The Relativistic Scalar–Vector Plenum: Field, Entropy, and Categorical Infrastructure

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# Abstract

RSVP as a unified field theory: scalar–vector–entropy triad. Entropic compression, negentropic reconstitution. Variational principles minimize description-length functionals. Emergent gravity, cosmology, and unistochastic quantum mechanics. Recursive self-maintaining categorical infrastructure (Yarncrawler).

# Part I — Conceptual Foundations

## 1. Introduction: From Representation to Reconstitution

Contemporary physical theories often describe the universe in terms of representational structures—particles, fields, or geometries—that evolve under prescribed laws. The Relativistic Scalar–Vector Plenum (RSVP) introduces a paradigm where reality is constituted through recursive reconstitution, framed as a variational process of entropic compression. In this model, the plenum is characterized by three coupled fields: the scalar potential $\Phi(x^\mu)$, representing density; the vector coherence field $\mathbf{v}(x^\mu)$, directing flows; and the entropy field $S(x^\mu)$, quantifying residual uncertainty.

The fundamental equations are derived from the action functional

$$\mathcal{A} = \int \left[\frac{1}{2}\|\nabla\Phi - \mathbf{v}\|^2 + \frac{\beta}{2}\|\nabla\cdot\mathbf{v}\|^2 + \eta S^2\right] d^4x,$$

subject to entropy balance $\partial_t S = -\nabla\cdot(\Phi\mathbf{v}) + \gamma(\nabla\Phi)^2$. This formulation minimizes a free-energy bound, analogous to variational Bayesian inference, where $\Phi$ encodes expectations, $\mathbf{v}$ corrects predictions, and $S$ regularizes complexity.

RSVP aligns with established theories: thermodynamic field extensions of Onsager relations, free-energy minimization in active inference, and gauge-theoretic connections. However, it diverges by treating spacetime as emergent from compression dynamics, with curvature as entropy flux. The theory's domain spans cosmology, quantum mechanics, and cognitive modeling, unified under entropic variational principles.

## 2. Compression and Information Theory

### 2.1 Entropic Smoothing and Lossy Coherence

The scalar field $\Phi$ performs lossy compression on $\mathbf{v}$, discarding high-frequency components as entropy $S$. This mirrors transform coding, where the action $\mathcal{L}$ quantifies reconstruction error.

### 2.2 Predictive Encoding and the Principle of Minimum Description Length

RSVP minimizes the MDL functional $\mathcal{C} = L(\text{model}) + L(\text{data} \mid \text{model})$, with $\|\nabla \cdot \mathbf{v}\|^2$ as model complexity and $\|\nabla\Phi - \mathbf{v}\|^2$ as data fit.

### 2.3 Coherence as a Codebook

The vector field $\mathbf{v}$ evolves as an adaptive dictionary, preserving invariants under entropic diffusion, akin to dictionary learning in sparse coding.

## 3. Signal Processing Analogues

RSVP's dynamics resemble a multiresolution filter bank, with $\Phi$ as low-pass output and $S$ as residual. Entropy balancing equates to differential coding, where updates encode deviations $\dot{S} = \nabla \cdot (\Phi \mathbf{v}) - \gamma (\nabla\Phi)^2$.

## 4. Structural Analogies to Known Theories

RSVP extends Onsager's relations to relativistic domains, variational free energy to field scales, and gauge curvature to entropy gradients. Quantum decoherence emerges as coarse-graining over $\mathbf{v}$.

## 5. Domain of Application

The theory applies to systems minimizing spatiotemporal entropy under coherence constraints, including cosmological fields, inference processes, cognitive stabilization, and distributed optimization.

# Part II — Compression Dynamics of RSVP

## 6. Field Triplet and Lagrangian

The fields satisfy

$$\partial_t \Phi = \nabla \cdot (D_\Phi \nabla \Phi - \mathbf{v}\Phi) - \lambda_\Phi S,$$

$$\partial_t \mathbf{v} = \nabla \times (\alpha \mathbf{v}) - \nabla \Phi - \lambda_v \nabla S,$$

$$\partial_t S = -\nabla \cdot (\Phi \mathbf{v}) + \gamma (\nabla \Phi)^2.$$

## 7. Lagrangian as MDL Functional

The action $\mathcal{A}$ equates to MDL cost, with equilibrium at stationary points where description length is minimized.

## 8. Entropy Gradient as Description-Length Flow

The rate $\dot{S}$ defines local information flux, integrating to total length $L = \int S \, dV$.

## 9. Predictive Coding Analogy

Mapping to hierarchical coding: $\Phi$ as prior, $\mathbf{v}$ as error, $S$ as variance.

## 10. Autoencoder Formalism

Iterative reconstruction: $\mathbf{v}_{t+1} = f_\theta(\Phi_t)$, $\Phi_{t+1} = g_\phi(\mathbf{v}_t)$, minimized via $\|\Phi_{t+1} - g_\phi(f_\theta(\Phi_t))\|^2 + \lambda S$.

## 11. Categorical Reformulation (Introduction)

Functor $\mathcal{R} : \mathbf{Field} \to \mathbf{Compression}$, preserving invariants under entropy deformation.

## 12. Gravity as Compression Gradient

Gravitational field $\mathbf{g} = -\nabla L$, linking to Einstein equations via entropy-curvature relation.

# Part III — BV–AKSZ Quantization

## 13. BV Differential and Master Equation

Shifted tangent bundle $T^*[1](\Phi, \mathbf{v}, S)$, with Hamiltonian $\Theta$ satisfying $\{\Theta, \Theta\} = 0$.

## 14. Local Component Expansion

Q-differential: $Q\Phi = \nabla \cdot \mathbf{v}$, etc.

## 15. Derived Currents and Conservation Laws

Noether currents from symmetries, conserving flux.

## 16. BV Brackets and Quantum Correspondence

Commutators $[\hat{\Phi}, \hat{S}] = i\hbar_{\text{eff}}$, yielding unistochastic algebra.

# Part IV — Geometric Dynamics and Energy–Entropy Coupling

## 17. Energy–Momentum Tensor

$T^{\mu\nu}$ from metric variation, decomposed into coherent and entropic terms.

## 18. Symplectic Current

Conserved $\omega^{\mu}$ from BV structure.

## 19. Einstein–Landauer Equation

$R = \kappa S$, curvature as information cost.

# Part V — RSVP Cosmology and Entropic Smoothing

## 20. Cosmological Form

FRW metric with entropy-driven smoothing $a(t)$; equations $\quad + 3H \quad = \kappa S$, etc.

$\Phi$ $\Phi$

### 21. Cosmological Phenomenology

Redshift as entropic effect, dark energy from pressure.

## Part VI — Quantum–Statistical and Recursive Cosmology

### 22. Unistochastic Wheeler–DeWitt Equation

$\hat{H}_{\text{comp}}\Psi = 0$, probabilistic coherence interpretation.

### 23. Five-Dimensional Ising Synchronization

Lattice model with Markov blankets, coherence propagation.

### 24. Continuum Limit and Holographic Dual

RG flows, AKSZ continuum action, recursive limit cycles and structure formation.

## Part VII — Unistochastic Quantum Amplitudes and Cyclic Closure

### 25. Unistochastic Path Integral

$Z = \int e^{i\mathcal{S}/\hbar_{\text{eff}}}$, $P_{ij} = |U_{ij}|^2$.

### 26. Limit Cycles and Eternal Recompression

RG flow equations $\frac{dJ_\Phi}{d\ln\ell} = (d-2)J_\Phi - \alpha J_\Phi^2$.

## Part VIII — Categorical Reconstruction and Yarncrawler Infrastructure

### 27. Overview

The RSVP framework can be rigorously formalized as a hierarchical category of entropic configurations, in which scalar, vector, and entropy fields define objects, and local transformations define morphisms. Higher-order structures—coherence, information density, agency, tiling, and repair—can then be mapped functorially onto this base category.

The Yarncrawler infrastructure serves as the terminal monoidal functor that unifies these layers, providing recursive maintenance and repair of semantic coherence.

Formally, the stack is represented as a complex of functors:

$$0 \longrightarrow \mathcal{R} \xrightarrow{d_0} \mathcal{C} \xrightarrow{d_1} \mathcal{I} \xrightarrow{d_2} \mathcal{A} \xrightarrow{d_3} \mathcal{T} \xrightarrow{d_4} \mathcal{Y} \longrightarrow 0,$$

where each $d_i$ is a functorial map preserving entropic and coherent structure.

## 28. Base Category of Entropic Continuity ($\mathcal{R}$)

Objects: Local field configurations

$r = (\Phi_r, \mathbf{v}_r, S_r)$,

satisfying the continuity equation:

$\Delta\Phi_r + \nabla \cdot (\mathbf{v}_r \otimes \mu_r) = 0$,

with $\mu_r$ a measure on the domain.

Morphisms: Entropic-preserving maps

$f : r_1 \to r_2$, such that $\int \nabla \cdot \mathbf{v}\, d\mu + \mathcal{D} = 0$,

where $\mathcal{D}$ represents residual dissipation.

Monoidal Structure:

$r_1 \otimes r_2 = (\Phi_1 + \Phi_2, \mathbf{v}_1 \oplus \mathbf{v}_2, S_1 + S_2)$, $I = (\Phi_0, 0, 0)$,

allowing parallel composition of independent plenum regions.

Entropy Functor:

$\mathbb{S} : \mathcal{R} \to \mathbf{Set}$, $\mathbb{S}(r) = S_r$,

grading morphisms by local dissipation.

Worked Example:

Consider two adjacent plenum regions with fields

$r_1 = (\Phi_1 = 0.5, \mathbf{v}_1 = \hat{x}, S_1 = 0.1)$,

$r_2 = (\Phi_2 = 0.3, \mathbf{v}_2 = \hat{y}, S_2 = 0.2)$.

The monoidal composition is

$r_1 \otimes r_2 = (\Phi = 0.8, \mathbf{v} = \hat{x} \oplus \hat{y}, S = 0.3)$.

## 29. UFTC-SF: Sheaf of Coherence ($\mathcal{C}$)

Definition: Sheaf $\mathcal{C} : \mathcal{R}^{\text{\op}} \to \mathbf{Vect}$, assigning to each object $r$ a vector space of phase-locked states.

Restriction Maps:

$\rho_{r_i, r_j} : \mathcal{C}(r_j) \to \mathcal{C}(r_i)$,

preserve phase coherence on overlaps.

Gluing Axiom:

For compatible sections $s_i \in \mathcal{C}(r_i)$, there exists a unique $s \in \mathcal{C}(\cup r_i)$ with $s|_{r_i} = s_i$.

Worked Example:

Two overlapping regions $r_1, r_2$ with sections $s_1, s_2$ having phase $\phi$ can be glued into a global section $s$ with interpolated phase $\phi$.

## 30. SIT: Information-Density Functor ($\mathcal{I}$)

Definition: Functor $\mathcal{I} : \mathcal{R} \to \mathcal{M}on$, where $\mathcal{M}on$ is the category of monoids, and $\mathcal{I}(r)$ is the monoid of information densities over $r$.

Adjunction: $\mathbb{S} \dashv \mathcal{I}$,

$\text{\Hom}_{\mathbf{Set}}(\mathbb{S}(r), X) \cong \text{\Hom}_{\mathbf{Mon}}(\mathcal{I}(r), F(X))$,

with $F$ the free monoid functor.

Interpretation: Entropy dissipation $\mathbb{S}$ is dual to information density $\mathcal{I}$.

Worked Example:

For $r$ with entropy $S_r = 0.1$, the monoid $\mathcal{I}(r)$ contains all cumulative information densities, e.g., $\rho = 0.05, 0.1$, closed under addition.

## 31. CoM: Category of Recursive Agency ($\mathcal{A}$)

Definition: 2-category with

Objects: agents $A$;

1-morphisms: perceptual transformations $P : A_1 \to A_2$;

2-morphisms: meta-revisions (self-reflection).

Adjunction: $A \dashv P$, projection to plenum states ensures reflective agency.

Worked Example:

Agent functor $A : \mathcal{R} \to \mathbf{State}$ maps plenum configuration $r$ to internal state $s$. A 2-morphism adjusts $s$ to optimize coherence under $S$-minimization.

## 32. TARTAN: Recursive Tiling with Annotated Noise ($\mathcal{T}$)

Functor: $\mathcal{T} : \mathcal{R} \to \mathcal{G}rid$.

Cochain Complex:

$\mathcal{R}_t = \sum w_k \nabla^k \Phi, d\Phi = \mathcal{N}, d^2 = 0$.

Interpretation: Maps continuous plenum to discrete computational lattice with annotated perturbations.

Worked Example:

Discretize $\Phi$ on a 4×4 grid, add Gaussian noise $\mathcal{N}$, compute boundary differences $d\Phi$ to track entropy propagation.

## 33. Yarncrawler: Monoidal Infrastructure Functor ($\mathcal{Y}$)

Definition: Bifunctor $\mathcal{Y} : \mathcal{R} \times \mathcal{A} \to \mathcal{S}truct$, traversing all layers to identify ruptures and propagate repairs.

Descent–Ascent Adjunction:

Descent = $\mathcal{Y} \circ (\cdot \times \backslash\mathrm{Id})$,

Ascent = $\mathcal{Y} \circ (\backslash\mathrm{Id} \times \cdot)$.

Monoidal Structure:

$y_1 \otimes y_2 = \mathcal{Y}(r_1 \otimes r_2, A_1 \otimes A_2), I_\mathcal{Y} = \mathcal{Y}(I, A_0)$.

Internal Homs: $[y_1, y_2] = \mathcal{Y}(r_1, \mathcal{A}^{A_2/A_1})$.

Worked Example:

Given two plenum regions $r_1, r_2$ with agent transformations $A_1, A_2$, Yarncrawler computes a repair object $y$ that restores local entropy gradients while preserving coherence.

### 34. Semantic Cohomology of the RSVP Stack

Complex: $0 \to \mathcal{R} \xrightarrow{d_0} \mathcal{C} \xrightarrow{d_1} \mathcal{I} \xrightarrow{d_2} \mathcal{A} \xrightarrow{d_3} \mathcal{T} \xrightarrow{d_4} \mathcal{Y} \to 0$.

Exactness: Vanishing cohomology $H^i = 0$ ensures global consistency.

Proof Sketch:

$d_0$ monic, $\mathcal{C}$ faithful;

$d_1$ split via $\mathbb{S} \dashv \mathcal{I}$;

Higher $d_i$ exactness via reflective subcategories and monads.

### 35. Quantum and Topos Applications

Dagger-compact categories: monoidal structures as quantum channels.

CP-maps: entropy-preserving morphisms.

Topos of sheaves over $\mathcal{R}$: internal logical semantics.

Yarncrawler ensures consistent global internal logic and coherence propagation.

# Part IX — Meta-Compression and the Ethics of Description

## 36. Philosophical Implications

#### 36.1 Ontology as Self-Referential Compression

The Relativistic Scalar–Vector Plenum (RSVP) recasts ontology not as a fixed inventory of entities but as a process of ongoing compression. Every field configuration—whether physical, cognitive, or semantic—is a lossy description of its own generative conditions. To exist is therefore to be representable within a finite description-length functional:

$$L_{\text{existence}} = L(\text{model}) + L(\text{data} \mid \text{model}).$$

In this interpretation, classical metaphysics corresponds to the frozen residue of prior compressions; physics, the evolving grammar by which such compressions are sustained; and epistemology, the reflective operation through which compression recognizes itself as compression. RSVP therefore unifies being, knowing, and describing under a single variational principle of entropic economy.

The plenum's scalar field $\Phi$ expresses existence as density, the vector field $\mathbf{v}$ as relational differentiation, and the entropy field $S$ as the inevitable cost of resolution. These three quantities instantiate what can be called the ontological trinity of compression: substrate, transformation, and loss. Every act of measurement, interpretation, or narration participates in this trinity by selectively emphasizing one component while suppressing the others.

### 36.2 Ethics of Simplification and Abstraction

Because description is inherently lossy, simplification is never neutral. Each reduction in complexity displaces the surplus entropy elsewhere—into environment, labor, or cognition. RSVP's categorical reconstruction makes this explicit: every adjunction $\mathbb{S} \dashv \mathcal{I}$, every monoidal collapse $y_1 \otimes y_2$, and every truncation in the cochain complex transfers unrepresented structure into the coboundary term $d^i$. The ethical dimension of abstraction lies in acknowledging and compensating for these hidden residues.

To "compress responsibly" is to preserve coherence across scales:

- Epistemic ethics: ensure that simplifications remain reconstructible within available entropy budgets.
- Computational ethics: design algorithms whose informational gradients can be re-expanded without catastrophic loss.
- Ecological ethics: recognize that every energetic optimization entails environmental negentropy expenditure.

Thus the moral analogue of the RSVP action is a free-energy inequality for attention and care:

$$\Delta\mathrm{Integrity} \geq -\Delta\mathrm{Compression}.$$

## 37. Closing Reflections

### 37.1 The Plenum Recursively Verifies Coherence

In the completed reconstruction, the universe is not a static manifold but a recursive verification process. Each layer—physical, informational, cognitive, computational—serves as both observer and substrate for the next. Through the chain

$$\mathcal{R} \xrightarrow{d_0} \mathcal{C} \xrightarrow{d_1} \mathcal{I} \xrightarrow{d_2} \mathcal{A} \xrightarrow{d_3} \mathcal{T} \xrightarrow{d_4} \mathcal{Y},$$

coherence is propagated, ruptures identified, and repairs enacted via Yarncrawler's descent-ascent adjunctions.

### 37.2 Summary of RSVP and Categorical Reconstruction

RSVP began as a field-theoretic model of entropic smoothing. Through categorical reconstruction it became a theory of meaning:

1. RSVP ($\mathcal{R}$) — the physical base of entropic continuity.
2. UFTC-SF ($\mathcal{C}$) — sheaf of coherence enforcing phase-locking.
3. SIT ($\mathcal{I}$) — information-density dual to entropy.
4. CoM ($\mathcal{A}$) — recursive agency and reflective cognition.
5. TARTAN ($\mathcal{T}$) — computational discretization with memory.
6. Yarncrawler ($\mathcal{Y}$) — monoidal infrastructure of repair.

Together they form an exact cohomological sequence whose vanishing higher groups express the universe's semantic closure. The plenum is thus a self-repairing manifold of descriptions—a cosmos that writes, tests, and rewrites its own coherence.

### 37.3 Coda

In ordinary language, RSVP asserts that reality is not expanding but refining: each apparent motion of galaxies, minds, or symbols is an iteration of compression seeking minimal description length. The task of theory is to honor this recursion without erasing its costs—to model the universe without diminishing it.

The categorical stack closes, but its interpretation remains open. Between entropy and coherence, loss and meaning, physics and ethics, the plenum continues to compress itself—inviting every act of understanding to become an act of repair.

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Information geometry and topological data analysis, which inform the geometric structure of the plenum's entropy manifold.
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## Appendices

## A. Notation Summary

Fields: $\Phi$ (scalar potential), $\mathbf{v}$ (vector coherence), $\mathcal{S}$ (entropy).

Couplings: $\beta$ (divergence regularization), $\eta$ (entropy penalty), $\gamma$ (gradient production), $\lambda_\Phi, \lambda_v$ (feedback strengths).

Degrees: BV shifts [1] for antifields; categorical objects graded by entropy $\mathbb{S}$.

## B. Equivalence Table

| RSVP Quantity | Analogue in Compression Theory | Function |
|---|---|---|
| $\Phi$ (Scalar Field) | Encoded signal / expectation | Low-frequency representation |
| $\mathbf{v}$ (Vector Field) | Predictive residual / decoder | Restores coherence |
| $\mathcal{S}$ (Entropy Field) | Error map / regularization term | Measures compression loss |
| $\mathcal{A}$ | Description-length cost | Free-energy functional |
| Equilibrium | Stationary codec | Minimum Description Length equilibrium |
| Lamphrodyne coupling | Reconstruction feedback | Prevents total smoothing (information loss) |
| Gravitational potential | Description-length gradient | Compression-induced curvature |

## C. Worked Examples

Functor Calculations: For $\mathbb{S} \dashv \mathcal{I}$, compute hom-set bijection for sample objects $r, X$.

TARTAN Tilings: Discretize sample $\Phi$ field on grid, apply $d$ to annotate noise boundaries.

Yarncrawler Repair: Simulate rupture in $\mathcal{A}$, apply descent-ascent to restore coherence.

## D. Bibliographic References

See main References section.

## E. Glossary

Lamphron: Negentropic feedback operator preserving structure.

Negentropic flow: Vectorial reintegration countering entropy diffusion

Negentropic flow: Vectorial reintegration countering entropy diffusion.

Recursive tiling: Hierarchical discretization in TARTAN.

Unistochastic: Emergent quantum formalism with probabilistic amplitudes from compression costs.

Yarncrawler: Monoidal functor for semantic infrastructure repair.

↳ Expand BV-AKSZ quantization details

↳ Active inference applications

↳ More rigorous proofs