ and kernels W_ℓ. If the $h^{(\ell)}$ are distributed in halo-like configurations around luminous matter, rotation curves and lensing can be modeled.

4.3 Simple analytic halo family

For illustration, suppose hidden coefficients at a single dominant scale $\ell = \ell_0$ produce a spherically symmetric halo with radial profile

$$h^{(\ell_0)}(r) = h_0\left(1 + \frac{r^2}{r_c^2}\right)^{-\beta},$$

and W_{ℓ_0} approximates a local smoothing giving $\rho_{\mathrm{UNNS}}(r) \propto h^{(\ell_0)}(r)$. Then circular speed satisfies

$$v_c^2(r) = r\,\frac{d\Phi}{dr} \sim \frac{GM_{\mathrm{eff}}(r)}{r},$$

with $M_{\mathrm{eff}}(r) = 4\pi\int_0^r s^2(\rho_b(s) + \rho_{\mathrm{UNNS}}(s))\,ds$. Appropriate choices of (h_0, r_c, β) can reproduce flat rotation curves without invoking particle dark matter.

5 From UNNS dynamics to cosmological expansion

We now sketch how global UNNS renormalization and UPI can contribute to cosmic expansion.

5.1 Coarse-grained UPI and an effective cosmological term

Define the spatially averaged UPI over a comoving region $\mathcal{R}$ at cosmic time t:

$$\overline{\mathcal{P}}(t) \; = \; \frac{1}{|\mathcal{R}|} \int_{\mathcal{R}} \mathcal{P}(\mathcal{R}_x, t) \, d^3x,$$

where $\mathcal{P}(\mathcal{R}_x, t)$ is the local UPI computed on a window centered at x. We propose the effective cosmological constant receives a UNNS contribution

$$\Lambda_{\mathrm{UNNS}}(t) \; = \; \beta \, \overline{\mathcal{P}}(t), \tag{2}$$

with dimensionful constant β set by microscopic UNNS-to-geometry coupling.

5.2 Modified Friedmann equations

Assume standard FRW cosmology with scale factor $a(t)$ and Hubble parameter $H = \dot{a}/a$. The Friedmann equations with the UNNS term become

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}\rho_{\mathrm{tot}} + \frac{\Lambda_{\mathrm{bare}} + \Lambda_{\mathrm{UNNS}}(t)}{3} - \frac{k}{a^2}, \tag{3}$$

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}(\rho_{\mathrm{tot}} + 3p_{\mathrm{tot}}) + \frac{\Lambda_{\mathrm{bare}} + \Lambda_{\mathrm{UNNS}}(t)}{3}.$$

We hypothesize that $\Lambda_{\mathrm{UNNS}}(t)$ is slowly varying at late times and can produce the observed acceleration when positive and of the observed magnitude.

5.3 Dynamical model for $\overline{\mathcal{P}}(t)$

For simplicity, consider a phenomenological ODE for $\overline{\mathcal{P}}$:

$$\dot{\overline{\mathcal{P}}} = \alpha_1 \mathcal{G}(a, \rho, \ldots) - \alpha_2 \overline{\mathcal{P}},$$

where $\mathcal{G}$ encodes the production of self-reference (e.g. growth of nested structures as the universe expands), and $\alpha_{1,2} > 0$ are rates for UPI generation and dissipation (repair/normalization). If generation dominates at certain epochs, $\overline{\mathcal{P}}$ can grow, increasing Λ_{UNNS} and driving acceleration. Repair processes (large α_2) suppress $\overline{\mathcal{P}}$.

6 Compatibility with observations and constraints

Any credible alternative to standard dark matter/energy must confront a wide range of observational constraints: galaxy rotation curves, gravitational lensing (including Bullet Cluster), cosmic microwave background (CMB) anisotropy, baryon acoustic oscillations (BAO), large-scale structure (LSS), structure formation rates, N-body simulations, and direct particle searches. We discuss how the UNNS hypothesis can be compatible or where tensions arise.

6.1 Galaxy rotation curves and lensing

UNNS effective density (1) can be tuned to produce halo-like profiles. Since ρ_{UNNS} is not made of particles, it can be collisionless in its effective gravitational behavior if the hidden coefficient fields do not exchange momentum with baryons except via gravity. This can reproduce observed lensing maps in many cases, provided the spatial distribution of $h^{(\ell)}$ matches inferred halos.

6.2 Bullet Cluster and collisional behavior

The Bullet Cluster is often cited as a smoking gun for particle dark matter: lensing peaks separate from baryonic gas after collision. A UNNS explanation requires that hidden inlayed coefficients behave effectively collisionlessly and remain associated with the pre-collision collisionless components (e.g. galaxy centers) while gaseous baryons interact hydrodynamically. If the hidden coefficient fields are encoded in lattice structures co-moving with collisionless components, this behavior can be mimicked.

6.3 CMB and structure formation

CMB acoustic peaks and LSS are sensitive to the amount and behavior of dark matter at early times. A UNNS model must reproduce the cold-dark-matter (CDM)-like behavior during the radiation-matter transition era to preserve the peak structure. This sets strong constraints on the temporal behavior of $\rho_{\mathrm{UNNS}}(t)$: it must act like additional, pressureless mass during those epochs. That requirement constrains choices of γ_ℓ and the time-dependence of hidden coefficients.

6.4 Parameter degeneracies and falsifiability

We outline key falsifiable signatures:

- If direct detection of WIMPs (or other dark matter particles) is confirmed with properties inconsistent with UNNS effective mass, the hypothesis is falsified as a full replacement — though mixed models (UNNS + particle DM) remain possible.
- Detailed fits of CMB power spectra and BAO that demand the CDM fraction at early times may require UNNS to behave like CDM at $z \gtrsim 1000$; if UNNS cannot reproduce this without fine-tuning, the hypothesis is disfavored.
- Unusual correlations between cosmic expansion rate and measures of structural self-reference (UPI proxies computed from large-scale surveys) would support the UNNS dark energy idea.

7 Numerical experiment plan

We propose a specific simulation plan to test the hypothesis numerically.

7.1 Stage A: Local galaxy models

1. Construct a synthetic UNNS lattice Λ_ℓ with a few nested levels around a baryonic disk model.
2. Specify hidden coefficient fields $h^{(\ell)}$ with halo-like priors (parametric families).
3. Solve discrete Poisson equation for potential Φ and compute rotation curves and lensing maps.
4. Fit to observed rotation curves (SPARC dataset) to infer posterior distributions on $(h_0, r_c, \beta, \gamma_\ell)$.

7.2 Stage B: Cosmological box

1. Build an N-body-like code augmented with UNNS effective density computed from nested lattices (coarse-grained).

2. Initialize with primordial baryon perturbations and hidden coefficient fields with cosmological priors.
3. Evolve structure formation and compare power spectra with Planck results and LSS surveys.

7.3 Stage C: FRW toy cosmology for dark energy

1. Implement the ODE system coupling $a(t)$ and $\overline{\mathcal{P}}(t)$ with phenomenological $\mathcal{G}$.
2. Fit $\Lambda_{\mathrm{UNNS}}(t)$ to supernova (SN Ia) distance modulus data to constrain β and $\alpha_{1,2}$.

8 Algorithmic pseudocode: computing ρ_{UNNS} and $\overline{\mathcal{P}}$

Pseudocode (discrete grid):

```
for each level ell = 0..L:
  build lattice Lambda_ell with spacing a0 * alpha^{-ell}
  assign hidden coefficients h_ell[y] (prior or trained)
  compute smoothing kernel W_ell
compute rho_UNNS[x] = sum_ell gamma_ell * sum_{y in Lambda_ell} h_ell[y]*W_ell(x-y)
solve Poisson: Laplacian Phi = 4*pi*G*(rho_b + rho_UNNS)
compute rotation curve v_c(r) from Phi
compute local UPI P_R(x) using windowed diagnostics
compute mean_P = spatial_average(P_R)
```

9 Philosophical and foundational remarks

The UNNS cosmogenesis hypothesis reframes physical ontology: rather than treating particles and fields as primary, it posits that *recursion, nesting and algebraic-integer structured lattices* are more primitive. Observable particles and forces emerge as sectors that couple to particular UNNS coefficients. This is reminiscent of algebraic approaches to physics (e.g. spectral geometry) but emphasizes the dynamical, algorithmic aspect: the universe is a running recursive program that repairs, inlays and inletts.

This viewpoint has epistemic virtues (unifies number-theoretic structure with discrete field models) but also significant philosophical costs: it requires an ontology of algorithmic substrates and new coupling constants bridging discrete recursion with continuum geometry. These constants are to be constrained empirically.

10 Discussion: advantages, challenges and open problems

10.1 Advantages

- Provides a unified narrative tying number-theoretic invariants, discrete field geometry, and cosmological phenomena.
- Offers new free parameters and structural mechanisms that may fit galactic and cosmological data without new particle species.
- Naturally incorporates nonlocal/hierarchical contributions through nested lattices.

10.2 Challenges

- Matching early-universe constraints (CMB acoustic peaks, nucleosynthesis) requires UNNS to behave like CDM at early times — nontrivial.
- Explaining the detailed collisional/ collisionless separation (e.g. Bullet Cluster) demands precise modeling of hidden coefficient dynamics.
- Mapping UNNS variables to metric degrees of freedom requires a micro-to-macro coupling theory (discrete-to-continuum limit).

10.3 Open theoretical tasks

1. Develop a microscopically motivated coupling between UNNS lattice energy and Einstein equations (e.g. via coarse-grained stress-energy tensor of the lattice).
2. Prove continuum limits showing that nested inlaying fields converge to smooth effective densities under natural priors.
3. Link UPI to conserved quantities or coarse-grained entropy measures to better model its evolution.

11 Concrete observational tests (summary)

1. **Rotation curve fits:** Fit individual galaxies using ρ_{UNNS} and compare Bayesian evidence versus NFW/CDM halos.
2. **Lensing maps:** Check whether inferred ρ_{UNNS} reproduces strong-lensing and weak-lensing mass maps.
3. **Bullet Cluster-type tests:** Run hydrodynamic + UNNS effective mass simulations of cluster collisions to test mass-gas separation behavior.
4. **CMB / BAO:** Ensure UNNS-induced changes to expansion/history are consistent with acoustic peaks and BAO scales. This constrains $\Lambda_{\mathrm{UNNS}}(t)$ behavior at $z \gtrsim 1000$.
5. **UPI correlations:** Search for statistical correlations between large-scale structure measures of nestedness/self-reference (a proxy UPI from galaxy surveys) and local expansion rate estimates.

12 Concluding remarks

The UNNS cosmogenesis hypothesis is intentionally speculative: it replaces the search for unknown particles/fields with a search for *structure* and *recursion* at the most basic level. It offers a pathway to connect number-theoretic invariants, discrete field models, and cosmological phenomenology. The approach is practical: it generates clear numerical experiments and falsifiable predictions. Whether the universe ultimately admits such a description is an empirical question; the purpose of this paper is to provide a precise, testable framework for deciding that question.

A Appendix A: Examples of UNNS kernels and choices

Examples of smoothing kernels W_ℓ:

$$W_\ell(x) = \frac{1}{(2\pi\sigma_\ell^2)^{3/2}} \exp\Big(- \frac{|x|^2}{2\sigma_\ell^2} \Big), \qquad \sigma_\ell \sim a_\ell.$$

Choices of coupling coefficients γ_ℓ may follow a power law $\gamma_\ell = \gamma_0\, \alpha^{-\kappa\ell}$.

B Appendix B: Suggested further readings

The framework draws on ideas from discrete exterior calculus and finite-element exterior calculus for discrete fields, as well as number-theoretic constants arising from Gauss/Jacobi sums. Useful background (select):

References

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