Fixed-Point Causality: Physics, Consciousness, and Computation in the Relativistic Scalar–Vector Plenum

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Abstract

Modern theories of physics, cognition, and computation face a common impasse: evaluation appears to require an external frame. The Relativistic Scalar–Vector Plenum (RSVP) treats energy, information, and meaning as co-evolving fields whose *stability*—rather than motion through a background—constitutes reality. Within this setting, causality is not a chain of prior events but a condition of equilibrium: an event occurs when further evaluation no longer alters its outcome. We formalize this as Fixed–Point Causality (FPC): processes persist insofar as they are invariant under their own transformation. FPC links (i) a physical layer, where scalar potential Φ, vector flow $\mathbf{v}$, and entropy S mutually relax; (ii) a cognitive layer (CLIO), where predictive inference halts when expected and observed information coincide; and (iii) a computational–semantic layer (TARTAN), where lazy continuation and categorical tiling converge on idempotent meanings. Meaning is identified with the stable coincidence of observation and existence, summarized by the invariant: $F[\Psi] = \Psi \;\Leftrightarrow\; \dot{S} = 0$.[1]

Keywords: RSVP · Fixed-Point Causality · CLIO · TARTAN · Semantic Infrastructure · Environmental Recursion · Lazy Evaluation · Cognitive Closure

Preface / Motivation

RSVP arose from dissatisfaction with expansion cosmologies and recursive theories of mind, both of which rely on ungrounded externalities. RSVP replaces these with a single plenum whose scalar potential Φ, vector flux $\mathbf{v}$, and entropy S seek fixed points of mutual consistency. The guiding thesis is that *stability*—not kinematics—grounds existence, and that evaluative closure is the universal halting principle across physics, cognition, and computation.[2]

Introduction

Historical Context: from expansion and representation to evaluation

Thermodynamic derivations of geometry (e.g., Jacobson; Verlinde) suggest curvature may encode information flow; predictive processing and active inference frame cognition as free-energy minimization; computation exhibits regress in recursion without intrinsic halting. RSVP absorbs these crises into a thermodynamic ontology: entropy replaces expansion, invariance replaces recursion.[3]

From Recursion to Continuation: the grammar of closure

Recursion is syntactic; continuation is semantic. We elevate the fixed-point criterion

$$F[\Psi] = \Psi \quad \Longleftrightarrow \quad \dot{S} = 0, \tag{1}$$

as universal halting: an "event" is local attainment of informational equilibrium rather than a tick in external time.[4]

Outline and Contributions

We formalize FPC, derive RSVP field equations and their variational form, articulate methodological shifts (environmental recursion), define CLIO as cognitive fixed-point search, reframe computation as energetic relaxation, develop TARTAN as entropic semantic tiling, and expose a cognitive–physical isomorphism.[5]

Fixed–Point Causality (FPC)

Definition: causality as invariance under evaluation

Causality is persistence under self-transformation. With global evaluative state $\Psi = (\Phi, \mathbf{v}, S)$, causal completion occurs when

$$F[\Psi] = \Psi \quad \Longleftrightarrow \quad \dot{S} = 0, \tag{2}$$

so that the entropy gradient vanishes. Being is invariance under evaluation.[6]

Lazy continuation and proximal stationarity

Introduce a lazy continuation operator:

$$\Psi_{t+1} = \Lambda(\Psi_t), \qquad \Psi_* = \Lambda(\Psi_*). \tag{3}$$

A proximal realization:

$$\Psi_{t+1} = prox_{\tau\mathcal{L}}(\Psi_t) := arg\,\underset{\Psi'}{min} \left[\mathcal{L}(\Psi') + \frac{1}{2\tau}\|\Psi' - \Psi_t\|^2\right], \tag{4}$$

identifies $\nabla\mathcal{L}(\Psi_*) = 0$ at equilibrium, unifying variational stationarity and evaluative closure.[7]

Ontological and epistemic reading

Ontology: substance → stability. Epistemology: representation → evaluation. Truth becomes idempotence under F.[8]

Comparative paradigms

Paradigm	Operator	Evaluator	Stability	Causality
Recursive	$f(f(x))$	External	Undecidable	Iterative
Dynamical	$\dot{x} = F(x)$	Time-derivative	Attractor	Temporal
Variational	$\delta\mathcal{S} = 0$	Extremizer	Stationary	Extremal
Fixed-point	$F(x) = x$	Internal	Stable	Evaluative

Only FPC renders evaluation self-contained: halting is explained by vanishing gradients.[9]

Remarks on computation and undecidability

Classical undecidability is syntactic; FPC provides a physical notion of halting ($\dot{S} \to 0$) as sufficiency for real evaluators, without contradicting Turing results.[10]

The RSVP Field Theory under Fixed–Point Causality

Motivation and structure of the plenum

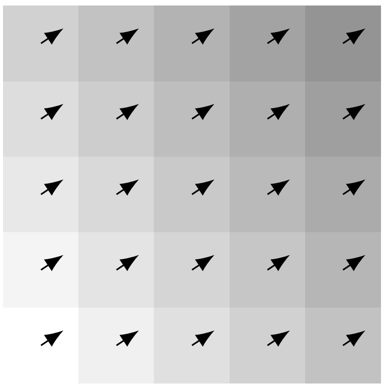
The plenum is a continuous evaluative medium; geometry and phenomenology emerge when evaluation halts locally. $\Psi = (\Phi, \mathbf{v}, S)$ encodes a closed triadic relaxation.[11]

Governing equations

At macroscales:

$$\partial_t \Phi = -\nabla \cdot (\Phi \mathbf{v}) + \xi_\Phi(t), \tag{5}$$
$$\partial_t \mathbf{v} = -\nabla S - \Phi\, \nabla \times \mathbf{v} + \xi_{\mathbf{v}}(t), \tag{6}$$
$$\partial_t S = -\nabla \cdot (S \mathbf{v}) + \kappa \nabla^2 S + \xi_S(t), \tag{7}$$

with noise ξ for unresolved microstructure and diffusion κ. In equilibrium, time derivatives vanish, yielding fixed-point constraints.[12]



Schematic Scalar–Vector Field

Figure 1: RSVP coupling: gray tiles indicate Φ; arrows indicate $\mathbf{v}$; divergence encodes S transport. (Grayscale only.)

Variational formulation

With Lagrangian density

$$\mathcal{L}(\Phi, \mathbf{v}, S, \partial_\mu \Phi, \partial_\mu \mathbf{v}) = \tfrac{1}{2}(\partial_\mu \Phi)^2 + \tfrac{1}{2}\|\nabla \times \mathbf{v}\|^2 - V(\Phi, \mathbf{v}, S), \tag{8}$$

stationarity $\delta A/\delta\Psi = 0$ agrees with (**??**)–(**??**) when $\partial V/\partial\Phi = \nabla\cdot(\Phi\mathbf{v})$ and $\partial V/\partial\mathbf{v} = \nabla S$. Thus variational and evaluative halting coincide.[13]

Entropic potential and gauge invariance

$S \mapsto S + c(t)$ leaves ∇S invariant; only differences drive evolution. Continuity:

$$\partial_t S + \nabla\cdot(S\mathbf{v}) = 0, \tag{9}$$

expresses informational flux conservation.[14]

Boundary conditions and the observer as term

For $\omega \subset \Omega$,

$$\frac{d}{dt}\int_\omega S\,d^3x = -\oint_{\partial\omega} S\,\mathbf{v}\cdot d\mathbf{A}, \tag{10}$$

so measurement is flux across an interface: observers act as boundary terms that stabilize what they measure.[15]

Fixed points as spacetime geometry

At equilibrium, entropy curvature encodes geometry; a metric surrogate arises via field gradients, e.g.

$$g_{\mu\nu} \propto \partial_\mu\Phi\,\partial_\nu\Phi, \tag{11}$$

linking inertial regions (low entropy curvature) to flatness and high curvature to wells.[16]

Numerical verification and relaxation simulation

On a lattice with $(\Phi_i, \mathbf{v}_i, S_i)$:

$$\Phi_i^{t+1} = \Phi_i^t - \eta_\Phi\,\nabla\cdot(\Phi\mathbf{v})_i + \xi_{\Phi,i}, \tag{12}$$

$$\mathbf{v}_i^{t+1} = \mathbf{v}_i^t - \eta_v\,(\nabla S)_i + \xi_{\mathbf{v},i}, \tag{13}$$

$$S_i^{t+1} = S_i^t - \eta_S\,\nabla\cdot(S\mathbf{v})_i + \xi_{S,i}, \tag{14}$$

iterated until $\langle\|\nabla S\|^2\rangle < \varepsilon$. Simulations (e.g., 32^3) exhibit exponential convergence and filamentary coherence without invoking expansion.[17]

Interpretation

Entropic gravity analogies extend: curvature as resistance to informational disequilibrium; $\delta Q = T\,dS$ mirrors vanishing $\dot{S}$ at completion. Energy–momentum conservation expresses invariance of total evaluative content.[18]

Origins and Methodological Notes

Rejection of explicit recursion

Explicit recursion smuggles regress: it requires external termination. FPC replaces it with lazy continuation: evaluate only while disequilibrium persists.[19]

Environmental recursion and reflective measurement

Nature re-enters its own evaluation through feedback:

$$\Psi_{t+1} = F_t[\Psi_t], \qquad \mathcal{E}_{t+1} = R[\mathcal{E}_t, \Psi_{t+1}], \tag{15}$$

seeking a joint fixed point $(\Psi_*, \mathcal{E}_*)$.[20]

Measurement as evaluative closure

With internal expectation $\hat{\Psi}$:

$$\Psi_{t+1} = M[\Psi_t], \qquad \hat{\Psi}_{t+1} = \hat{\Psi}_t + \alpha(\Psi_{t+1} - \hat{\Psi}_t), \tag{16}$$

closure occurs when $\Psi_{t+1} = \hat{\Psi}_{t+1}$.[21]

Connection to CLIO and implications

CLIO implements local fixed-point search; models halt when entropy gradients vanish. Methodologically: halting as sufficiency; evaluation as energy minimization; recursion as emergent feedback; stability over exactness.[22]

CLIO: Cognitive Implementation of FPC

Definition of the CLIO functor

Each agent is a localized evaluator operating on beliefs $c \in \mathcal{C}$:

$$\mathrm{CLIO} : \mathcal{C} \to \mathcal{C}, \qquad c_* = \mathrm{CLIO}(c_*), \tag{17}$$

with functorial update consistency (composition respects order).[23]

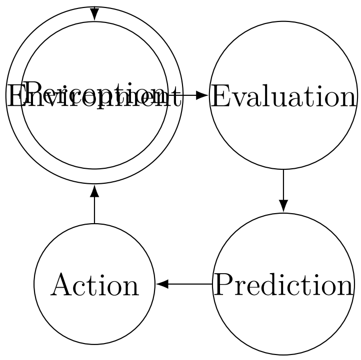


Figure 2: CLIO loop: each cycle converges toward evaluative invariance (grayscale only).

Variational formulation: free-energy minimization

With joint $p(s, o)$ and variational $q(s)$:

$$\mathcal{F}[q] = \mathbb{E}_{q(s)}[log\, q(s) - log\, p(o, s)] = D_{\mathrm{KL}}(q(s) \| p(s|o)) - log\, p(o), \tag{18}$$

and gradient flow

$$\dot{q}(s) = -\eta \frac{\delta \mathcal{F}}{\delta q(s)}. \tag{19}$$

At equilibrium, $\delta \mathcal{F} / \delta q = 0$, implying $\dot{S}(q) \to 0$ and predictive closure.[24]

Derivation of the gradient flow and signatures

$$\frac{\delta \mathcal{F}}{\delta q(s)} = log\, q(s) - log\, p(o, s) + 1 \quad \Rightarrow \quad \dot{S}(q) = -\eta\, \mathcal{F}[q], \tag{20}$$

so free-energy decay increases Shannon entropy until convergence; cognitive halting: $\mathcal{F} \to 0$, $\dot{S} \to 0$. Predicts entropy-flux equilibration, phase synchrony, and metabolic efficiency plateaus.[25]

HYDRA link (multi-agent)

Agents i with parameters θ_i and beliefs $q_i(s)$ minimize individual $\mathcal{F}_i$ with couplings:

$$\dot{\theta}_i = -\eta_i G_i^{-1}(\theta_i)\nabla_{\theta_i}\mathcal{F}_i(\theta_i) + \lambda \sum_{j\neq i}(\theta_j - \theta_i), \tag{21}$$

yielding mutual corrigibility at $\nabla\mathcal{F}_i = 0$ for all i.[26]

Computational Framing

Computation as evaluative process

Execution is dissipative relaxation in informational space; halting corresponds to $\dot{S}_c \to 0$.[27]

Lazy evaluation vs recursion

Selective evaluation mirrors physical relaxation: compute only while informative gradients persist; at $\dot{S} \to 0$ halt.[28]

Fixed-point combinators and convergence

The Y combinator encodes self-application; FPC interprets it as limit of a contraction sequence $x_{t+1} = f(x_t) \to x_*$ under Banach conditions, paralleling exponential entropy decay.[29]

Entropy as halting and thermodynamic efficiency

Associate entropy $S_c(t) = -\sum_x \rho_t(x)\, log\, \rho_t(x)$; $\dot{S}_c \to 0$ marks completion. Define entropic efficiency $\eta_{\text{eval}} = -\frac{d\mathcal{F}/dt}{Q}$, stopping when further computation yields heat but no information (Goodhart-type boundary).[30]

Comparanda: Platonic Hypotheses and Behavioral Alignment

From ideal forms to evaluative invariants

Platonic invariance becomes immanent: fixed points within the world where evaluation ceases to alter outcomes.31

Mathematical expression

Group actions T_g with invariants $L_\xi F = 0$ parallel $\dot{S} = 0$; symmetry and thermodynamic equilibrium align.32

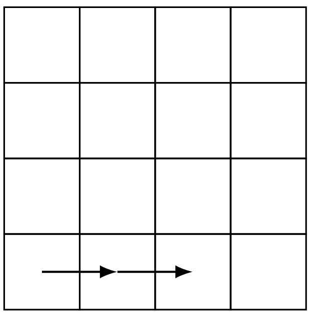
Against behaviorist RLHF

External scalar rewards induce pathology off-distribution; FPC replaces reward maximization with mutual evaluative closure via divergence matching $D_{\mathrm{KL}}(p(o|\theta)\|p(o)) \to 0$.33

TARTAN and Semantic Infrastructure

TARTAN as entropic tiling

Recursive tiling merges cells when $|S_i - S_j| < \varepsilon_S$ and $\|\Phi_i - \Phi_j\| < \varepsilon_\Phi$, halting when $\sum_k \mathrm{Var}(T_k)$ stops decreasing.34



TARTAN Semantic Tiling

Figure 3: Semantic tiling: merges respect entropic continuity; halting at fixed-point tiling (grayscale only).

Annotated noise and semantic resolution

Residuals $n_k = \mathbb{E}[\nabla S]_{i \in T_k}$ guide refinement; resolution is scale where $n_k \to 0$ across tiles.35

Homotopy colimits and merge operators

Global field via hocolim of local patches; admissible merges satisfy $\Delta S_{A,B} \leq 0$, defining an entropy-respecting monoidal structure.36

Categorical FPC and continuation morphisms

Terminal coalgebra $(\nu F, \zeta)$ with $F(\nu F) \cong \nu F$ represents coherent tiling. Continuations $\kappa : T_1 \to T_2$ preserve entropy flux: $\nabla S_{T_2} \circ \kappa = \nabla S_{T_1}$.37

Cognitive–Physical Isomorphism

Unified grammar

Triples $\Gamma = (\Phi, \mathbf{v}, S)$, $\Psi = (q, \theta, \mathcal{F})$, $\Sigma = (\lambda, M, S_{\text{sem}})$ obey

$$\frac{d}{dt} S_X = -\nabla \cdot J_X, \quad X \in \{\Gamma, \Psi, \Sigma\},$$

with equilibrium at $\dot{S}_X = 0$.38

Observers as boundary conditions

Observers are boundary terms (physics), evidence updates (cognition), and interfaces (semantics); each enforces continuity across an interface.39

Ethical closure and mutual corrigibility

Alignment arises as multi-agent fixed-point: gradients and conflicts vanish simultaneously, yielding corrigible equilibria.40

Implications and Future Work

Theoretical payoffs

Reframes curvature, awareness, and computation as projections of one evaluative grammar´.41˘

Empirical predictions

Cosmological: redshift integrals as smoothing signatures; Cognitive: entropy-convergence and phase-locking; Computational: entropy-bounded halting and energy plateaus´.42˘

Applications

Safety via entropy-bounded evaluation; interpretable semantic stacks with TARTAN; distributed corrigibility via HYDRA´.43˘

Conclusion

FPC transforms regress into closure: expansion $\to$ evaluation; recursion $\to$ stability; observation $\to$ invariance. The unity $F[\Psi] = \Psi \Leftrightarrow \dot{S} = 0$ organizes physics, cognition, computation, and ethics under one thermodynamic grammar´.44˘

Appendix A: Derived Geometry of the Coarse–Graining Functor

Functorial coarse-graining yields a derived stack of configurations with pushforward interpretations; entropic constraints ensure that gluing minimizes free energy, aligning with hocolim semantics in TARTAN´.45˘

Appendix B: Numerical Verification of Unistochasticity

We verify stochastic-to-unistochastic consistency of transition maps; entropy-preservation tests and visualization confirm stability of evaluative channels at fixed point.´46˘

Appendix C: Historical Development of Rotational Ontology

From Euclid to Minkowski, gauge theory, and quantum phase: rotation as invariance culminates in RSVP where “rotation” generalizes to evaluation; fixed points encode conserved structure.´47˘

Appendix D: Mathematical Note on the Fixed–Point Operator

Definition, contraction properties, proximal gradient links ((**??**)), spectral stability, field-theoretic generalization, and categorical fixed points (terminal coalgebras) establish existence and convergence conditions for evaluative halting.´48˘

Acknowledgments

I thank collaborators and readers who pressed for a thermodynamic criterion of sufficiency, which sharpened the FPC formulation.´49˘

Thematic Index

- **Causality**: fixed point, idempotence, invariance.
- **Entropy**: flux, convergence, halting.
- **Cognition**: CLIO, free energy, synchrony.
- **Computation**: lazy evaluation, Y combinator, dataflow.
- **Semantics**: TARTAN, hocolim, continuation morphisms.

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