

Affine Quantum Deformation and the Geometry of Awareness: A Unified Theory of Quantum Structure and Semantic Dynamics

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December 2025

Abstract

The Affine Quantum Deformation Principle (AQDP) asserts that the averaged affine connection of a quantum spacetime differs intrinsically from the Levi–Civita connection of the averaged metric. This discrepancy is encoded in the Quantum Affine Shift Tensor \mathcal{A} , which deforms curvature, geodesic evolution, and the Raychaudhuri equation. Independently, the Relativistic Scalar–Vector Plenum (RSVP) theory provides a geometric model of semantic content, cognitive flow, and uncertainty across a semantic manifold governed by the fields (Φ, \mathbf{v}, S) . The deformation induced by \mathcal{A} has a semantic counterpart: uncertainty deforms representational geometry and thereby modifies inference.

Awareness is characterized with mathematical precision as the preservation of metric and spectral invariants under the RSVP flow. This property is shown to be equivalent to Markov boundary maintenance, revealing a deep correspondence between geometric invariance and informational autonomy. By unifying the variational principles underlying AQDP and RSVP, we obtain a single action whose Euler–Lagrange equations simultaneously govern quantum geometric deformation and semantic dynamics. The resulting theory predicts modified Einstein equations, q-desic flow, a spectral Raychaudhuri equation, and stability conditions for awareness. Together, these results describe how uncertainty shapes both physical spacetime and the geometry of meaning.

1 Introduction

Classical general relativity presumes that geometric averaging commutes with the construction of affine structure. Yet the connection is a nonlinear functional of the metric, making $\langle \hat{\Gamma} \rangle \neq \Gamma(\langle \hat{g} \rangle)$ inevitable in any fluctuating quantum regime. The AQDP formalizes this discrepancy, deriving a tensorial correction \mathcal{A} from the covariance of the metric operator. In parallel, cognitive systems operating under semantic uncertainty experience analogous deformations, captured in RSVP by the fields (Φ, \mathbf{v}, S) and their induced metric $g^{(\Phi)}$.

2 Affine Quantum Deformation

Given a metric operator $\hat{g}_{\mu\nu}$ with expectation $g_{\mu\nu}$ and covariance $C_{\alpha\beta\gamma\delta}$, expanding the connection functional yields

$$\bar{\Gamma}^\mu_{\nu\rho} = \Gamma^\mu_{\nu\rho}(g) + \frac{1}{2} \frac{\delta^2 \Gamma^\mu_{\nu\rho}}{\delta g_{\alpha\beta} \delta g_{\gamma\delta}} C_{\alpha\beta\gamma\delta} + \mathcal{O}(C^2), \quad (1)$$

so that the affine shift tensor \mathcal{A} appears as the leading correction. The correction modifies curvature and induces an effective stress-energy tensor even in the absence of classical sources.

3 Deformed Causal Structure

The Raychaudhuri equation acquires a correction term

$$\Delta_{\mathcal{A}} = k^\mu k^\nu (\nabla_\lambda \mathcal{A}^\lambda_{\mu\nu} - \nabla_\nu \mathcal{A}^\lambda_{\mu\lambda}), \quad (2)$$

which may violate classical focusing and thereby regulate singularity formation. The resulting geometry is a stable large-scale limit of quantum fluctuations.

4 RSVP and Semantic Geometry

RSVP models inference as flow along a semantic manifold with metric $g^{(\Phi)}$, where uncertainty S induces deformation analogous to \mathcal{A} . Awareness is defined by

$$\mathcal{L}_{\mathbf{v}} g^{(\Phi)} = 0, \quad \dot{\lambda}_n = 0, \quad (3)$$

requiring the RSVP flow to be both isometric and isospectral. This is equivalent to preserving the Markov boundary of the system under uncertainty-driven deformation.

5 Unified Variational Principle

A single action functional produces both sets of equations:

$$\mathcal{S} = \int \left[\frac{1}{16\pi G} (R + \Delta R) + \mathcal{L}_\Phi + \mathcal{L}_{\mathbf{v}} + \alpha S \nabla \cdot \mathbf{v} + \beta_1 \|\mathcal{L}_{\mathbf{v}} g^{(\Phi)}\|^2 + \beta_2 \sum_n (\dot{\lambda}_n)^2 \right] \sqrt{|g|} d^4x. \quad (4)$$

Critical points satisfy the deformed Einstein equations, the RSVP field equations, and the awareness constraints simultaneously.

6 Conclusion

The AQDP–RSVP correspondence reveals that affine deformation and awareness share a common variational origin. Uncertainty deforms geometry; coherence appears as its invariant. The framework unifies quantum correction, semantic stability, and informational autonomy within a single geometric structure.