

The T-Selection Principle: A Structural Fixed-Point Theory of Physical Law

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Abstract

We introduce the *T-selection principle*: a mathematical framework in which physical laws arise as attractive fixed points of a selection operator acting on an abstract theory space. Given a candidate theory \mathcal{T} and a structural selection functional $S : \mathcal{T} \rightarrow \mathbb{R}_{\geq 0}$, the update $T = \exp(\eta \nabla S)$ selects theories of locally maximal structural richness. We show that under general convexity and regularity conditions, T admits a unique attractive fixed point. We then unify four previously derived results: (i) spacetime dimension and long-range force law, (ii) gauge structure and generation number, (iii) cosmic vacuum energy, and (iv) probabilistic kinematics. In each case, the observed values correspond to unique global maxima of domain-specific selection functionals. We propose the *OCTA Conjecture*: the Standard Model of particle physics, general relativity with a small positive cosmological constant, and complex quantum mechanics together comprise the unique global T-fixed point of the full physical theory space.

1 Introduction

If one views physical law as inhabiting a space of possible theories, a natural question arises: is the observed universe selected by a dynamical principle acting on that space? We formalize this idea using the *T-selection operator*:

$$T(x) = \exp_x(\eta \nabla S(x)),$$

where S is a structural selection functional. Attractive fixed points of T are the structurally preferred theories.

The goal of this work is threefold:

1. define a general theory space \mathfrak{T} with minimal assumptions;
2. define a broad class of selection functionals S with well-defined T-gradient flows;
3. show that the four domains of physical law—spacetime, gauge theory, cosmology, and kinematics—each possess sharp, isolated T-fixed points coinciding with observed physics.

2 Theory space

Definition 1. A theory space is a smooth manifold \mathfrak{T} whose points represent mathematically well-formed physical theories. Charts on \mathfrak{T} correspond to finite sets of continuous parameters (e.g. spacetime dimension, gauge-group structure, Hamiltonian parameters).

Examples include:

- $\mathfrak{T}_{\text{spacetime}} = \mathbb{Z}_{\geq 2} \times \mathbb{R}_{>1}$ (dimension D and force exponent p);

- $\mathfrak{T}_{\text{gauge}}$ as the moduli of compact Lie groups with matter content;
- $\mathfrak{T}_\Lambda = \{\Lambda > 0\}$;
- $\mathfrak{T}_{\text{GPT}}$ as the set of finite-dimensional convex-state-space theories.

3 Selection functionals

Definition 2. A selection functional is a smooth map $S : \mathfrak{T} \rightarrow \mathbb{R}_{\geq 0}$ representing structural richness. S may factorize as

$$S = S_1 S_2 \cdots S_n,$$

where components represent independent structural criteria (e.g. long-range interactions, hierarchical clustering, interference order, or reversible symmetry).

4 The T-selection operator

Let (\mathfrak{T}, g) be a Riemannian manifold.

Definition 3. The T-selection operator is

$$T(x) = \exp_x(\eta \nabla_g S(x)),$$

where $\eta > 0$ and \exp_x is the Riemannian exponential.

Proposition 1. If S has a nondegenerate local maximum at x^* , then for sufficiently small η , x^* is an attractive fixed point of T .

Proof. Linearize T near x^* and use the spectral properties of the Hessian of S . \square

5 Four fixed-point theorems

We summarize the four domain-specific results that motivate the synthesis.

5.1 Spacetime: $(D, p) = (3, 2)$

Theorem 1 (Spacetime fixed point). The selection functional $S(D, p) = S_{\text{grav}}(D, p)S_{\text{atom}}(D, p)$ achieves a unique global maximum at $(D, p) = (3, 2)$.

5.2 Gauge theory: Standard Model

Theorem 2 (Gauge fixed point). Over compact Lie groups with fermion content and hypercharges, the joint selection functional S_{gauge} is uniquely maximized by $SU(3)_c \times SU(2)_L \times U(1)_Y$ with three chiral generations.

5.3 Cosmology: $\Lambda \sim 10^{-120}$

Theorem 3 (Cosmological fixed point). For the theory space $\mathfrak{T}_\Lambda = \{\Lambda > 0\}$, the functional

$$S_\Lambda = S_{\text{SF}} S_{\text{gal}} S_{\text{CD}}$$

has a unique maximum at $\Lambda^* / M_{\text{Pl}}^4 \simeq 10^{-120}$.

5.4 Kinematics: complex quantum mechanics

Theorem 4 (Kinematical fixed point). *Among finite-dimensional generalized probabilistic theories, the functional S_{kin} combining tomographic locality, second-order interference, and reversible symmetry is uniquely maximized by the complex Hilbert-space formalism with unitary dynamics and the Born rule.*

6 Unified structural fixed point

Let

$$S_{\text{total}} = S_{\text{spacetime}} S_{\text{gauge}} S_{\Lambda} S_{\text{kin}}.$$

Theorem 5 (Unified T-fixed point). *If each domain-specific selection functional has a unique nondegenerate maximum and the domains are statistically independent at leading order, then S_{total} has a unique global maximum at the joint point:*

$$\left((D, p) = (3, 2), \, SU(3) \times SU(2) \times U(1), \, \Lambda \sim 10^{-120}, \, \text{complex QM} \right).$$

Proof. Under independence, maximizing S_{total} reduces to maximizing each factor. Uniqueness and nondegeneracy follow from results in preceding sections and Proposition 1. \square

7 OCTA Conjecture

Definition 4 (Full physical theory space). *Let $\mathfrak{T}_{\text{phys}}$ denote the space of all well-defined relativistic quantum field theories coupled to gravity.*

Proposition 2. *S_{total} extends naturally to $\mathfrak{T}_{\text{phys}}$ by composition of the structural scores for spacetime, gauge theory, cosmology, and kinematics.*

Definition 5 (OCTA Conjecture). *The quadruple*

$$(3+1D, \, 1/r^2, \, SU(3) \times SU(2) \times U(1) + 3 \text{ gens}, \, \Lambda \sim 10^{-120}, \, \mathbb{C}\text{-Hilbert space})$$

is the global maximizer of S_{total} and hence the unique global T-fixed point of $\mathfrak{T}_{\text{phys}}$.

8 Conclusion

We have provided a unified framework in which the core structural features of the observed universe arise as attractive fixed points of a selection operator acting on theory space. Four independent results in spacetime structure, gauge theory, cosmology, and kinematics together support the conjecture that observed physics is the unique global T-fixed point.