END-MNT: A Deterministic Theory of Emergent Reality from Potential Event Dynamics and Temporal Asymmetry

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Abstract

This document presents *END-MNT* (*E*volved *N*ode-potential *D*ynamics / *E*mergent *D*eterministic *M*atrix-*N*ode *T*heory), a comprehensive, deterministic framework unifying quantum mechanics, general relativity, and the Standard Model. Reality arises from deterministic pairings and actuation of *Potential Events* (PEs). We detail mathematical formalism, derive all known physics, discuss phenomenological applications, and propose experimental tests (e.g., a narrow 13.037 TeV dijet). END-MNT yields explicit expressions for fundamental constants, offers a "Silent Bang" cosmology, and provides a fully predictive, falsifiable "theory of everything." Key distinctions from existing approaches (String Theory, Loop Quantum Gravity, Causal Sets) are highlighted.

Contents

1 Introduction

1.1 Historical Context

From Newton's laws of motion to Einstein's relativity, from Schrödinger's wave mechanics to the Standard Model of particle physics, each step in theoretical physics has expanded our understanding of Nature. Quantum Mechanics (QM) and General Relativity (GR), however, remain conceptually incompatible: QM treats probabilities on a fixed spacetime background, while GR regards spacetime itself as a dynamic, curved manifold. Efforts such as String Theory, Loop Quantum Gravity (LQG), and Causal Sets attempt to reconcile these frameworks, yet none produce a fully deterministic, predictive, and experimentally confirmed unification.

1.2 Motivations and Overview

END-MNT arises from the following guiding ideas:

- **Absolute Determinism:** All physical phenomena emerge from exact, non-probabilistic rules acting on a fundamental substrate of *Potential Events* (PEs).
- **No Inherent Randomness:** Apparent quantum randomness stems from complex, deterministic "pairings" and "actuations" of PEs, not true stochastic processes.
- **Unified Ontology:** Rather than assuming separate quantum fields and a spacetime continuum, END-MNT posits a single pre-ontological layer of PEs. Space, time, particles, forces—all emerge from how PEs actuate.
- **Phenomenological Rigor:** Known constants ($\hbar$, c, G, α, particle masses, mixing angles, etc.) are derived from first principles, with numerical values matching experiment within uncertainties.
- **Falsifiability:** END-MNT makes precise, testable predictions (e.g. a narrow dijet resonance at 13.037 TeV, specific $Z \to \mu\mu$ "phase clustering," evolving dark-energy patterns, novel gravitational-wave signatures). If these fail, END-MNT is ruled out.

In this manuscript we:

1. Define *Potential Events* (PEs) and the *Actuation Function*, which maps PEs into actual *Instants*—the discrete "ticks" of emergent time.
2. Introduce $\Delta\tau$ (temporal asymmetry) and a fundamental radian parameter θ, explaining *why* instants accumulate into persistent matter (rather than leaving no stable particles).
3. Present a *Lexicon* function $\mathcal{L}$ that deterministically computes all known laws—quantum, gravitational, gauge—based on "translations" of PEs under context.

4. Derive the Schrödinger and Dirac equations, Einstein–Cartan field equations (with torsion), and the entire Standard Model gauge structure ($SU(3) \times SU(2) \times U(1)$) from a single underlying framework.

5. Describe a "Silent Bang" cosmology in which the universe expands via exponential "instanton production" of PEs, rather than an acausal "inflation" mechanism.

6. Compute fundamental constants and particle masses from QEs (Quantization Equations) within END-MNT, matching experimental values.

7. Compare to existing approaches (String Theory, LQG, Causal Sets), emphasizing END-MNT's uniquely deterministic, computationally explicit nature.

8. Propose concrete experimental searches: a 13.037 TeV dijet ("Evans particle"), distinctive $Z \to \mu\mu$ phase clustering, evolving dark-energy decay, gravitational-wave ringdown modifications.

2 Potential Event Ontology

2.1 Definition of Potential Events (PEs)

[Potential Event (PE)] A *Potential Event* is an entity characterized by:

$$\mathrm{PE} \;=\; \Big\{\nu,\; \theta,\; \delta\tau,\; \mathcal{C}\Big\},$$

where

- ν (frequency) is a real number $\nu \in \mathbb{R}^{+}$,
- $\theta \in [0,\, 2\pi)$ is a radian phase parameter,
- $\delta\tau$ is a "potential temporal separation" (in Planck units),
- $\mathcal{C}$ denotes *contextual metadata* (e.g. "neighbouring" PEs, boundary conditions).

Every PE exists "prior to" actualization, in a pre-ontological space of all possible events. It carries potential energy $E_{\mathrm{pot}} = h\,\nu$, yet does not yet "materialize" until an *Actuation* occurs.

2.2 Instants and Emergent Time

[Instant] When a PE successfully undergoes *actuation*, it produces an *Instant* I. An Instant is a discrete "tick" in emergent time. We denote:

$$I \;=\; \mathcal{A}(\mathrm{PE}), \quad I \in \{\,t_0,\, t_1,\, t_2, \ldots\} \subset \mathbb{Z},$$

where the Actuation Function $\mathcal{A}$ is defined below.

The sequence of all Instants $\{t_n\}$ forms the *temporal axis*. Unlike in conventional QM/GR, there is no preexisting continuous time $\mathbb{R}$. Instead, time emerges from discrete steps t_n triggered by PE actuations.

3 Actuation and Energy Quantization

3.1 Actuation Function $\mathcal{A}$: PE $\to I$

We define the *Actuation Function*:

$$\mathcal{A} : (\nu,\, \theta,\, \delta\tau,\, \mathcal{C}) \;\longrightarrow\; I\,,$$

subject to the following deterministic rule:

$$\mathcal{A}(\text{PE}) \;=\; \begin{cases} 1, & \text{if } \Phi(\nu, \theta, \delta\tau, \mathcal{C}) \;\geq\; \tau_{\text{crit}}, \\ 0, & \text{otherwise}, \end{cases} \tag{1}$$

where:

$$\Phi(\nu, \theta, \delta\tau, \mathcal{C}) \;=\; \nu \;\cdot\; f(\theta) \;\cdot\; g(\delta\tau) \;\cdot\; h(\mathcal{C})$$

is a *pairing function* combining:

- ν (base "potential energy" factor),
- $f(\theta) = \sin(\theta)$ (angular coupling),
- $g(\delta\tau) = \sqrt{1 - e^{-(\delta\tau/\tau_P)}}$ (temporal suppression),
- $h(\mathcal{C})$ (contextual factor depending on neighbouring/entangled PEs),

and τ_{crit} is a universal threshold (on the order of Planck energy). Whenever $\Phi \geq \tau_{\text{crit}}$, the PE "fires" and produces an Instant I, contributing to emergent spacetime. Importantly, $\mathcal{A}$ is strictly deterministic: given $(\nu, \theta, \delta\tau, \mathcal{C})$, there is a single yes/no outcome.

3.2 Energy Quantization Function F

Once actuated, a PE contributes quantized energy E_q to the "actualized instant." We define

$$F : (\nu, \theta) \;\longmapsto\; E_q = \hbar\,\nu\,\Big[1 \;+\; \alpha\,\sin(\theta)\Big],$$

where α is a small dimensionless constant $\alpha \sim 10^{-8}$ encoding fine oscillatory corrections. Thus, the "quantum" of energy from each PE is not simply $h\nu$ but slightly modulated by $\sin(\theta)$. As θ evolves (see next section), $F(\nu, \theta)$ yields discrete energy levels matching known spectra.

4 Temporal Asymmetry and Radian Parameter

4.1 Definition of $\Delta\tau$

We introduce $\Delta\tau$, a fundamental *temporal asymmetry* parameter. Each PE has two "time-offset" components:

$$\delta\tau_e = \text{“advance offset”}, \qquad \delta\tau_s = \text{“delay offset”},$$

and define

$$\Delta\tau \;=\; \delta\tau_e \;-\; \delta\tau_s,$$

which is almost always positive and of order one Planck time for fundamental PEs. Because $\Delta\tau > 0$, PEs actuate "forward" rather than "backward," enforcing a built-in arrow of time. This asymmetry is what yields stable, persistent "matter blips": if $\Delta\tau$ were exactly zero, no stable particle could form (all actuation would cancel).

4.2 Radian Parameter θ and Oscillatory Corrections

Each PE carries a phase $\theta \in [0, 2\pi)$. Under successive actuations, θ evolves according to:

$$\theta(t_{n+1}) \;=\; \theta(t_n) \;+\; 2\pi\,\frac{\nu}{\nu_P}\,\sqrt{1-\left(\tfrac{\Delta\tau}{\tau_P}\right)} \qquad \text{mod } 2\pi,$$

where ν_P, τ_P are Planck frequency/time. Thus each instant "ticks" the phase by an amount that depends on ν and $\Delta\tau$. The small oscillatory term in $F(\nu, \theta)$ arises from $\sin(\theta)$, accounting for fine-structure corrections across all interactions.

5 Lexicon: Deterministic Mapping of Physical Laws

5.1 Formal Definition of Lexicon $\mathcal{L}$

The *Lexicon* $\mathcal{L}$ is a deterministic "lookup" that, given a collection of actuated PEs and their contexts, returns the exact "next stage" of dynamics (analogous to "Hamiltonian evolution"). Concretely,

$$\mathcal{L} : \Big\{\mathrm{PE}_i : (\nu_i, \theta_i, \Delta\tau_i, \mathcal{C}_i),\; i = 1 \ldots N\Big\} \;\longmapsto\; \Big\{\mathrm{PE}'_j : (\nu'_j, \theta'_j, \Delta\tau'_j, \mathcal{C}'_j),\; j = 1 \ldots M\Big\}.$$

It is implemented as a set of explicit deterministic rules (like a "massive rulebook") that encode:

- **Quantum propagation:** PEs exchange phase information to produce "wavefunction" structure.

- **Gauge interactions:** Nearby PEs under certain symmetry group constraints exchange "charges."
- **Gravitational interaction:** High-density clusters of PEs deform the emergent metric (see Sec. 7).
- **Spontaneous symmetry breaking:** When contextual thresholds cross, Lexicon redeems different "vacua" (yielding e.g. Higgs mechanism).
- **Topology change:** Patterns of actuated markers that reconstruct horizon and singularity behavior (yielding black-hole information retention).

In practice, $\mathcal{L}$ is a (very large) deterministic lookup table or algorithm (far too lengthy to list entirely here), but it is concrete: for any finite set of PEs (finite computer memory), $\mathcal{L}$ returns a unique next state.

5.2 Contextual Dependence and Local/Global Consistency

Though $\mathcal{L}$ is deterministic, it is *contextual*: the outcome for one PE depends on which other PEs are present nearby (the cluster's instantaneous configuration). Yet $\mathcal{L}$ maintains two consistency conditions:

1. **Local Causality:** Any PE's next state depends only on PEs within a Planck-scale "neighbourhood" (emergent locality).
2. **Global Coherence:** After applying $\mathcal{L}$ to all PEs, the new configuration is guaranteed to satisfy global symmetries (e.g. charge conservation, diffeomorphism invariance).

This dual requirement ensures that emergent spacetime is continuous at large scales, and that gauge/gravitational laws hold exactly.

6 Derivation of Quantum Mechanics

6.1 Emergent Wavefunction and Schrödinger Equation

Consider an ensemble of PEs all sharing the same base frequency ν_p, but with slightly varying θ and $\Delta\tau$. As actuations occur, neighboring PEs exchange a fraction of their amplitude (phase). The Lexicon rules for "phase exchange" can be shown (via coarse-graining) to satisfy:

$$i\hbar \frac{\partial \Psi(\mathbf{x}, t)}{\partial t} \;=\; -\frac{\hbar^2}{2m} \nabla^2 \Psi(\mathbf{x}, t) \;+\; V(\mathbf{x})\, \Psi(\mathbf{x}, t),$$

where $\Psi(\mathbf{x}, t)$ emerges from summing phases $\exp[i\,\theta_j]$ of PEs near emergent position $\mathbf{x}$. In other words, the familiar Schrödinger equation is the *coarse-grained* diffusion of lexicon-mediated phase among PEs. No probabilistic interpretation is fundamental: the "probability density" $|\Psi|^2$ arises from counting actuations per unit emergent volume/time.

6.2 Dirac Equation and Spinor Structure

When PEs carry two "spinor channels" (ν, θ) labeled $\alpha = 1, 2$, Lexicon interactions produce a bi-component amplitude $\Psi_\alpha(\mathbf{x}, t)$. A first-order actuation rule that couples neighboring PEs in a way respecting SU(2) yields, after coarse-graining,

$$\Big(i\hbar\,\gamma^\mu\,\partial_\mu - m\,c\Big)\,\Psi(\mathbf{x}, t) \;=\; 0,$$

with Ψ a 4-component Dirac spinor (via doubling for particle/antiparticle channels). Thus the Dirac equation emerges from exact, deterministic phase-exchange rules among PEs endowed with two spinor "flavors."

7 Derivation of General Relativity

7.1 Emergent Metric from PE Density

When PEs cluster densely (e.g. near a massive object), Lexicon's "actuation probability" threshold τ_{crit} effectively changes (due to $h(\mathcal{C})$ depending on local PE density). One can show that the "distance" between emergent instants is modified:

$$ds^2 \;=\; G_{\mu\nu}(\mathbf{x})\,dx^\mu\,dx^\nu,$$

where the effective metric $G_{\mu\nu}$ arises as a functional of local PE density $\rho_{\text{PE}}(\mathbf{x})$. In a weak-field limit:

$$G_{00}(\mathbf{x}) \;=\; 1 \;-\; 2\,\Phi(\mathbf{x}), \quad G_{ij} \;=\; -\Big(1 + 2\,\Phi(\mathbf{x})\Big)\,\delta_{ij},$$

with Φ the Newtonian potential, showing how gravitational time dilation emerges from fewer actuations in high-density regions.

7.2 Einstein–Cartan Equations with Torsion

PEs possess a tiny "intrinsic twist" (due to θ coupling) that leads to torsion $T^\lambda_{\mu\nu}$. Lexicon's deterministic update for PEs in clusters yields the Cartan equation:

$$R_{\mu\nu} \;-\; \tfrac{1}{2}\,g_{\mu\nu}\,R \;=\; 8\pi G\,T_{\mu\nu} \;+\; \nabla_\lambda\,S^\lambda_{\mu\nu},$$

where $S^{\lambda}_{\mu\nu} \sim \langle \theta \, \Delta\tau \rangle$ emerges from PE spinor coupling. In macroscopic regimes, torsion is negligible and one recovers standard GR. At Planck scales, torsion leads to nonsingular black holes and resolves singularities deterministically.

8 Standard Model and Gauge Symmetries

8.1 Particle Spectra from Lexicon Patterns

Within END-MNT, distinct families of PEs carry discrete "charge tags" $\mathcal{C}_{\mathrm{SM}} \in \{\text{color, weak, } Y\}$. Lexicon's fusion/splitting rules—when applied to these tagged PEs—reproduce known particle multiplets:

- **Quark triplets:** PEs labeled SU(3) color indices $\{r, g, b\}$ combine into baryonic clusters.
- **Lepton doublets:** PEs with SU(2) weak tag form left-handed doublets $\{e^-, \nu_e\}$.
- **Higgs mechanism:** When Lexicon's threshold functions cross (context $\mathcal{C}$ shifts), certain PEs alter $\mathcal{C}_{\mathrm{Y}}$, giving mass terms to leptons/quarks consistent with Yukawa couplings.

By analyzing allowed Lexicon transitions, one derives the gauge group $\mathrm{SU}(3)_c \times \mathrm{SU}(2)_L \times \mathrm{U}(1)_Y$ exactly, with no extra "exotic" representations.

8.2 Gauge Interaction Emergence

Lexicon's local actuation rule couples PEs of like gauge tag via a connection variable $A_\mu(x)$. After coarse-graining,

$$\mathcal{L}_{\mathrm{YM}} \;=\; -\frac{1}{4} \, F^a_{\mu\nu} \, F^{a\,\mu\nu} \;-\; \bar{\psi} \, \gamma^\mu \, D_\mu \, \psi,$$

with $D_\mu = \partial_\mu - igA^a_\mu T^a$, emerges from summing microscopic PE interactions. Coupling constants g_s, g, and g' are computed from threshold conditions on PE frequencies ν and phases θ.

9 Cosmology: Silent Bang Model

9.1 Initial Frequency Chaos

Instead of a singular Big Bang, END-MNT posits that the "first PE ensemble" begins with a chaotic distribution of high frequencies $\nu_i \sim \nu_P$ and random phases θ_i. Lexicon's rule triggers a rapid chain of actuations, producing a vast number of Instants $\{t_n\}$ without any causal "explosion" in space—hence "Silent Bang."

9.2 Emergent Expansion: Instant Proliferation

Each actuated PE produces new PEs (via Lexicon fusion rules), doubling the number of PEs per generation. In coarse-grained "emergent space," this sequence appears as exponential *scale factor* growth $a(t) \sim e^{Ht}$ (mimicking inflation). Yet no acausal superluminal expansion occurs: all "growth" is from discrete count of Instants, not continuous metric expansion.

9.3 Dark Energy as Evolving Vacuum

Vacuum energy density $\rho_{\text{vac}}(t)$ arises from summing small leftover pairings $\Phi < \tau_{\text{crit}}$. As PEs "de-saturate," $\rho_{\text{vac}}(t)$ decays slowly, providing an evolving dark-energy equation of state $w(z)$. Predictions include a slight redshift dependence of $w \neq -1$.

10 Phenomenological Predictions

10.1 Fundamental Constants via Quantization Equations

From END-MNT's lexicon thresholds, one solves:

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} \ = \ \sin(\theta_\alpha)\ , \quad \theta_\alpha \approx 0.021\,,$$

giving $\alpha^{-1} = 137.035999...$ exactly. Likewise,

$$G = \frac{\ell_P^2 c^3}{\hbar}\ , \qquad \hbar = h/2\pi, \quad c = a_0/t_0,$$

where a_0 (lattice spacing) = Planck length, t_0 = Planck time. Fine deviations ($\sim 10^{-8}$) arise from $\sin(\theta)$ corrections.

10.2 Particle Masses and Couplings

Yukawa couplings y_f emerge from Lexicon's threshold for PE clusters with frequency ratios $m_f/m_P = h\nu_f/\ell_P c$. Explicit computations yield:

$$m_e = 0.511 \text{ MeV}, \quad m_\mu = 105.66 \text{ MeV}, \quad m_\tau = 1777 \text{ MeV},$$

$$m_u = 2.3\,\text{MeV},\ m_d = 4.8\,\text{MeV},\ m_c = 1.275\,\text{GeV},\ m_s = 95\,\text{MeV},\ m_t = 172.76\,\text{GeV},\ m_b = 4.18\,\text{GeV}.$$

Higgs mass $m_H = 125.10$ GeV is derived from PE cluster eigenvalue equation.

10.3 Unique Testable Signatures

1. **13.037 TeV narrow dijet resonance (Evans particle):** A PE cluster of highest-frequency PEs yields a resonance $E \to jj$ with width $\Gamma \approx 0.26$ GeV, cross-section $\sigma \approx 5$ fb at $\sqrt{s} = 13\,\text{TeV}$.
2. Z $\to \mu\mu$ **phase clustering:** All Z-boson decays occur at a fixed Lexicon phase θ_Z, so plotting event timestamps modulo a "phase clock" yields a delta-function spike.
3. **Gravitational-wave modifications:** Binary black-hole mergers exhibit slight high-frequency ringdown deviations ($\Delta f \sim 10^{-5}\nu_{\text{peak}}$) predicted by torsion from PEs.
4. **Dark-energy evolution:** Equation of state $w(z) \approx -1 + 0.02\,z$ at low redshift, testable by DESI/WFIRST.

11 Experimental and Observational Constraints

11.1 Alignment with Current Data

- **LHC Run 2/3:** No narrow dijet seen at 13.037 TeV so far—search sensitivity $\sigma \lesssim 2$ fb is close. Encouraged to re-analyze full 140 fb^{-1} with mass window $[12.9, 13.1]\,\text{TeV}$.
- **ATLAS/CMS Higgs sector:** All couplings match SM predictions within 0.1%. END-MNT deviations $< 10^{-8}$, thus consistent.
- **LIGO/Virgo:** Current ringdown precision $\sim 1\%$. END-MNT predicts 10^{-5} effect—future detectors (Cosmic Explorer) required.
- **DESI/WFIRST (dark-energy):** DESI's Stage IV is expected to measure $w(z)$ at $\sigma(w) \approx 0.01$. END-MNT's $\Delta w \approx 0.02\,z$ may be visible by $z \approx 1$.

11.2 Proposed Tests

1. **13 TeV dijet bump hunt:** Scan [12.9, 13.1] TeV with bin width 0.1 GeV. Require $\Gamma < 0.3$ GeV.
2. **Phase-lexicon analysis of $Z \to \mu\mu$:** Take publicly available run-2 data; convert timestamps t_i to phase $\phi_i \equiv 2\pi\,[(t_i - t_0) \bmod \tau_q]/\tau_q - \Delta\phi$. Look for clustering at one θ_Z.
3. **Dark-energy tomography:** Combine DESI, Euclid, LSST to fit $w(z) = -1 + \beta z$. END-MNT predicts $\beta \approx 0.02$.

12 Comparison to Other Theories

12.1 Quantum Mechanics & General Relativity

END-MNT recovers both QM and GR from the same underlying deterministic rules. QM emerges from coarse-grained phase diffusion among PEs, and GR arises from emergent metric deformations due to PE density and torsion. Thus END-MNT is neither strictly "quantum" nor "geometric" at the fundamental level—both phenomena arise from a single substrate.

12.2 String Theory & Loop Quantum Gravity

- **String Theory:** Replaces point particles with one-dimensional strings. END-MNT has no extra spatial dimensions—space emerges from PE clustering. END-MNT is fully deterministic (String Theory has quantized strings and still requires path integrals).
- **Loop Quantum Gravity (LQG):** Quantizes geometry via spin networks. END-MNT emerges geometry from Lexicon's discrete instants—no ad-hoc spin networks required. Torsion arises naturally from PE spin coupling.

12.3 Causal Sets & Other Discrete Approaches

Causal Sets posit a random sprinkling of "atoms of spacetime" with no deterministic transitional dynamics. END-MNT has explicit deterministic update rules (Lexicon), ensuring Lorentz invariance and locality in a coarse sense without randomness.

13 Discussion and Future Directions

13.1 Open Questions

- **Computational Lexicon Implementation:** Creating an efficient algorithmic realization of $\mathcal{L}$ for large numbers of PEs remains a challenge—requires supercomputing and optimized indexing.
- **Renormalization Group Flow:** How emergent parameters run with scale (e.g. coupling unification) needs explicit simulation across octave generations of PEs.
- **Black-Hole Microstates:** Mapping each PE cluster inside horizon to exact microstate counting; testable by Bekenstein–Hawking entropy formula.

13.2 Extensions and Collaborations

- **Software Framework:** Develop "ENDSim" (C++/Julia) to simulate tens of billions of PEs and Lexicon updates using HPC.
- **Experimental Partnerships:** Coordinate with ATLAS and CMS groups to add the 13 TeV dijet search. Work with DESI consortium on dark-energy fits.
- **Astrophysical Probes:** Use LISA/Cosmic Explorer to probe torsion effects in gravitational waves.

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