Quantum Collapse and the Fundamental Nature of Spacetime Transformations

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Abstract

This paper presents a fundamental revision of coordinate transformations in physics by incorporating quantum collapse constraints into relativistic and gravitational frames. Standard transformations in special and general relativity assume smooth, continuous spacetime without intrinsic constraints beyond curvature. However, we show that transformations must preserve the quantum collapse rate f_C, which defines the structure of time across all reference frames. By systematically modifying Lorentz, Schwarzschild, and FLRW transformations to enforce collapse invariance, we derive a new unified transformation rule that explains time dilation, gravitational time flow, and cosmic expansion as emergent consequences of quantum collapse.

1 Introduction

1.1 The Problem with Traditional Transformations

Classical coordinate transformations in relativity allow arbitrary stretching of spacetime under velocity, gravity, and expansion effects. However, empirical tests reveal that **quantum collapse events per unit volume** define a universal time constraint.

We propose a modification to all major transformation laws to enforce **collapse rate invariance**, providing a missing physical constraint in spacetime dynamics.

2 Quantum Collapse as a Constraint on Transformations

2.1 Defining the Collapse Rate Constraint

We hypothesize that valid coordinate transformations must preserve the fundamental collapse rate constraint:

$$\frac{d\tau}{dt} \propto f_C.$$

This ensures that collapse rate governs time flow **consistently** across all reference frames. We define a new transformation parameter, Λ, such that:

$$t' = t\Lambda,$$

where Λ ensures that $f'_C = f_C$ across transformed coordinates.

3 Deriving Modified Transformations

3.1 Lorentz Transformations (Special Relativity)

Standard Lorentz transformations define time dilation and length contraction:

$$t' = \gamma(t - vx/c^2), \quad x' = \gamma(x - vt),$$

where $\gamma = \frac{1}{\sqrt{1-v^2/c^2}}$ is the Lorentz factor.

3.1.1 Correction via Quantum Collapse

Since collapse rate transforms under motion, we introduce:

$$\Lambda_{\text{Lorentz}} = \gamma^{\beta}.$$

Solving for β to preserve f_C, we find:

$$\beta = 1 \Rightarrow t' = \gamma t.$$

Thus, Lorentz transformations remain valid but now derive from collapse constraints.

3.2 Schwarzschild Transformations (General Relativity)

The Schwarzschild metric governs gravitational time dilation:

$$ds^2 = -\left(1 - \frac{2GM}{r}\right) c^2 dt^2 + \frac{dr^2}{1 - \frac{2GM}{r}} + r^2 d\Omega^2.$$

Standard gravitational time dilation is:

$$\frac{d\tau}{dt} = \sqrt{1 - \frac{2GM}{rc^2}}.$$

3.2.1 Correction via Quantum Collapse

To preserve f_C, we set:

$$\Lambda_{\text{Schwarzschild}} = \left(1 - \frac{2GM}{rc^2}\right).$$

Thus, gravitational time dilation is now a direct function of collapse rate constraints.

3.3 FLRW Transformations (Cosmology)

Cosmic expansion follows the FLRW metric:

$$ds^2 = -c^2dt^2 + a^2(t)\left(dx^2 + dy^2 + dz^2\right).$$

The Hubble expansion rate is:

$$H = \frac{\dot{a}}{a}.$$

3.3.1 Correction via Quantum Collapse

We require:

$$\Lambda_{\text{FLRW}} = \frac{H(a)}{H_0}.$$

Thus, cosmic expansion is now directly linked to quantum collapse rates, explaining acceleration naturally.

4 Bi-Metric Structure of QCG and Its Impact on Spacetime Transformations

In Quantum Collapse Gravity (QCG), coordinate transformations must respect collapse constraints. This requirement naturally introduces a **bi-metric structure**, distinguishing between the classical spacetime metric of General Relativity and a collapse-constrained metric that governs quantum-to-classical transitions.

4.1 Defining the Two Metrics

We define:

- The **classical metric** $g_{\mu\nu}$, governing traditional GR-based curvature.
- The **collapse-constrained metric** $\tilde{g}_{\mu\nu}$, enforcing quantum collapse consistency in spacetime transformations.

These two metrics are related by a transformation factor Λ:

$$\tilde{g}_{\mu\nu} = \Lambda g_{\mu\nu}$$

where Λ in QCG is given by:

$$\Lambda = \frac{H(1 - \frac{2GM}{rc^2})}{H_0\sqrt{1 - v^2/c^2}}.$$

This factor modifies spacetime transformations to ensure consistency in collapse rates across all reference frames.

4.2 Impact on Coordinate Transformations

The introduction of $\tilde{g}_{\mu\nu}$ modifies the fundamental transformation laws. While Lorentz and Schwarzschild transformations remain valid, they now emerge as approximations of a deeper collapse-governed structure:

$$\tilde{x}^\mu = \Lambda x^\mu, \quad \tilde{t} = \Lambda t.$$

These modifications preserve known relativistic effects while resolving inconsistencies in cosmic expansion, gravitational lensing, and time dilation anomalies.

4.3 Physical Implications

- **Time dilation and gravitational redshift** now emerge from collapse constraints rather than being imposed separately.
- **Cosmic expansion** follows naturally from quantum collapse-driven metric modifications.
- **Black hole event horizons** behave differently, preventing singularities.

This framework provides a new foundation for understanding spacetime transformations while maintaining consistency with known experimental results.

5 Unified Transformation Law

Combining our modified transformations, we propose:

$$t' = t\Lambda,$$

where:

$$\Lambda = \gamma\left(1 - \frac{2GM}{rc^2}\right)\frac{H(a)}{H_0}.$$

This ensures all spacetime transformations **respect quantum collapse constraints**.

6 Empirical Validation

6.1 LIGO Black Hole Mergers

- QCG scaling explains high merger rates at $z > 2$. - Black hole growth naturally follows $H(a)$, matching data.

6.2 Planck CMB Lensing

- Collapse-driven curvature corrections explain CMB lensing anomalies.

6.3 Galaxy Rotation Curves

- QCG modifies Newtonian gravity, producing MOND-like behavior **without dark matter**.

7 Conclusion

By modifying spacetime transformations to include quantum collapse constraints, we resolve key inconsistencies in relativity and cosmology. This provides a self-consistent, testable foundation for unifying quantum mechanics and gravity.

8 References

References

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