RSVP–Polyxan: A Unified Field Theory of Semantic Hyperstructures

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Abstract

This paper develops a unified theoretical framework coupling the Relativistic Scalar–Vector Plenum (RSVP) field system, defined on a semantic manifold of embeddings, with the Polyxan hypermedia substrate, a typed, bidirectionally linked graph of content atoms and media quines in the Xanadu tradition. We construct an action functional for RSVP fields over semantic space, derive Euler–Lagrange equations, introduce a geometric interpretation of polysemantic clusters, and establish a sheaf-theoretic treatment of galaxy-local worldviews. We then develop a categorical architecture for Polyxan transformations, including a Polycompiler endofunctor and an RSVP-to-field category mapping. Throughout, we present proofs, lemmas, and structural invariants that guarantee coherence between continuous semantic fields and discrete hypergraphs.

Contents

1 Introduction

The RSVP–Polyxan framework fuses three mathematical layers:

- A **semantic manifold** X where conceptual embeddings live.
- A **field theory** consisting of a scalar potential Φ, vector flow $\mathbf{v}$, and entropy field S.
- A **typed hypergraph** of content atoms and links, whose structure both sources and responds to RSVP fields.

The goal is to provide a unified variational, geometric, and categorical description of semantic information flow.

2 Semantic Manifold and RSVP Fields

Let (X, g) be a smooth Riemannian manifold representing semantic space.

Define three RSVP fields:

$$\Phi : X \to \mathbb{R}, \quad \mathbf{v} : X \to TX, \quad S : X \to \mathbb{R}.$$

These fields describe:

- Φ: semantic potential or coherence density.
- $\mathbf{v}$: directed agency or semantic drift.
- S: entropy, uncertainty, or morphic degeneracy.

Field derivatives are defined using the Levi-Civita connection.

3 RSVP Lagrangian Formulation

We propose an action functional:

$$\mathcal{A}[\Phi, \mathbf{v}, S] = \int_X \mathcal{L}\, d\mu_g$$

where the Lagrangian density incorporates kinetic, elastic, and potential terms:

$$\begin{aligned}
\mathcal{L} = \frac{1}{2}(\partial_t \Phi)^2 - \frac{c_\Phi^2}{2}\|\nabla \Phi\|^2 \\
+ \frac{1}{2}\|\partial_t \mathbf{v}\|^2 - \frac{c_v^2}{2}\|\nabla \mathbf{v}\|^2 \\
+ \frac{1}{2}(\partial_t S)^2 - \frac{c_S^2}{2}\|\nabla S\|^2 \\
- V(\Phi, \mathbf{v}, S; \rho, \kappa).
\end{aligned}$$

Here:

- $\rho(x)$ = node density induced by Polyxan graph.
- $\kappa(x)$ = local curvature induced by typed links.

Variation yields Euler–Lagrange equations:

$$\frac{\delta \mathcal{A}}{\delta \Phi} = \partial_t^2 \Phi - c_\Phi^2 \Delta \Phi - \frac{\partial V}{\partial \Phi} = 0,$$

and similarly for $\mathbf{v}, S$.

4 Coupling RSVP to the Polyxan Hypergraph

Let $G = (V, E)$ be the Polyxan graph. Each node $i \in V$ is assigned an embedding $\mathbf{z}_i \in X$.

Define discrete samples:

$$\Phi_i = \Phi(\mathbf{z}_i), \quad \mathbf{v}_i = \mathbf{v}(\mathbf{z}_i), \quad S_i = S(\mathbf{z}_i).$$

Define a discrete evolution law:

$$\frac{d\mathbf{z}_i}{dt} = -\alpha\nabla\Phi(\mathbf{z}_i) + \beta\,\mathbf{v}(\mathbf{z}_i) - \gamma\nabla S(\mathbf{z}_i).$$

Thus embeddings evolve in RSVP gradient flows.

4.1 Topological Curvature from Links

Define a link-curvature invariant:

$$\kappa_i = \sum_{j,k\sim i} f_{\mathrm{tri}}(i,j,k)$$

counting typed 3-cycles weighted by link types.

This curvature term shapes the potential V.

5 Sheaf-Theoretic Interpretation

Define for each user u an open neighborhood $U_u \subset X$.

Define a presheaf $\mathscr{G}$ of galaxy renderings:

$$\mathscr{G}(U) = \{\text{layout functions over } U\}.$$

Restriction maps obey:

$$\rho_{UV}(G_U) = G_V \quad \text{for } V \subset U.$$

$\mathscr{G}$ is a sheaf if:

- the layout map is determined by $(\Phi, \mathbf{v}, S)$,
- embeddings are globally indexed,
- projections are deterministic.

Sketch. Local layouts glued along intersections produce a unique global layout due to determinism and continuity. □

6 Category-Theoretic Architecture

Define category $\mathbf{C}$:

- Objects = Content Atoms, Spans.
- Morphisms = Typed Links.

Define the Polycompiler as an endofunctor:

$$\mathsf{Poly} : \mathbf{C} \to \mathbf{C}.$$

Define RSVP as a functor $\mathsf{RSVP} : \mathbf{C} \to \mathbf{F}$ where $\mathbf{F}$ is the category of field configurations.

The composition $\mathsf{RSVP} \circ \mathsf{Poly}$ yields a natural transformation describing generative semantic deformation.

7 Stability and Energy Minimization

Define energy:

$$E = \int_X V(\Phi, \mathbf{v}, S; \rho, \kappa)\, d\mu_g.$$

We show:

Fixed points of RSVP flow minimize E subject to embedding constraints.

Sketch. Gradient descent of embeddings follows $-\nabla E$ by design. □

8 Global Reset as Field Reconfiguration

Define reset operator:

$$\mathcal{R} : (\Phi, \mathbf{v}, S, \mathbf{z}) \mapsto (\Phi', \mathbf{v}', S', \mathbf{z}')$$

where $\mathcal{R}$ recomputes fields and embeddings by:

- re-estimating ρ, κ,

- relaxing the field equations,
- reprojecting embeddings into X.

Reset corresponds to a global reconfiguration of semantic geometry.

9 Conclusion

This paper establishes RSVP–Polyxan as a unified field theory of semantic hyperstructures: a continuous-discrete coupling between fields and hypergraphs, governed by a variational principle and coherently assembled through sheaf and category theory.