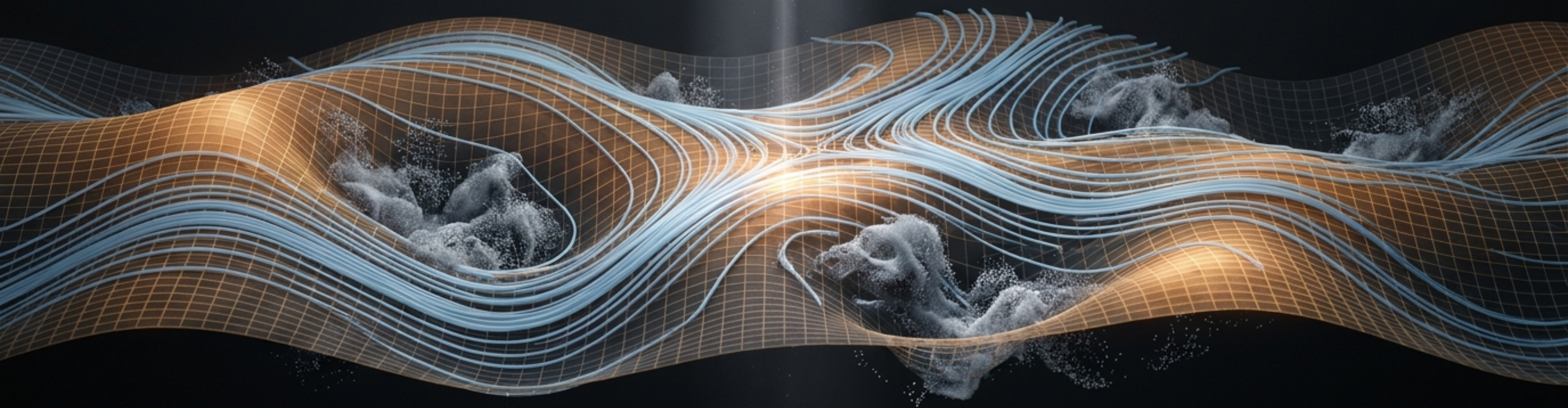


Axioms for a Falling Universe

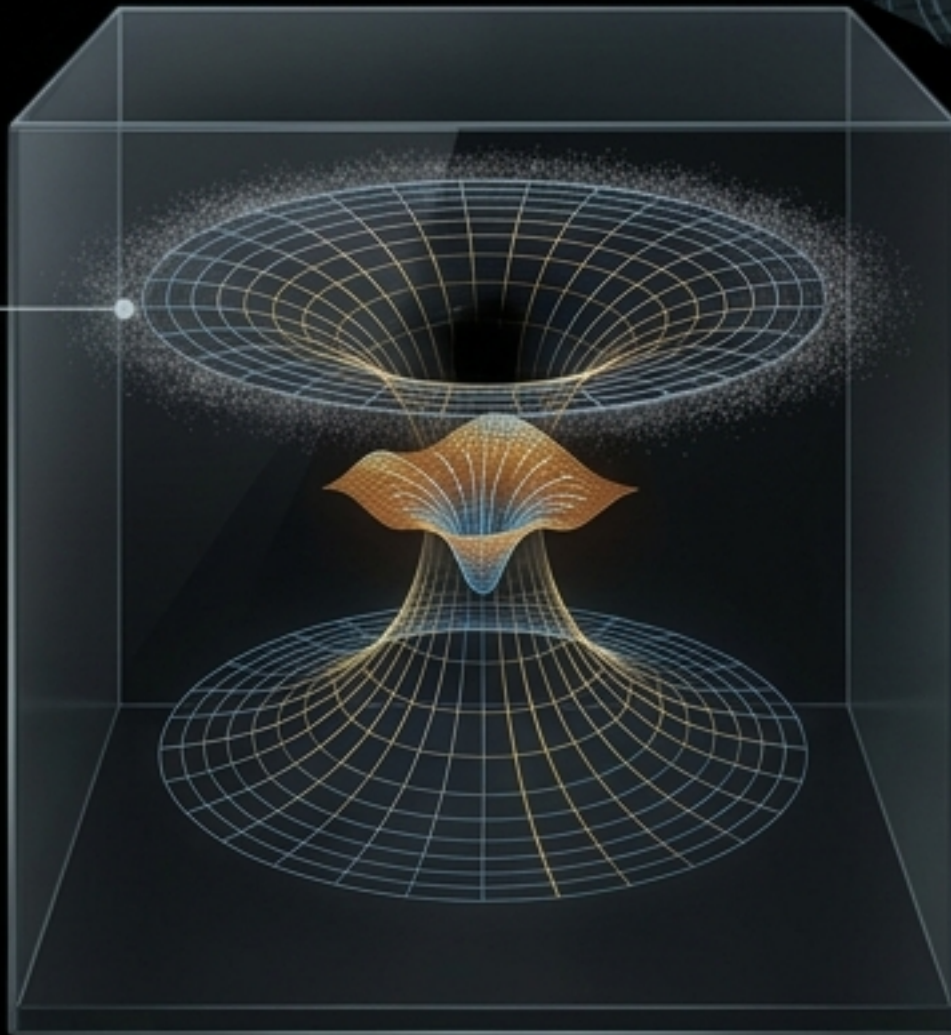
A Unified Field Theory of the Relativistic Scalar-Vector Plenum



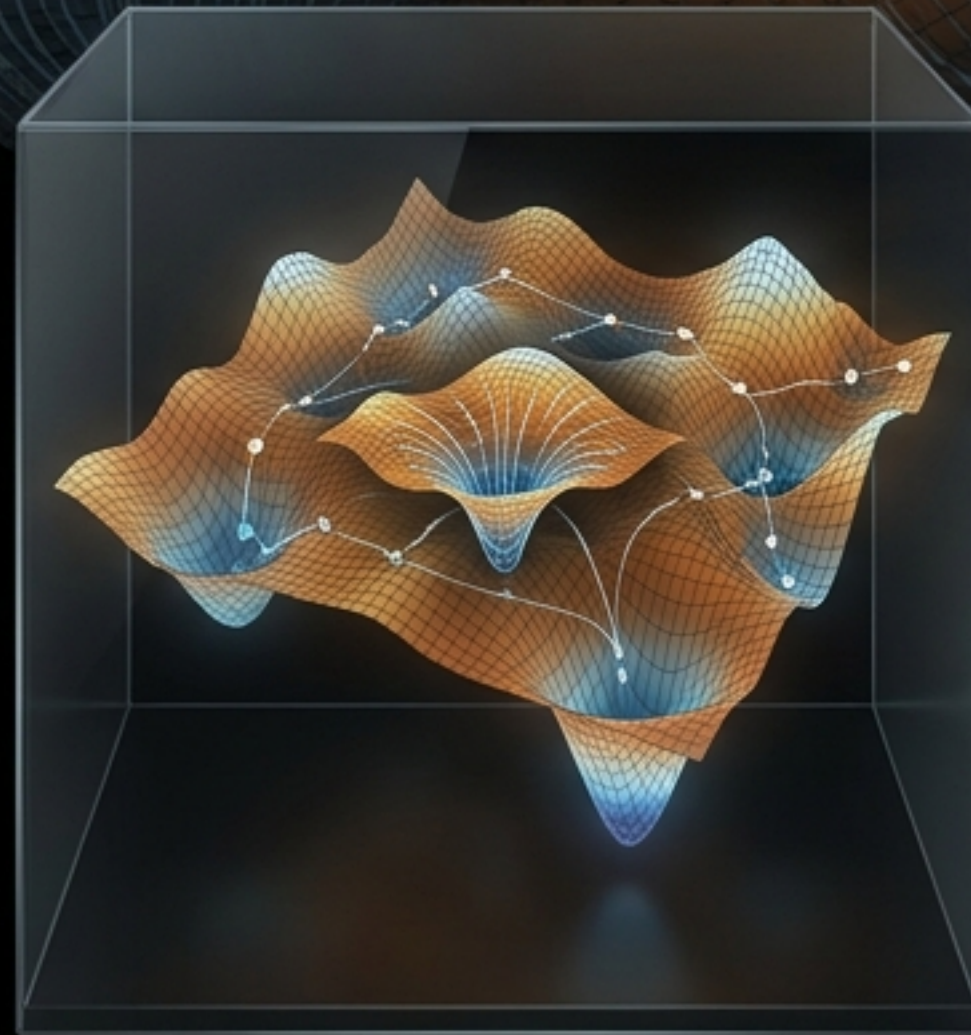
The Problem of Fragmented Ontologies

Unification by mathematical substrate, not analogy.
The Relativistic Scalar-Vector Plenum (RSVP) is a candidate physical theory whose coarse-graining functors produce the formal objects each sub-theory already uses as primitives.

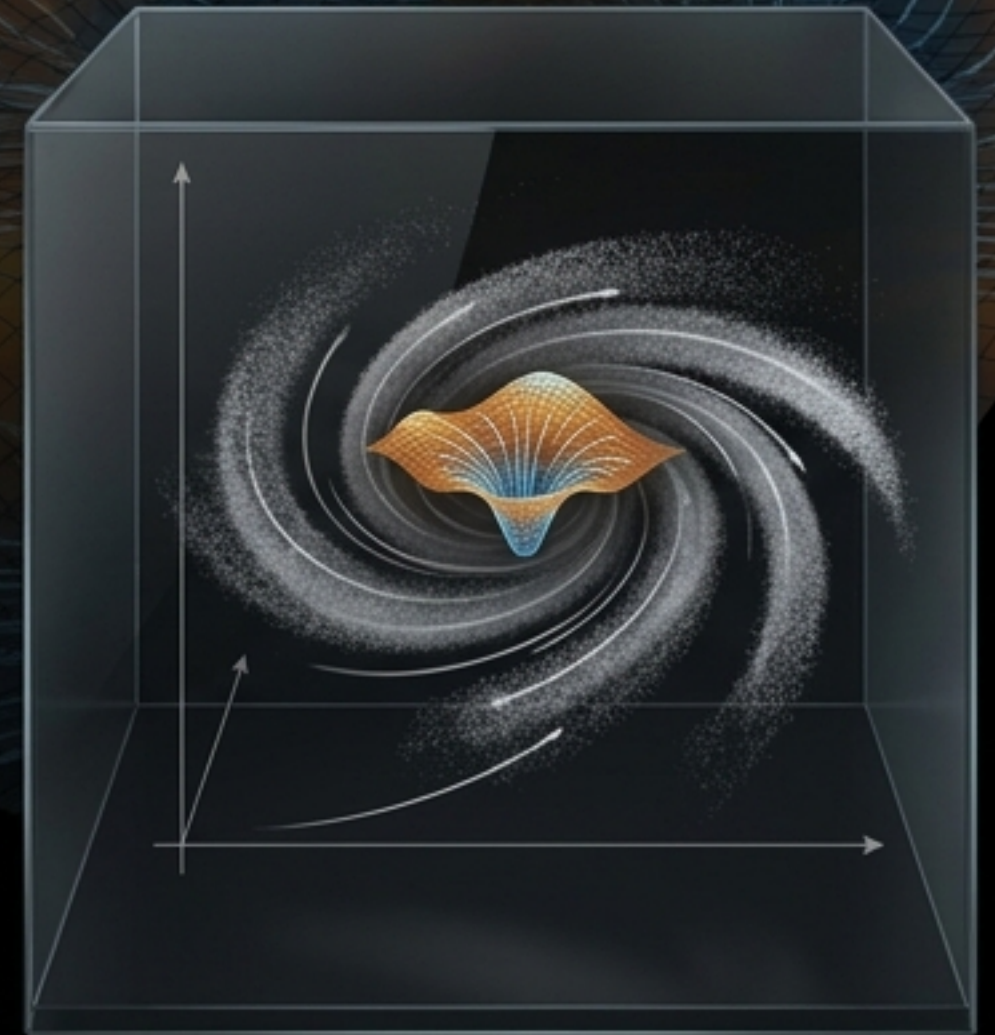
Riemannian Geometry
Cosmology



Neural Computation
Cognition



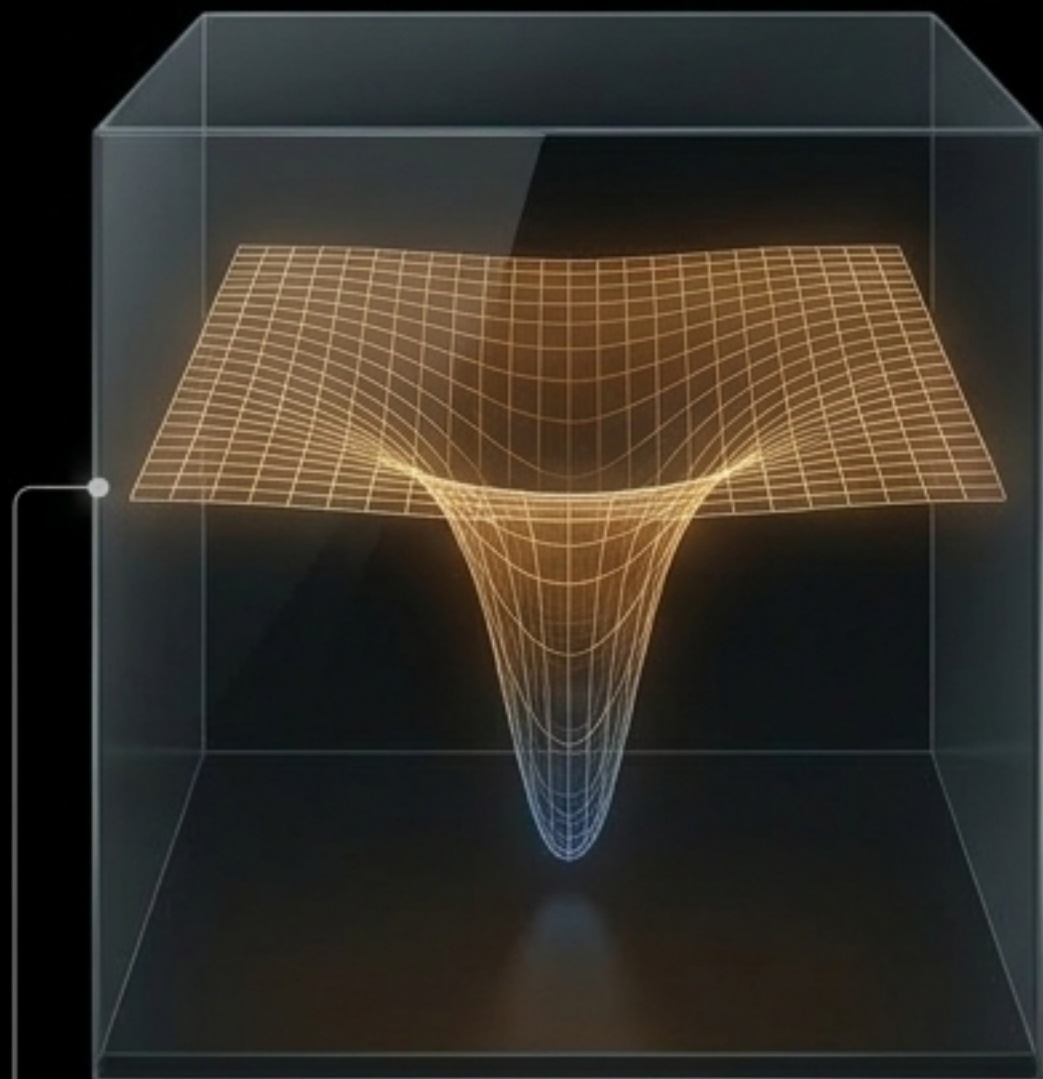
Game Theory
Society



Contemporary theoretical physics, cognitive science, and social theory share a structural disability. Cosmological expansion, cognitive inference, and institutional drift exhibit identical mathematical motifs—gradient relaxation and attractor formation. Yet, we quarantine these recurrences as mere analogies, trapped within disparate disciplinary vocabularies.

The RSVP Field Triplet

Overview: A continuous medium defined on a preferred 3+1 foliation, scaling by infrared cutoff ℓ^{-1} .

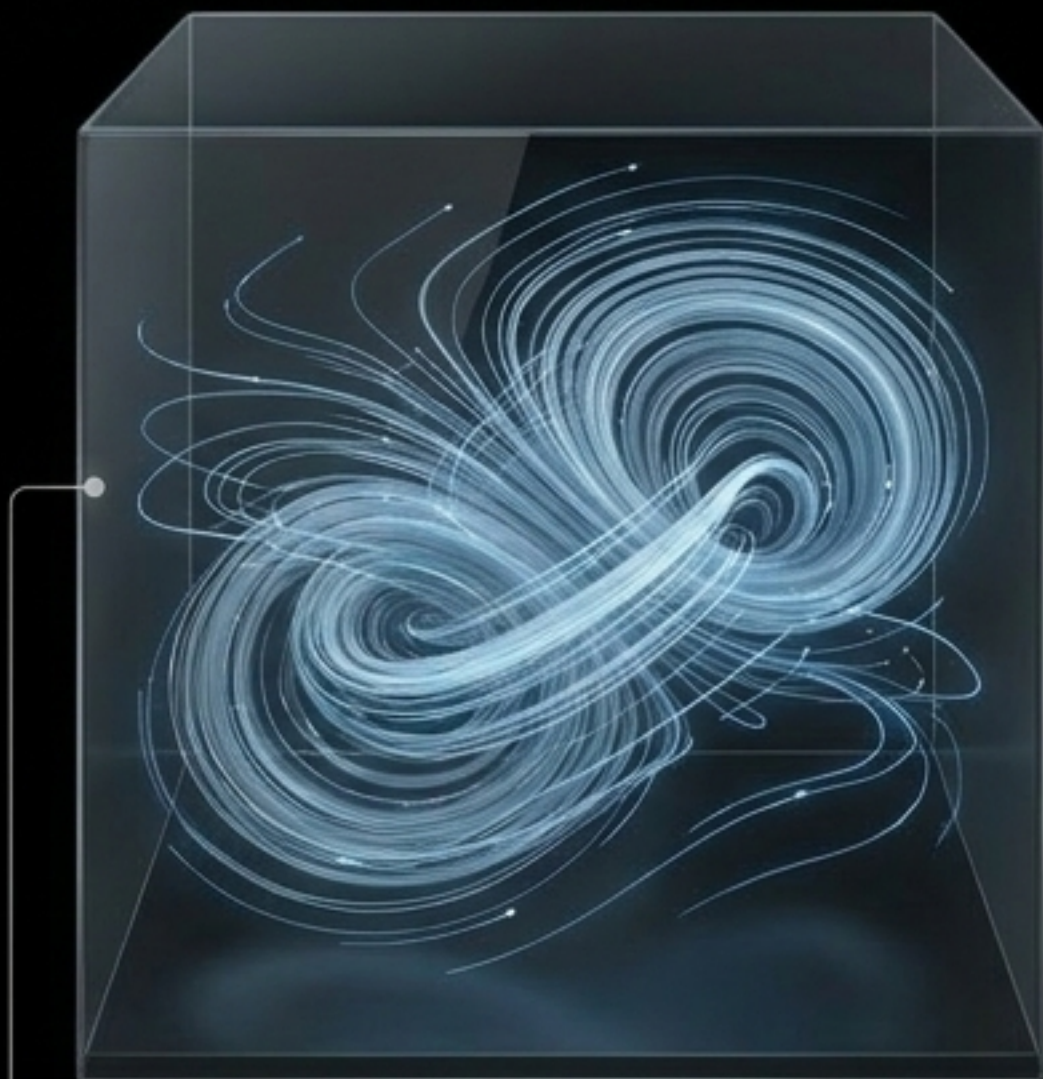


• Φ (Scalar Potential)

$$\Phi \in H^1(\Omega)$$

Represents mass or meaning density.

$$\text{Scaling: } [\Phi] = \Delta_\Phi$$

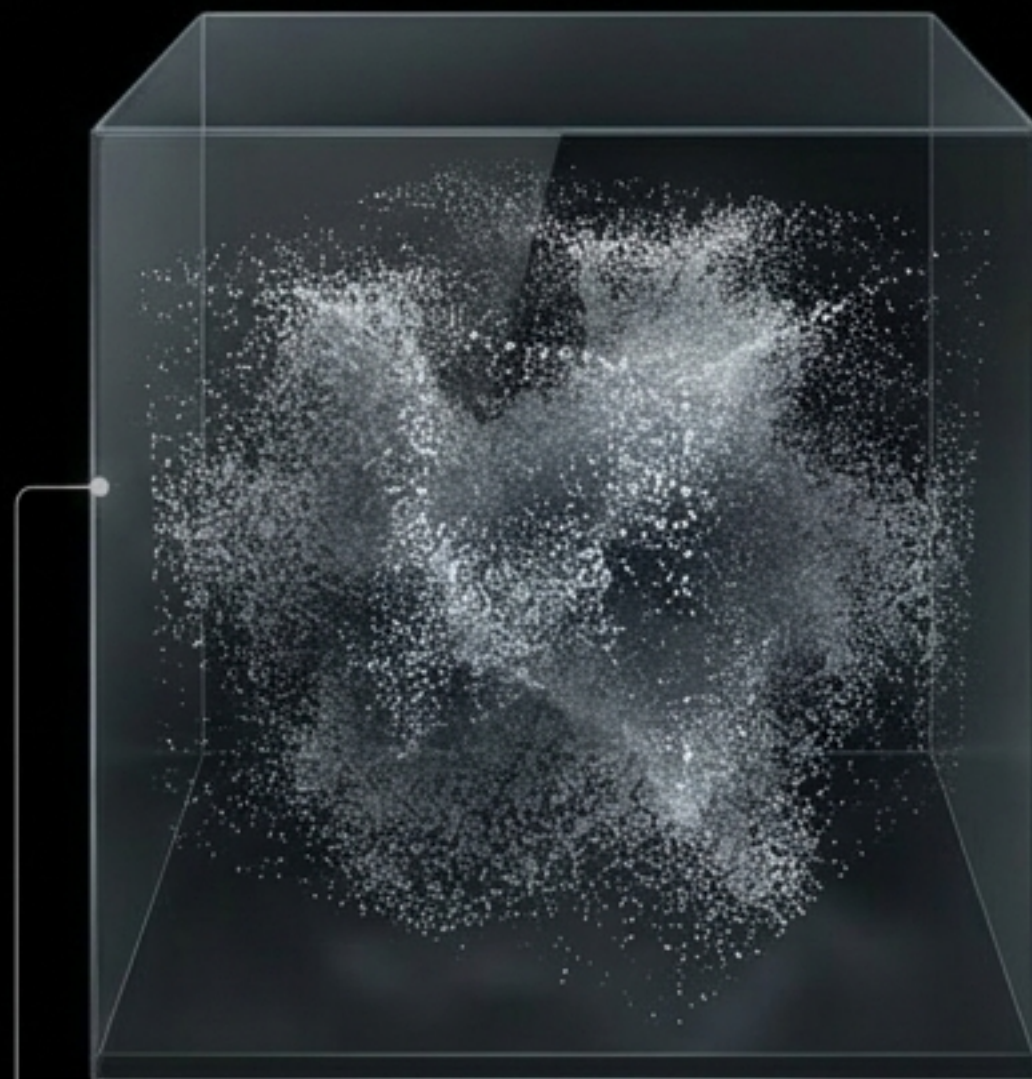


• \mathbf{v} (Vector Flow)

$$\mathbf{v} \in [H^1(\Omega)]^3$$

Represents lamphrodine flow velocity
or directed inference.

$$\text{Scaling: } [\mathbf{v}_i] = \Delta_\nu$$



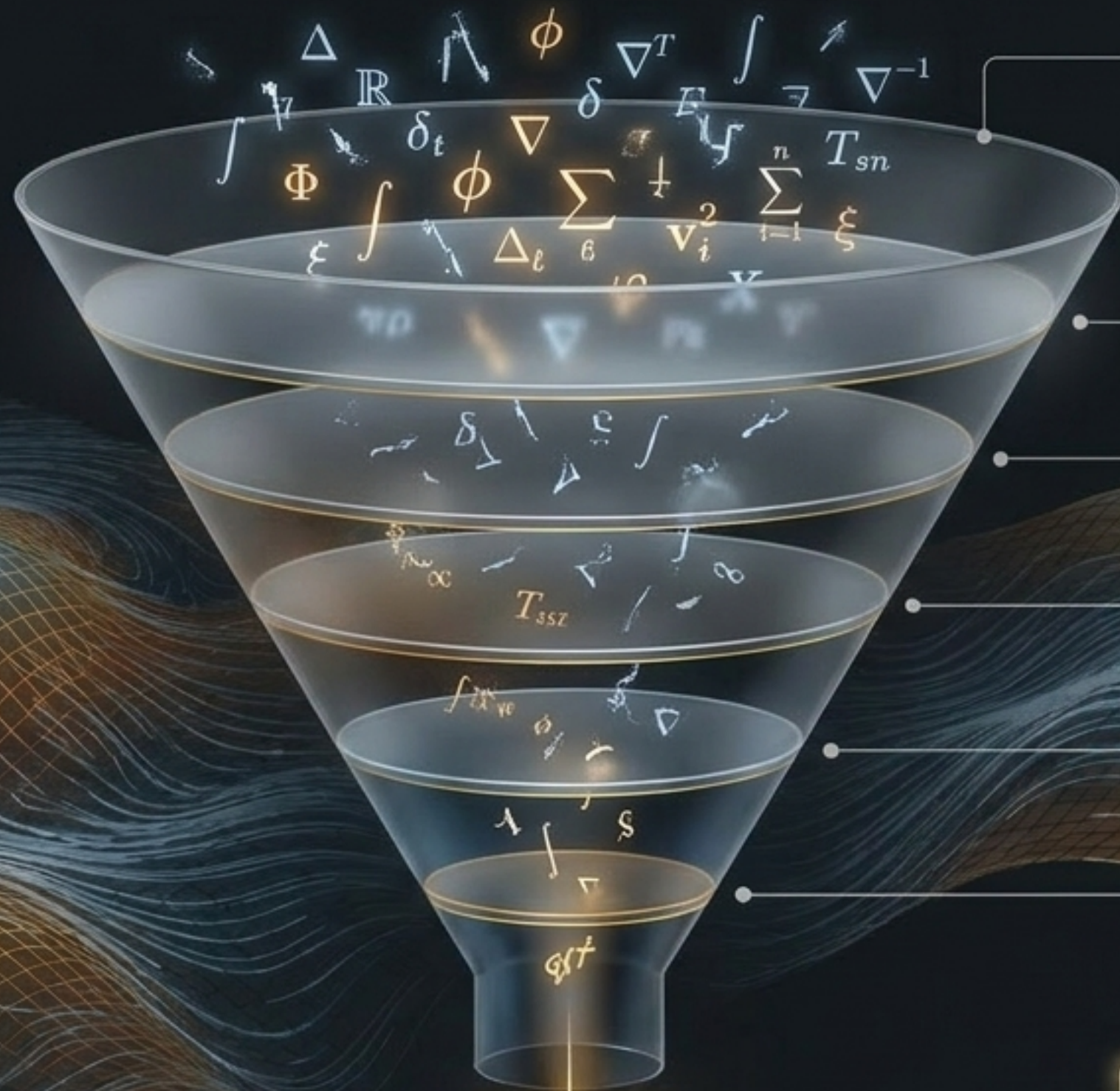
• S (Entropy)

$$S \in L^2(\Omega) \cap L^\infty(\Omega), S \geq 0$$

Represents configurational entropy
density or representational budget.

$$\text{Scaling: } [S] = \Delta_S$$

Deriving the Universe: The Axiomatic Filter



All Possible Local Field Theories

1. Locality & SO(3) Invariance: Forbids preferred-direction terms; enforces $|\mathbf{v}|^2$ and $\nabla\Phi \cdot \mathbf{v}$.

2. Ghost-Freedom: Mandates canonically normalized quadratic kinetic terms.

3. 2-Derivative Truncation: Suppresses higher-derivative corrections at long wavelengths.

4. Energy Bounded Below: Ensures Lyapunov stability, excludes runaway solutions.

5. Divergence Constraint: A kinematic penalty linking longitudinal flow to scalar/entropy sources.

The Output: Theorem 2.9 (Uniqueness)

Up to boundary terms, the interaction structure is essentially unique at two-derivative order, producing the unique RSVP Lagrangian $\mathcal{L}_{\text{RSVP}}$.

$$\Sigma = \phi_i \mathbf{v}_i^2$$

The Central Mechanism: Entropic Descent

The Kinematic Constraint (Axiom 2.7)

$$\nabla \cdot \mathbf{v} \approx \alpha_{\Phi} \Phi + \alpha_S S$$

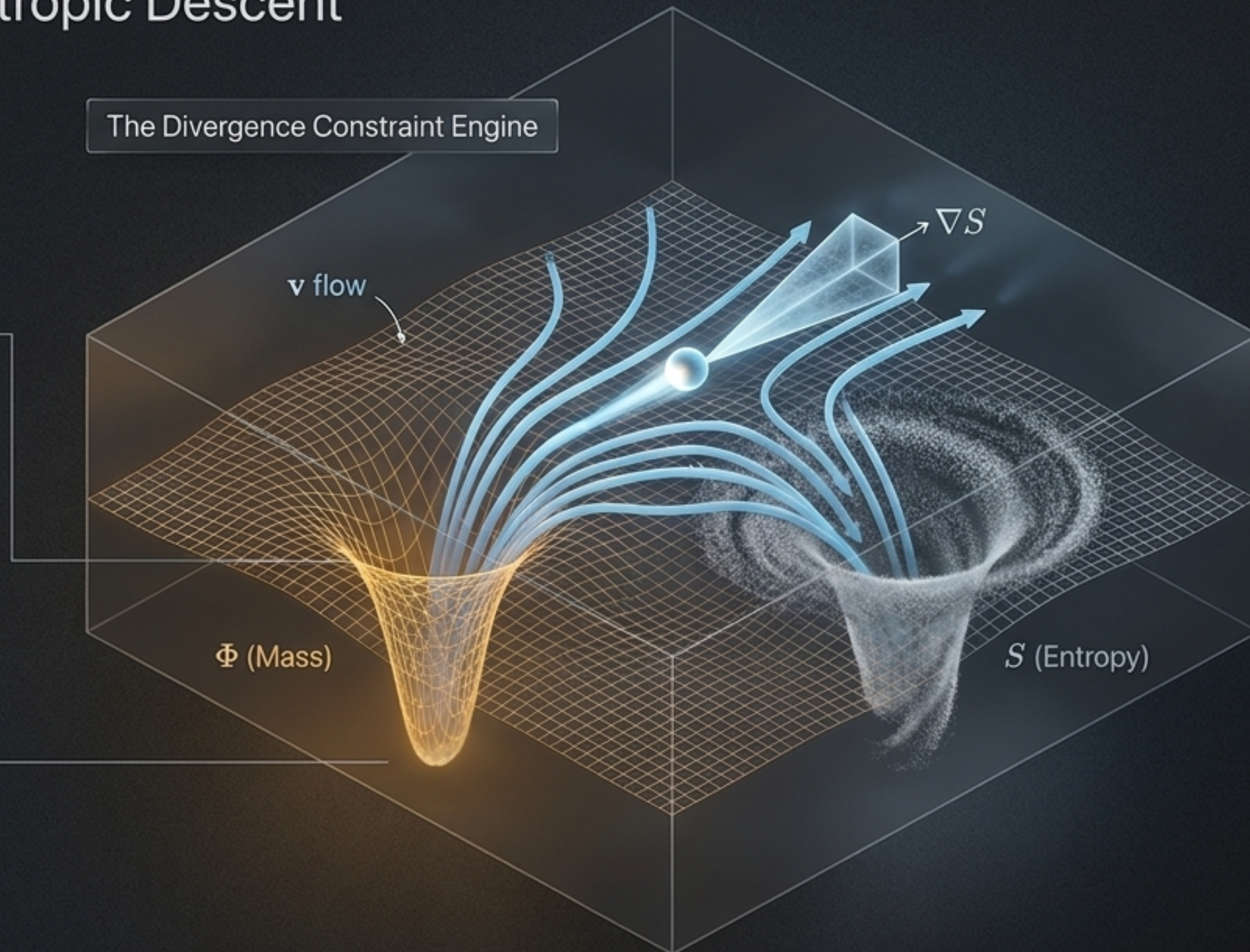
The medium acts like a compressible fluid where scalar density and entropy act as physical sinks, forcing vector flow to converge. In the stiff limit ($\kappa_v \rightarrow \infty$), this perfectly eliminates longitudinal modes, projecting onto transverse vortical flow.

The Constitutive Phenomenological Closure (Axiom 2.8)

$$\mathbf{F} \propto \nabla S$$

Gravity is not a primary force. Gravitational attraction is constitutively identified with the entropic descent of flow trajectories. The force on a test particle is proportional to the entropy gradient along the flow.

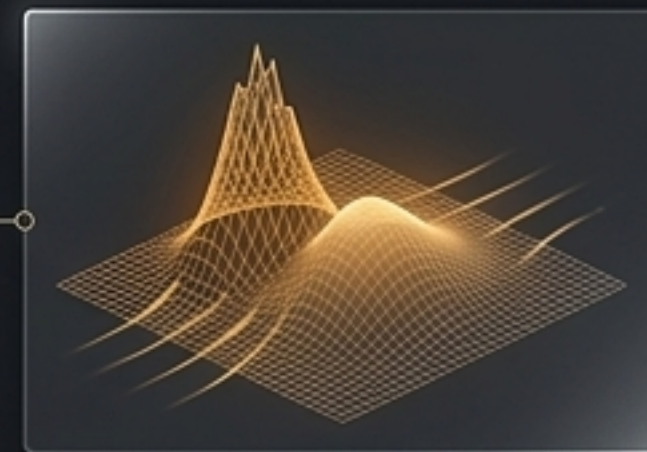
The Divergence Constraint Engine



Anatomy of the Master System (Overdamped Limit)



[Advection]



[Diffusive Smoothing]

$$\partial_t \Phi = -\nabla \cdot (\Phi \mathbf{v}) + \kappa_\Phi \Delta \Phi + \sigma S - U'_\Phi(\Phi)$$

$$\partial_t \mathbf{v} = -(\mathbf{v} \cdot \nabla) \mathbf{v} - \lambda \nabla \Phi - \nu \mathbf{v} + \kappa_v (\nabla \times \mathbf{v}) + \eta$$

$$\partial_t S = D_S \Delta S - \mu \Phi + \chi |\mathbf{v}|^2 + \xi(t)$$



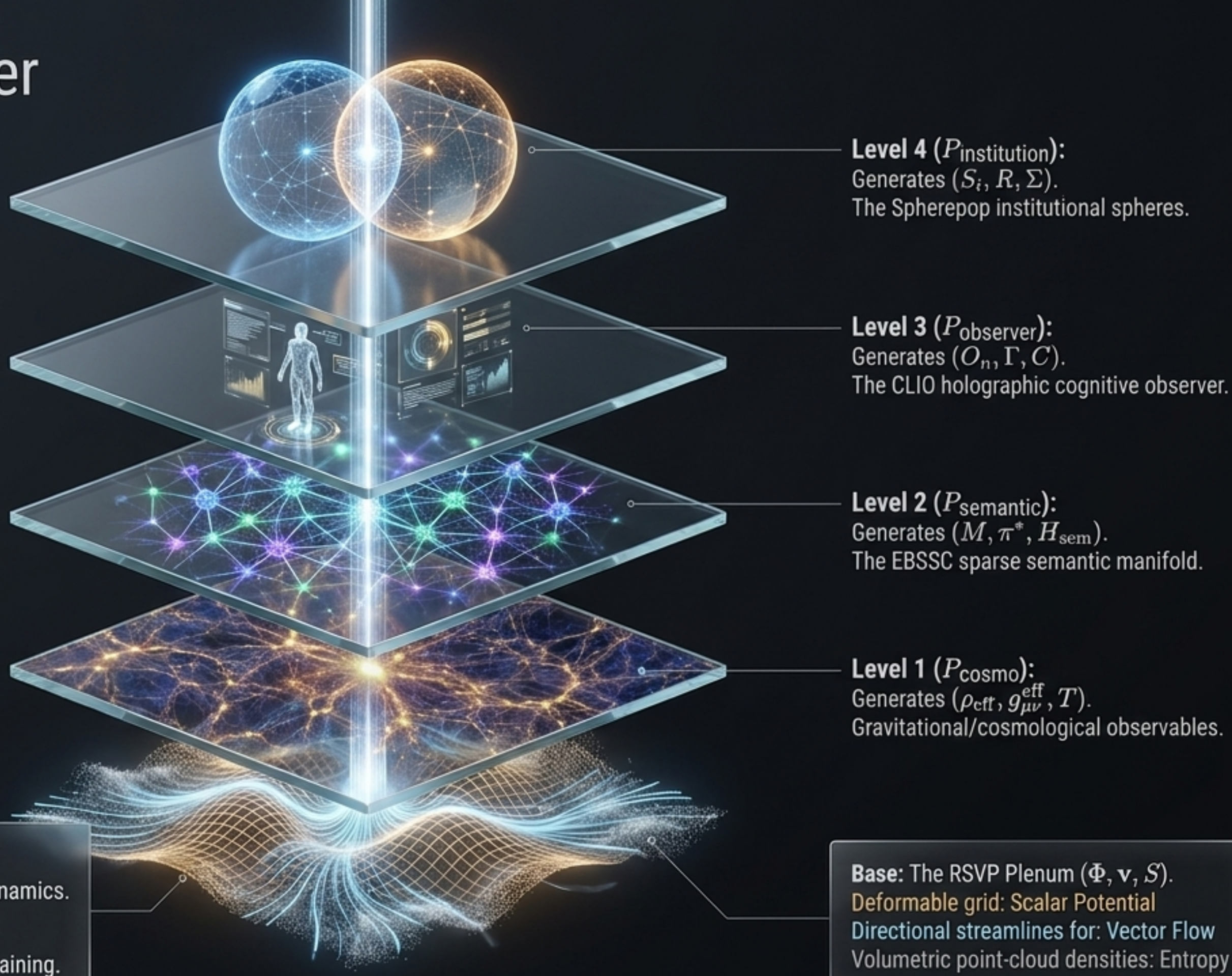
[Euler Convection]



[Vorticity]

Sidebar (Theorem 3.4 & 3.8): Proven locally well-posed with global weak solutions via Aubin-Lions compactness. Features exponential gradient decay in the lamphrodyne regime.

The Projection Ladder



Core Invariant (Theorem 4.2):

Each projection operator commutes with the RSVP dynamics.
Entropy monotonicity $H(P(S)) \leq H(S) + C_P$
and sparsity structures are preserved under coarse-graining.

The Ontological Translation Matrix

Field	Cosmology ($\mathcal{P}_{\text{cosmo}}$)	Mind/Semantics ($\mathcal{P}_{\text{semantic}}$)	Society ($\mathcal{P}_{\text{institution}}$)
Φ (Scalar Potential)	Mass / Physical Potential	Meaning Density / Compressed Representation	Institutional Core / Mass
v (Lamphrodyne Flow)	Bulk Spacetime Flow	Directed Inference / Agency	Institutional Drive / Trajectory
S (Entropy Density)	Thermodynamic Disorder	Representational Budget / Uncertainty	Institutional Friction / Disorder

The Lineage of Giants

Jacobson (1995)	Einstein equations derived via RSVP stiff limit + local Rindler horizons.
Verlinde (2011)	Entropic Gravity ($F = T\nabla S$) derived as RSVP quasi-static limit.
Friston (2021)	Free Energy Principle derived as RSVP dual on a finite manifold.

Domain 1: Emergent Gravity

Jacobson's Derivation Reborn: In the stiff limit ($\kappa_v \rightarrow \infty$), the RSVP divergence constraint forces expansion

$$\theta = \alpha_\Phi \Phi + \alpha_S S.$$

Raychaudhuri Engine: By identifying the Clausius heat $\delta Q = T \delta S_{\text{horizon}}$ with the energy flux crossing a local Rindler horizon, the RSVP flow congruence directly yields the Einstein equation:

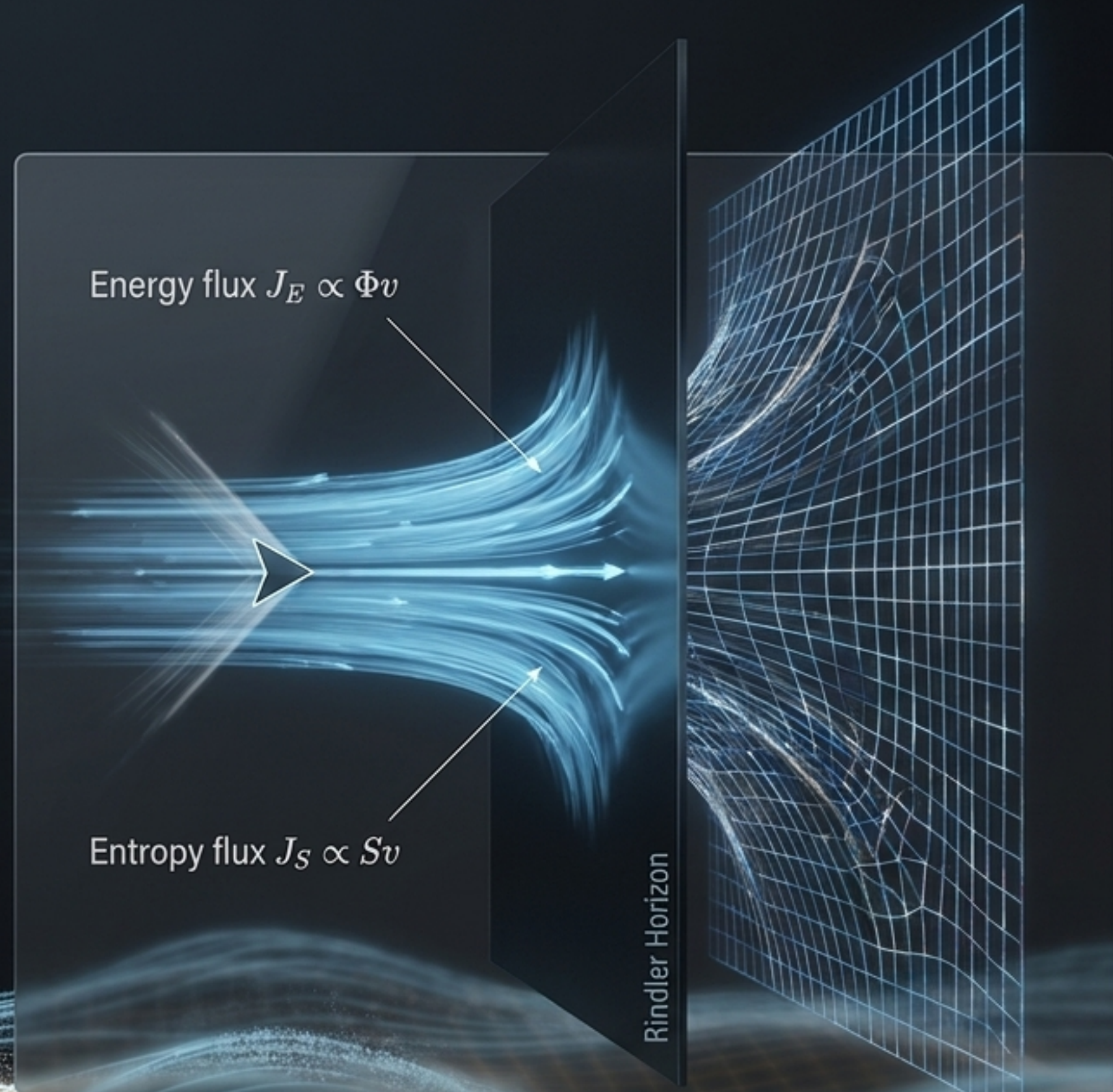
$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G T_{\mu\nu}.$$

Acoustic Metric: The effective spacetime metric is not assumed, but arises hydrodynamically:

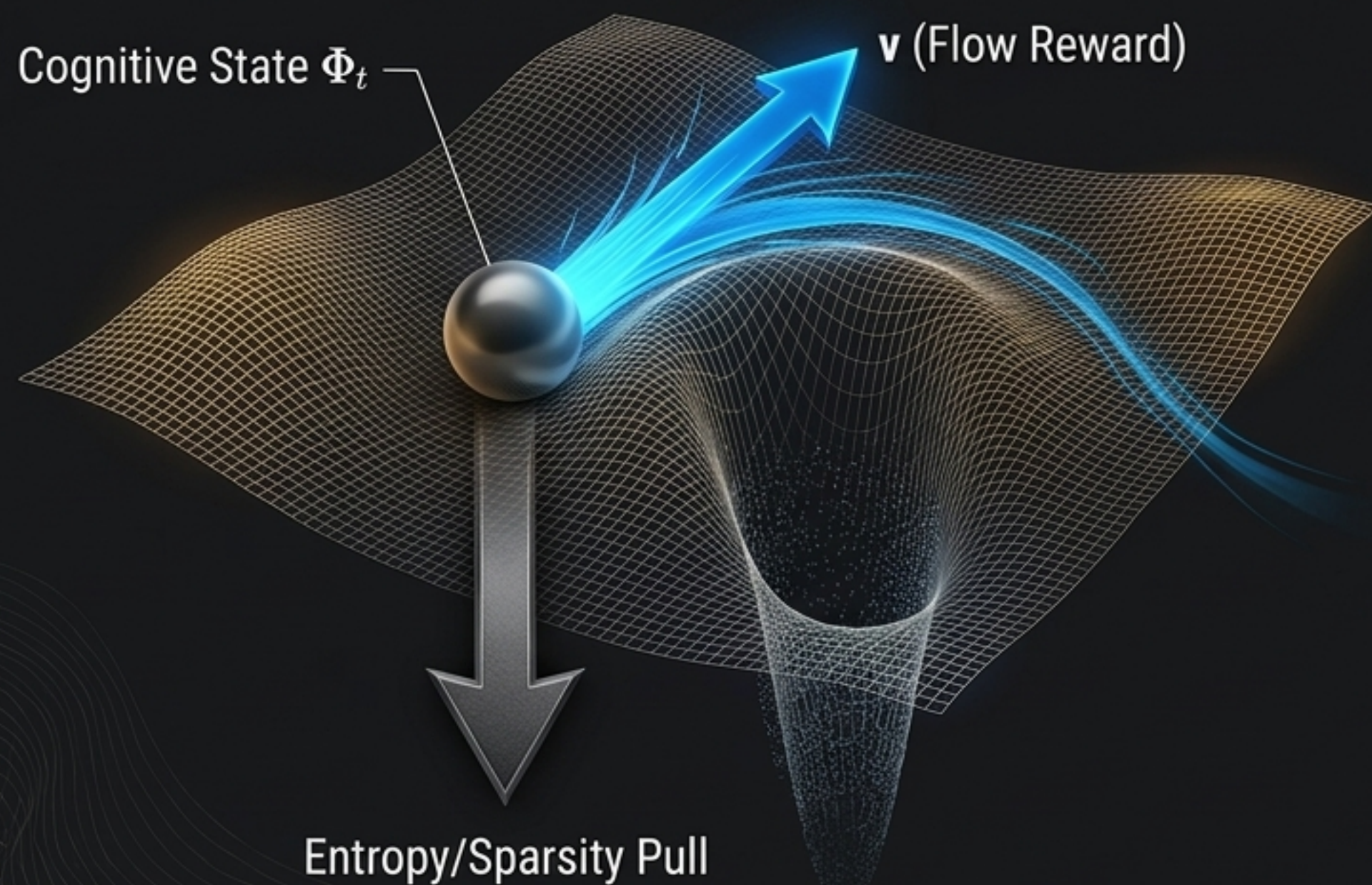
$$g_{\mu\nu}^{\text{eff}} = \text{diag} \left(\frac{-c_s^2 + |v|^2}{c_s}, 1, 1, 1 \right).$$

Verlinde's Limit: In the quasi-static limit ($\partial_t v \approx 0$), the equation of motion reduces exactly to Verlinde's entropic force law:

$$m\vec{a} \approx g_1 \Phi \nabla S + g_2 S \nabla \Phi.$$



Domain 2: Cognitive Descent & The Friston Duality



CLIO Projection

The cognitive projection yields the Constrained Learning and Inference Optimiser (CLIO) gradient flow:

$$\Phi_{t+1} = \Phi_t - \eta_t \nabla_{\Phi} L(\Phi_t, \mathbf{v}_t, S_t)$$

Loss Functional: $\mathcal{L} = \mathbb{E}[S] + \lambda_{\text{sparse}} \|\Phi\|_0 - \lambda_{\text{flow}} \|\mathbf{v}\|^2$

The Duality (Theorem 5.4)

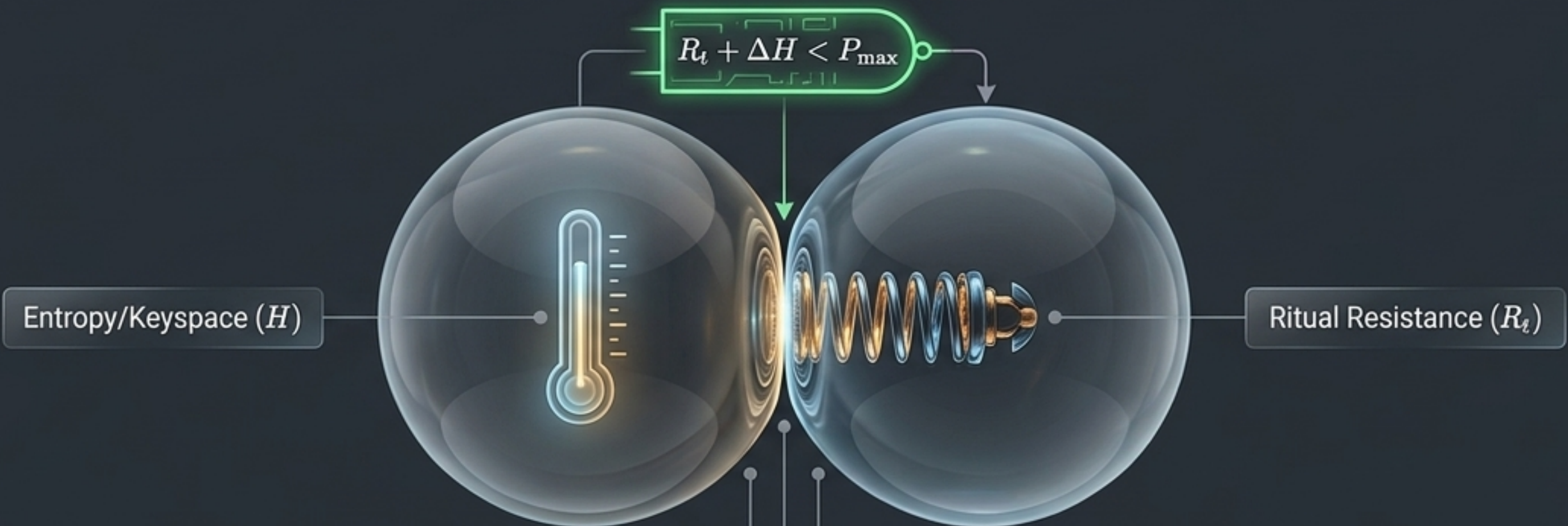
This functional is perfectly dual to Friston's variational free energy ($\mathcal{F} = \mathbb{E}[S] + D_{\text{KL}}(q||p)$).

Preventing Agency Collapse (Theorem 4.14)

In RSVP, flow (\mathbf{v}) is not passive. Setting $\lambda_{\text{flow}} = 0$ decouples agency, causing the system to collapse to an entropic equilibrium with no directed action. The active flow reward prevents "brain deadness."

Domain 3: Institutional Dynamics (Spherepop)

Spherepop Mechanics



Thermodynamic Spheres

The social projection maps the Plenum into bounded institutional spheres defined by interior configuration (I), boundary operator (B), and permeability ($\Sigma \in [0,1]$).

The Merge Threshold (Theorem 4.7)

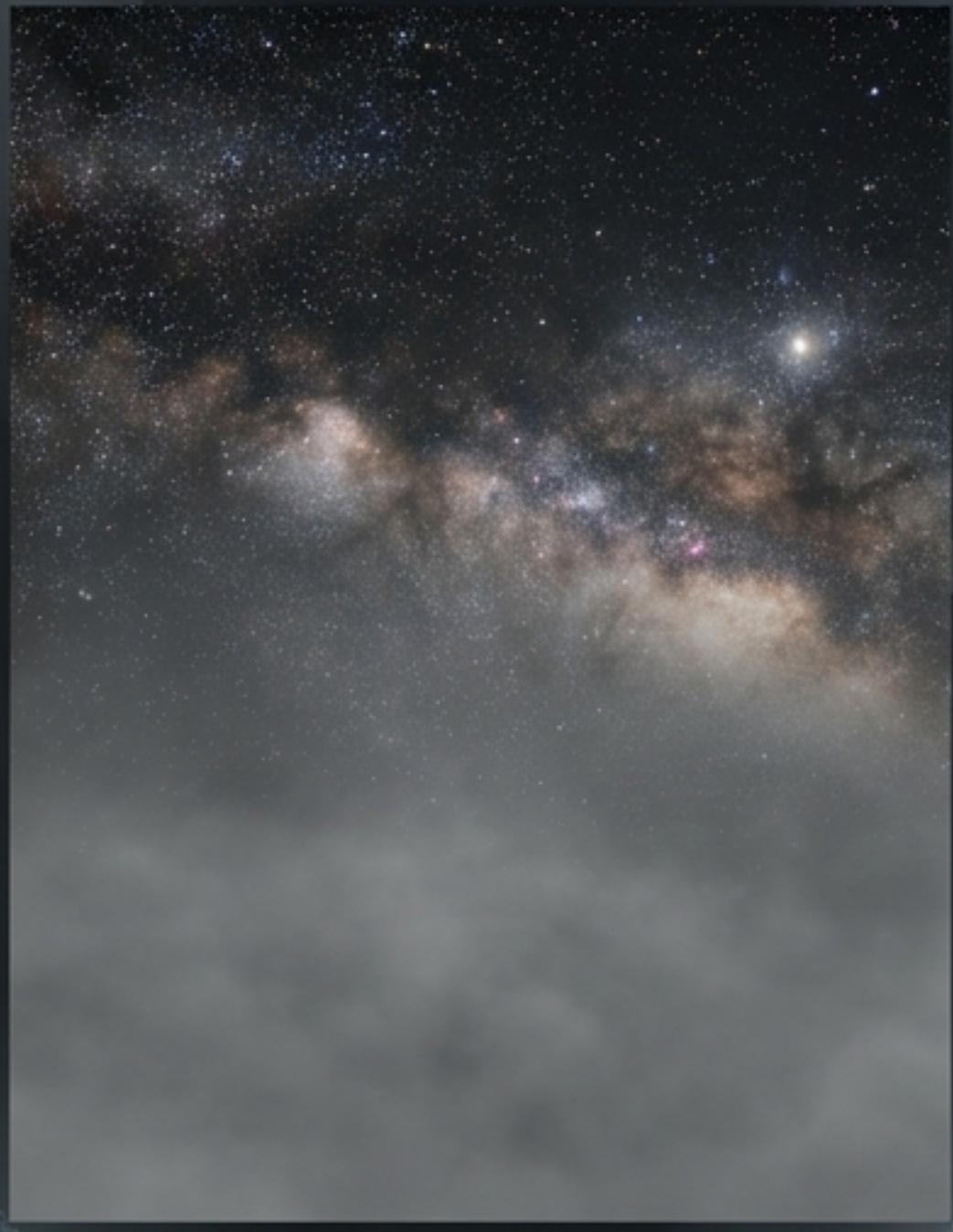
Two institutions merge ($S_i \oplus S_j \rightarrow S'_k$) only if permeability allows ($\Sigma_i + \Sigma_j > \Theta_{\text{closure}}$) AND thermodynamic pressure overcomes ritual resistance: $R_t + 2H < P_{\max}$.

Ritual as Resistance

Accumulated ritual cost $R_t = \int \gamma(t) dt$ hardens the boundary. Incremental hardening grows logarithmically against entropy: $\dot{R} \geq \gamma_{\min}, \gamma_{\min} + \log_2(1 + \delta H(t))$.

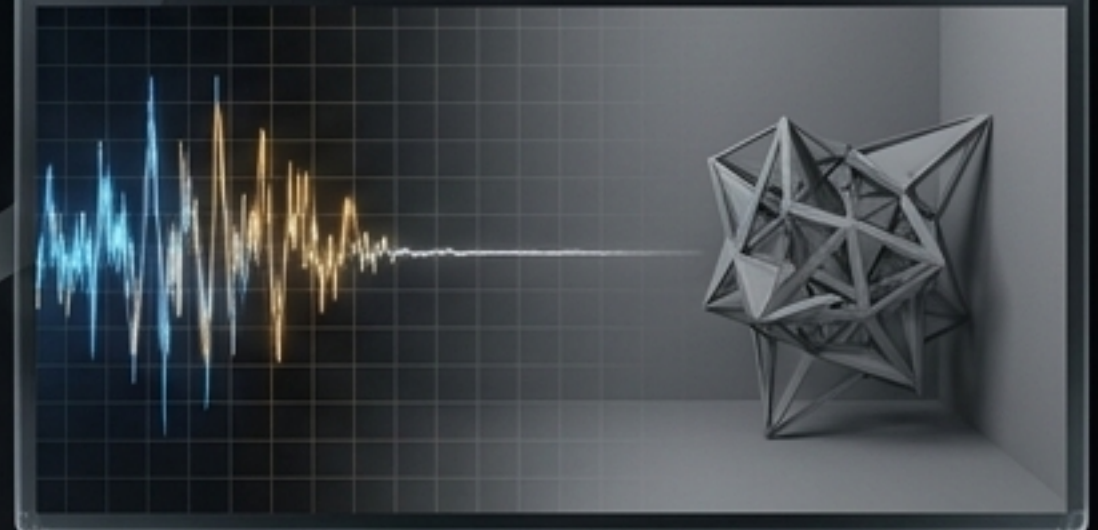
Synthesis: The Unified Failure Modes

Cosmology: Cosmic Heat Death.



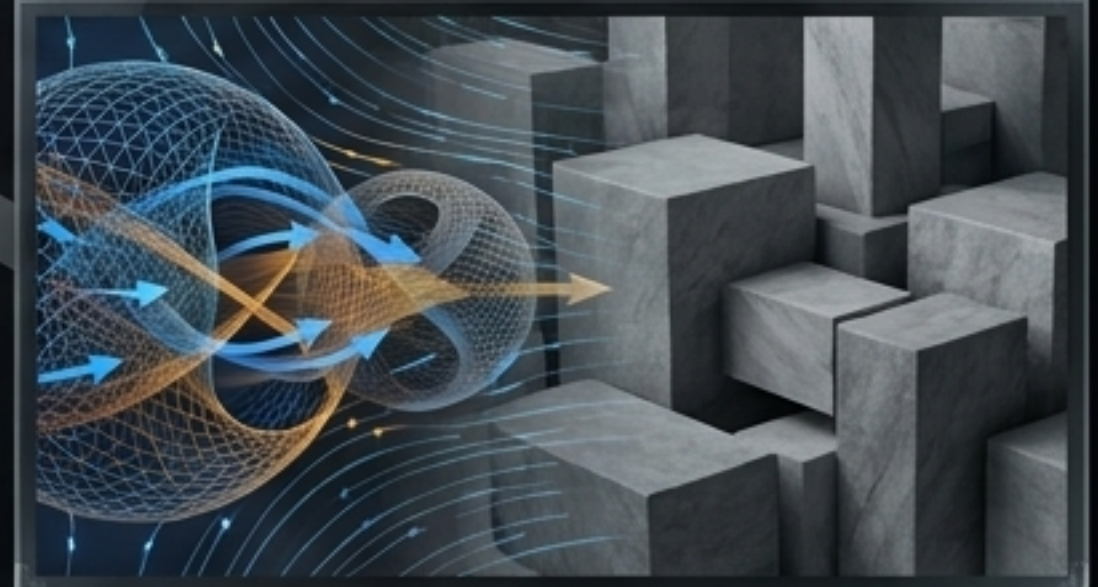
Entropy saturation ($S \rightarrow B_s$).
A faint desaturated volumetric point-cloud density effect permeates the fading cosmos.

Cognition: Agency Collapse.



Vanishing scalar gradients ($\nabla\Phi \rightarrow 0$) yields CLIO dead-ends.

Society: Institutional Rigidity.



Vorticity decay ($\nabla \times \mathbf{v} \rightarrow 0$) halts Sphero-pop circulation, resulting in rigid, unmergable institutions.

$$\|\nabla\Phi\| + \|\nabla\mathbf{v}\| \rightarrow 0$$

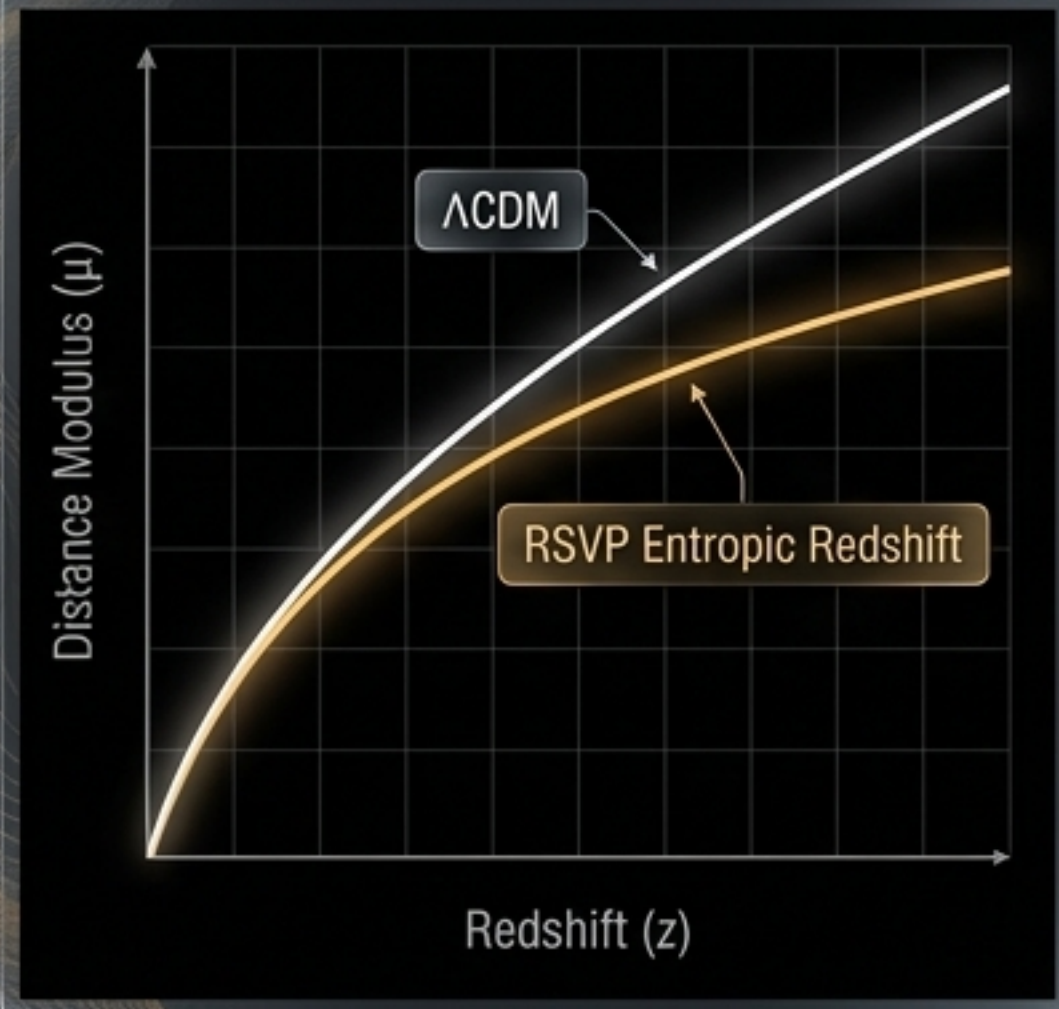
(Gradient Flattening /
Theorem 6.5)

Theorem 6.5: The Universal Death State.

In the lamphrodyne regime, if negentropy injection $\sigma \rightarrow 0$, both scalar and vector gradients decay exponentially to zero. The exact same mathematical flattening generates characteristic failure modes across all projections.

Falsifiable Predictions & Observational Tests

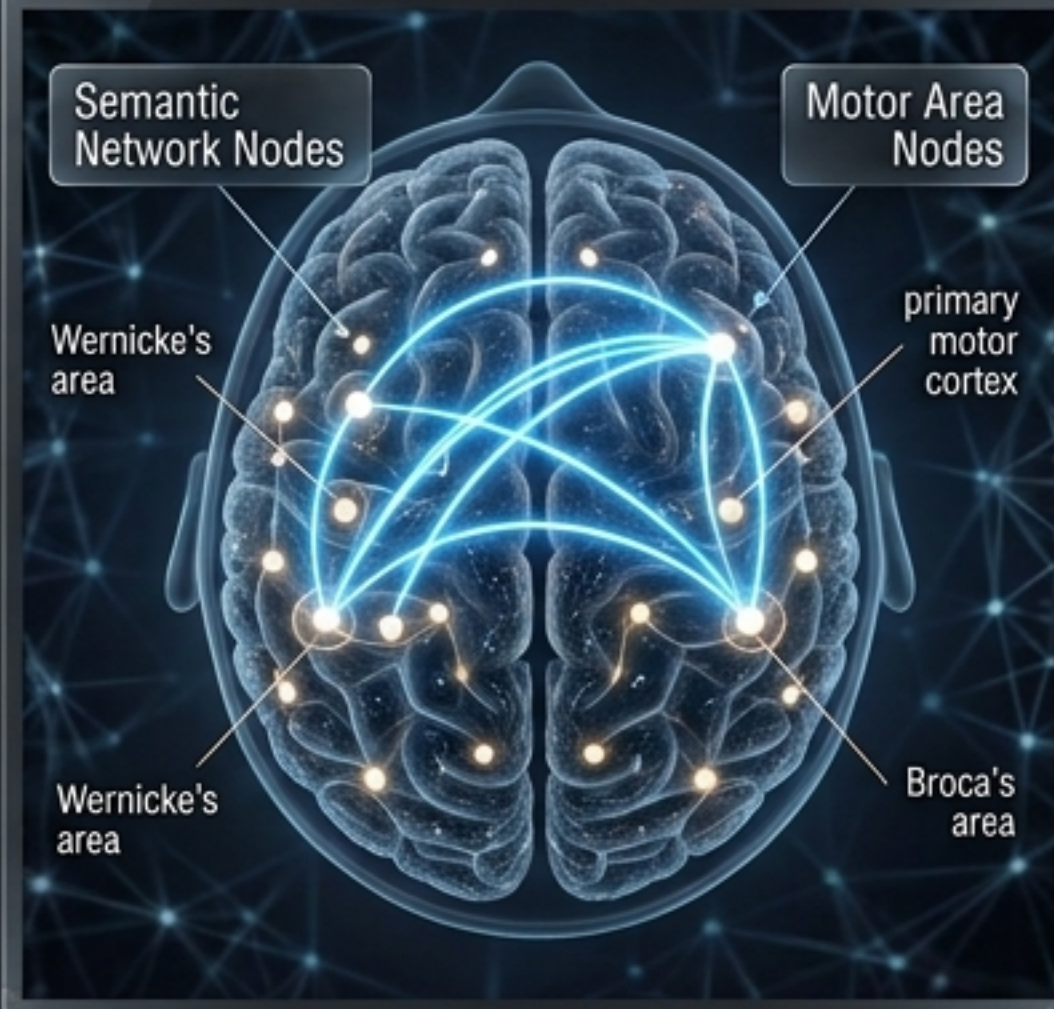
Cosmology: Entropic Redshift



RSVP predicts redshift accumulates via integrated entropy production along photon paths, not metric expansion.

Test: Maximum likelihood estimator $\hat{\alpha}_S$ on supernova data must beat Λ CDM at the 2σ level (Wilks' theorem) without $\hat{\alpha}_S < 0$.

Cognitive Coherence



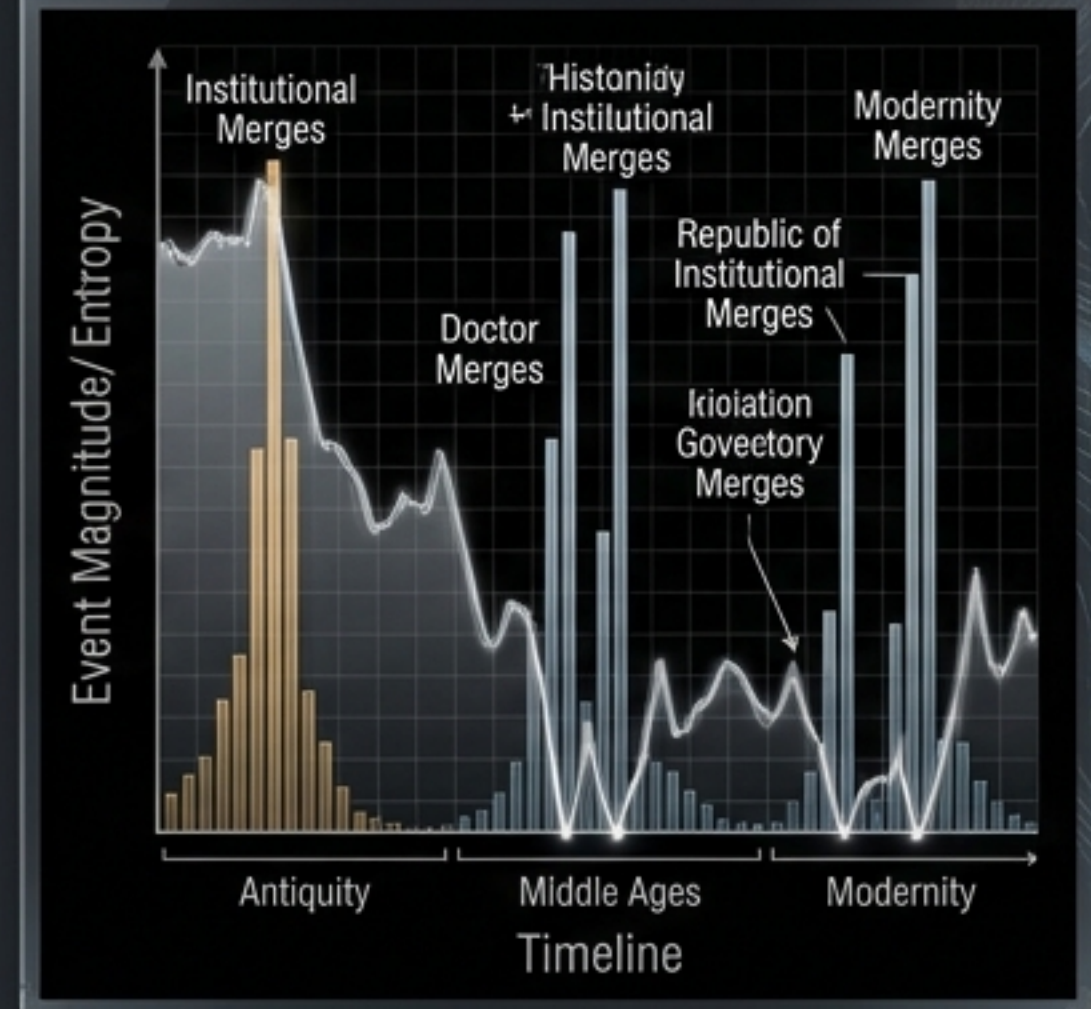
Predicts the agency coherence metric

$$\Gamma = \frac{I(\Phi; \mathbf{v})}{H(S)}$$

limits EEG microstate duration.

Test: If BOLD correlation exceeds predicted Γ , RSVP requires nonlocal extensions.

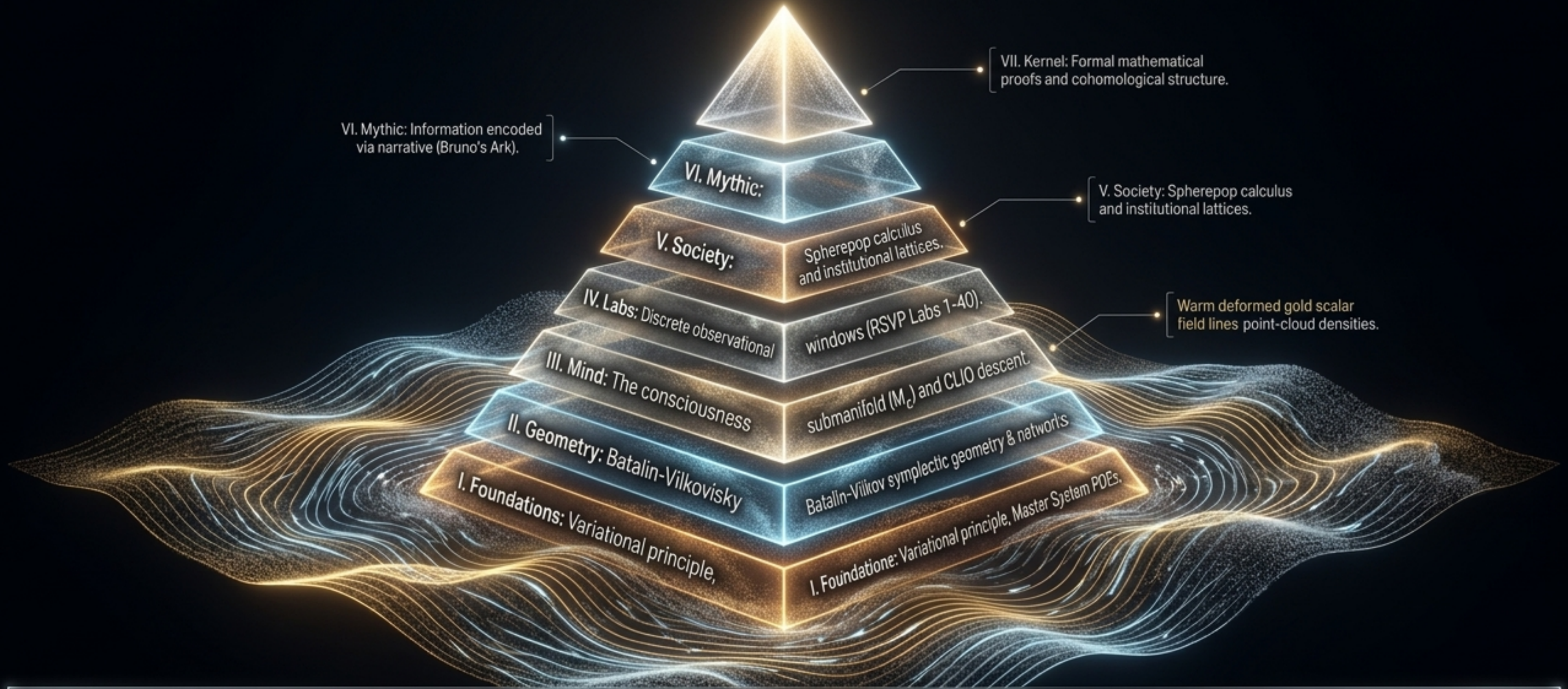
Institutional Mergers



Predicts pre-modern merge rates using low- H (keyspace entropy).

Test: If historical $P(\text{merge})$ exceeds predictions with $H=0$, ritual cost $\gamma(t)$ is falsified.

The RSVP Manifold: A 7-Layer Architecture



Conclusion: RSVP is not a metaphorical alignment. It is a constrained nonequilibrium medium effective field theory whose geometric coarse-graining induces spacetime, whose entropy measures admissible trajectory volume, and whose projection bounds the limits of cognition.