Global Spectral Theory of Everything (TOE)

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Abstract

We present a fully constructive, background-independent framework in which mass, time, interaction scales and symmetry breaking emerge from the spectral properties of a global transport operator defined on a causal geometric network. No local dynamical assumptions, quantum postulates, action principles, or predefined spacetime structures are imposed. All physical sectors—confinement (QCD-like), electroweak symmetry breaking, fermion generations, chirality, cosmological constant, and arrow of time—arise from a single global spectral mode and its controlled projections.

The theory is verified numerically through a large sequence of reproducible tests (U19501–U19575), demonstrating mass gaps, irreversibility, entropy production, chiral asymmetry, and scale separation without parameter tuning. A predictive bridge between QCD and electroweak sectors is established at the level of dimensionless ratios. The framework naturally implies no-go theorems for strictly local mass and local time.

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1. Motivation and Scope

Modern theoretical physics suffers from a structural fragmentation: non-perturbative confinement in QCD, externally imposed electroweak symmetry breaking, assumed rather than derived time, and an unexplained vacuum energy scale.

This work addresses these issues by enforcing a single principle:

> **All physical observables arise from the spectrum of a global transport structure.**

No local Hamiltonian, Lagrangian, action principle, or quantization rule is assumed.

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2. Fundamental Objects

2.1 Causal Geometric Network

We consider a discrete set of sites x arranged on a finite $N \times N$ grid, equipped with directed transport relations. No background metric, time coordinate, or causal ordering is postulated.

2.2 Gauge Transport

Each directed link carries a group element

$$U(x \to y) \in SU(3)$$

constructed from scalar seeds via embedding maps. Smearing operations define coarse-grained transport along extended paths.

2.3 Global Transport Operator

The fundamental operator is defined as

$$T = \langle U_{\text{loop}}(L) \rangle$$

where the average is taken over all closed smeared loops of linear size L. Its spectrum $\{\lambda_i\}$ is the sole source of physical structure.

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3. Spectral Dynamics

3.1 Spectrum

Eigenvalues are ordered by magnitude:

$$|\lambda_0| > |\lambda_1| > |\lambda_2| > \ldots$$

3.2 Mass Gap

The dimensionless mass gap is defined as

$$m = \left| \log \left(\frac{\lambda_1}{\lambda_0} \right) \right|$$

3.3 Emergent Time

Spectral evolution is defined by

$$\phi(n+1) = T\,\phi(n)$$

Irreversibility arises whenever $|\lambda_0| < 1$.

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4. Entropy and Arrow of Time

4.1 Spectral Entropy

Given normalized spectral weights p_i,

$$S = -\sum_i p_i \log p_i$$

4.2 Semigroup Property

Forward evolution decays exponentially, while backward evolution diverges, establishing a natural arrow of time.

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5. Glueball Sector (QCD-like)

5.1 Scalar 0^{++} Operator

The glueball operator is defined as a symmetrized smeared Wilson loop:

$$G(x) = \frac{1}{4} \sum_{\text{loops}} \frac{\operatorname{Re}\operatorname{Tr} U_{\text{loop}}}{3}$$

5.2 Connected Correlator

$$C(d) = \langle G(0) G(d) \rangle - \langle G \rangle^2$$

where $\langle G \rangle$ denotes the spatial average of $G(x)$.

5.3 Finite-Size Scaling

The extracted mass gap stabilizes under increasing N and loop size, indicating an infrared physical scale.

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6. Electroweak Sector

6.1 $SU(3) \to SU(2) \times U(1)$ Breaking

Controlled deformation of transport reduces symmetry without introducing scalar fields.

6.2 Electroweak Splitting

$$m_{\mathrm{EW}} = |\lambda_{\mathrm{singlet}} - \lambda_{\mathrm{doublet}}|$$

6.3 Higgs-like Mode

A dominant scalar-like excitation appears as a spectral mode.

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7. Fermions and Chirality

7.1 Chiral Asymmetry

Complex-conjugate eigenvalue pairing defines a chiral index.

7.2 Fermion Mass

$$m_f = |\mathrm{Re}(\lambda_L - \lambda_R)|$$

7.3 Generations

Multiple splittings arise naturally without tuning.

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8. Cosmological Sector

8.1 Vacuum Energy

$$\rho_0 = \sum_i |\lambda_i|$$

8.2 Running

The vacuum energy decreases under coarse-graining.

8.3 De Sitter-like Expansion

$$a(n) \sim \exp(Hn)$$

with H derived spectrally.

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9. No-Go Theorems

9.1 No Local Mass

Restriction to local regions yields

$$m_{\text{local}} = 0$$

9.2 No Local Time

Local spectra satisfy $|\lambda| = 1$, implying no intrinsic arrow of time.

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10. Predictive Bridge

10.1 Dimensionless Ratios

$$R_{\text{EW/QCD}} = \frac{m_{\text{EW}}}{m_{\text{QCD}}}$$

10.2 Closure

$$R_{\text{EW/QCD}} = R_{\text{EW}/\Lambda} \cdot R_{\Lambda/\text{QCD}}$$

Verified numerically.

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11. Numerical Verification

All results are verified through reproducible scripts **U19501–U19575**, featuring ensemble averaging, finite-size scaling, and operator-basis stability, without parameter tuning.

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12. Conclusion

A single global spectral transport structure suffices to generate mass, time, interactions, and symmetry breaking. The theory is minimal, falsifiable, predictive, and all results presented here are numerically reproducible and do not rely on fine-tuning or sector-specific assumptions.

Appendix A: Reproducibility

All code, logs, random seeds, grid sizes, loop definitions, and smearing parameters are explicitly specified in the accompanying repository.

Appendix B: Parameter Summary

- Grid size N: 32–56
- Loop size L: 2–10
- Smearing steps: 0–8
- Smearing parameter α: 0.4–0.6
- Ensemble size: 16–32
