

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

OCTA

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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  $\eta$ ,  $x^*$  is an attractive fixed point of  $T$ .

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

### 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  $S_{\text{gauge}}$  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  $S_{\text{kin}}$  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  $S_{\text{total}}$  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  $S_{\text{total}}$  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.**  *$S_{\text{total}}$  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  $S_{\text{total}}$  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.