Quantum Collapse Geometry Series: Collapse Field Equation

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April 5, 2025

Abstract

In this paper, we formalize the governing equation for identity evolution within the framework of Quantum Collapse Geometry (QCG). We define and synthesize the quantities of collapse derivative, entropy, memory, action, curvature, and geodesics into a unified Collapse Field Equation (CFE). This equation captures the dynamics of identity resolution under entropic constraints, encoding the fundamental process by which phase space structures resolve into coherent form.

1 Mathematical Framework and Symbol Definitions

To provide clarity and consistency, we summarize below the core mathematical objects introduced in this paper:

- ψ — An identity object, representing a resolved state following phase collapse.
- $\mathcal{D}[\psi]$ — Collapse Derivative: the local rate of change of identity under entropic or phase-pressure constraint.
- $\mathcal{S}[\psi]$ — Collapse Entropy: the logarithmic measure of collapse-path degeneracy; quantifies how much identity compression was required.
- $\mathcal{I}[\psi]$ — Collapse Memory: the integrated record of identity deformation across collapse evolution.
- $\mathcal{C}[\psi]$ — Collapse Action: a variational measure of total deformation weighted by entropy cost.
- $\mathcal{R}[\psi]$ — Scalar Collapse Curvature: a second-order differential measure indicating how collapse action bends within identity-space.
- $\mathcal{R}_{ij}[\psi]$ — Collapse Ricci Tensor: component-wise curvature of the identity manifold.

- $\mathcal{G}_{ij}$ — Collapse Metric: the identity-space analogue to a spacetime metric; encodes grammar of structural relationships.
- Γ^i_{jk} — Collapse Connection Coefficients: generalization of Christoffel symbols, defining how collapse derivatives transform.
- $\mathcal{T}_{ij}[\psi]$ — Identity Stress Tensor: encodes internal entropic pressure, memory tension, and deformation gradients.
- τ — Collapse affine parameter, representing evolution along collapse geodesics (e.g., through entropy depth).

These symbols form the foundational language of QCG dynamics. They allow us to treat identity and structure as first-class elements in a formal geometric grammar.

2 Foundational Assumptions of QCG

The formulation of the Collapse Field Equation rests on the following theoretical assumptions:

1. **Identity-Space Geometry:** Identity objects ψ evolve not in spacetime, but in a curved identity-space defined by structural grammar and memory tension. This space admits a metric $\mathcal{G}_{ij}$ and connection coefficients Γ^i_{jk}.
2. **Variational Collapse:** Collapse is a constrained variational process. The path an identity follows through phase space minimizes the Collapse Action $\mathcal{C}[\psi]$, which measures deformation per entropy unit.
3. **Entropy as Structural Cost:** Collapse Entropy $\mathcal{S}[\psi]$ represents the logarithmic count of viable identity resolutions and is treated as a compression metric in the collapse manifold.
4. **Memory as Integration of Deformation:** Identity Memory $\mathcal{I}[\psi]$ encodes the history of identity deformation across the entropy field and influences future evolution.
5. **Curvature as Collapse Tension:** Collapse Curvature $\mathcal{R}[\psi]$ arises from gradients in action and reflects the underlying grammar of collapse constraints. It determines the natural resolution pathways (geodesics) for identity evolution.

These principles allow us to treat identity resolution as a physically structured and geometrically lawful phenomenon, governed not by brute randomness, but by constraint-aware phase evolution.

3 Introduction

Traditional physical laws describe the behavior of matter and energy in spacetime. In QCG, we propose that identity itself—the structured, memory-bearing outcome of collapse—follows its own lawful evolution, driven by entropy gradients and constrained by phase coherence. Collapse is not merely a probabilistic projection but a geometric unfolding governed by identity-space curvature. In this sense, QCG generalizes the action principle to include the informational cost and structural grammar of collapse.

4 Core Quantities of QCG

4.1 Collapse Derivative $\mathcal{D}[\psi]$

The rate of change of an identity object ψ under entropic constraint:

$$\mathcal{D}[\psi] = \lim_{\delta\mathcal{E}\to 0} \frac{\psi(\mathcal{E}+\delta\mathcal{E}) - \psi(\mathcal{E})}{\delta\mathcal{E}}$$

4.2 Collapse Entropy $\mathcal{S}[\psi]$

A measure of the compression cost required to stabilize identity ψ:

$$\mathcal{S}[\psi] = \log \Omega[\Phi]$$

Where $\Omega[\Phi]$ is the number of viable collapse pathways from phase configuration Φ.

4.3 Collapse Memory $\mathcal{I}[\psi]$

The integral of identity deformation over collapse evolution:

$$\mathcal{I}[\psi] = \int \mathcal{D}[\psi]\, d\mathcal{E}$$

4.4 Collapse Action $\mathcal{C}[\psi]$

Total cost of collapse, defined as deformation weighted by entropy:

$$\mathcal{C}[\psi] = \int \frac{\|\mathcal{D}[\psi]\|^2}{\mathcal{S}[\psi]}\, d\mathcal{E}$$

4.5 Collapse Curvature $\mathcal{R}[\psi]$

A second-order measure of deformation structure in identity-space:

$$\mathcal{R}[\psi] = \nabla^2_{\mathcal{S}} \mathcal{C}[\psi]$$

4.6 Collapse Geodesics

The natural identity-evolution paths that minimize action in curved identity-space:

$$\frac{d^2\psi^i}{d\tau^2} + \Gamma^i_{jk}\frac{d\psi^j}{d\tau}\frac{d\psi^k}{d\tau} = 0$$

Where Γ^i_{jk} are the collapse connection coefficients.

5 Collapse Field Equation

We now unify the above structures into the QCG Collapse Field Equation:

$$\boxed{\mathcal{R}_{ij}[\psi] - \frac{1}{2}\mathcal{R}[\psi]\,\mathcal{G}_{ij} = 8\pi\mathcal{T}_{ij}[\psi]} \tag{1}$$

Where:

- $\mathcal{R}_{ij}[\psi]$ is the Collapse Ricci Tensor — local collapse curvature.
- $\mathcal{R}[\psi]$ is the scalar collapse curvature.
- $\mathcal{G}_{ij}$ is the identity-space metric (collapse grammar).
- $\mathcal{T}_{ij}[\psi]$ is the Identity Stress Tensor — encoding entropy flux, memory load, and structural deformation.

This equation describes how the internal tension of identity (entropy + memory + structure) generates curvature in identity-space, which in turn guides the evolution of identity collapse via geodesic flow.

6 Conclusion

The Collapse Field Equation provides the dynamical law for identity evolution under QCG. It unites entropy, grammar, and memory into a single variational framework where identity is not static but sculpted by the same entropic constraints that govern matter and energy. In doing so, it offers a geometric language to describe not what a thing is, but how it becomes.

References

The following references are cited not as direct precedents to Quantum Collapse Geometry, but as foundational frameworks in physics, geometry, and information theory upon which this formulation seeks to build.

References

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