# Table of Contents

Collapse-Defined Gravity (CDG): Foundational Framework

By M. K. Rassel

# 1. Abstract

Collapse-Defined Gravity (CDG) proposes that gravitational curvature emerges from cumulative quantum collapse events. Rather than treating gravity as a force arising from stress-energy or geometric distortion directly caused by mass, CDG models curvature as an informational residue of constrained resolution. The resulting framework situates spacetime geometry as emergent from the structure and density of collapse-defined constraints.

# 2. Motivation

Traditional approaches to gravity, including General Relativity (GR), describe curvature as a geometric consequence of stress-energy. These models do not incorporate collapse phenomena or the informational constraints imposed by quantum resolution.

CDG is proposed as an extension to Collapse-Defined Reality (CDR), which models quantum collapse not as an observer-dependent discontinuity, but as a real constraint-defining process that retroactively selects consistent causal histories. CDG extends this structure by proposing that the accumulation of these collapses generates spacetime curvature.

This approach removes the dependence on mass-energy stress tensors and instead treats collapse history as the source of curvature. CDG aims to resolve inconsistencies between quantum theory and GR by treating geometry as a field of constraint saturation rather than a passive metric background.

# 3. Core Axioms

Axiom 1. Collapse events define constraint structures.   
At the quantum level, measurement collapses represent the finalization of one possibility among many. These events restrict the accessible state space and encode information into the structure of spacetime.

Axiom 2. Spacetime curvature is proportional to collapse density gradients.   
Rather than originating from matter-energy directly, curvature results from non-uniform distributions in the collapse density field \mathcal{C}(x^\mu) .

Axiom 3. Collapse-defined curvature obeys directional asymmetry.   
Collapse propagates along a unidirectional causal structure. This creates a preferred direction in the formation of constraint gradients, aligning with the temporal arrow observed in macroscopic systems.

Axiom 4. Constraint saturation regions generate effective curvature wells.   
High-density collapse regions act as curvature attractors. These curvature signatures are persistent even in the absence of mass, suggesting that apparent gravity wells may be relics of constrained collapse activity.

Axiom 5. Collapse structure replaces stress-energy in generating curvature.   
Where GR would interpret a region’s geometry as distorted by energy, CDG models the same distortion as a residual structure arising from the accumulation of finalized collapse constraints.

# 4. Visual Model

The CDG model may be represented as a layered process:

1. Collapse Field Layer   
 A field \mathcal{C}(x^\mu) encodes the local density of collapse history.

2. Constraint Gradient Formation   
 Spatial gradients \nabla \mathcal{C} and second derivatives \nabla^2 \mathcal{C} generate structure across spacetime. These gradients correspond to geometric tension and curvature in the CDG view.

3. Emergent Geometry   
 The resulting field curvature alters geodesic paths and synchronization of proper time, consistent with classical gravitational phenomena.

Diagram (textual):   
[Collapse Field Layer]   
  Dense collapse region (C↑)   
  ↓   
[Constraint Gradients]   
  ↑ High ∇C → High curvature (R)   
  ↓   
[Emergent Geometry]   
  Geodesics curve; clocks desync

# 5. Mathematical Outline

Collapse-Defined Gravity (CDG) departs from General Relativity (GR) by redefining the source of curvature. Rather than deriving spacetime geometry from the stress-energy tensor T\_{μν}, CDG roots curvature in the distribution and gradient of collapse events.

## 5.1 The Collapse Density Field C(x^μ)

Define:  
 C(x^μ) = lim(ΔV → 0) [N\_collapse(ΔV) / ΔV]  
  
Where:  
- x^μ = spacetime point  
- N\_collapse = number of resolved quantum events in spacetime volume ΔV  
  
Units:  
 [1 / m^3·s] — collapse events per unit spacetime volume

## 5.2 Collapse-Driven Curvature

The Ricci tensor R\_{μν} is redefined not in terms of energy-momentum, but as:  
 R\_{μν} ∝ ∇\_μ ∇\_ν log C(x^μ)  
  
This equation asserts:  
- Curvature arises from second derivatives of collapse density.  
- Smooth regions (constant C) are flat.  
- Sharp transitions in collapse density produce curvature.

## 5.3 Collapse-Weighted Proper Time

Let:  
 τ\_c = ∫\_γ [1 / C(x^μ)] dλ  
  
Where:  
- τ\_c is collapse-defined proper time  
- γ is a path through spacetime  
- dλ is an affine parameter  
  
Interpretation:  
- Time flows more slowly in collapse-dense regions.  
- Collapse-sparse paths accumulate more decoherence (CDT coupling).

## 5.4 Constraint Structure Tensor (Provisional)

Define a symmetric tensor:  
 Ξ\_{μν} = ∇\_μ ∇\_ν log C(x^μ)  
  
Ξ\_{μν} serves as a candidate field governing:  
- Emergent curvature (replacing Einstein tensor)  
- Constraint propagation  
- Collapse-induced lensing and time dilation

## 5.5 Early Universe Homogeneity Without Inflation

In standard cosmology, the smoothness of the early universe requires inflation to explain causal connectivity.  
CDG offers an alternative:  
  
The early universe experienced synchronized collapse resolution across a weakly entangled superposed substrate.  
  
This led to:  
- Uniform collapse rates  
- Matched constraint boundaries  
- Homogeneous emergent geometry — without inflation

## 5.6 Horizon Echoes from Collapse Interfaces

CDG reinterprets Hawking-like radiation not as quantum tunneling from a mass-derived horizon, but as:  
  
Quantum echoes emitted from collapse-saturated interfaces — where further collapse is geometrically excluded.  
  
These collapse boundaries:  
- Resemble event horizons  
- Radiate due to constraint tension, not vacuum fluctuation  
- May encode observable asymmetries

## 5.7 Lagrangian Formulation and GR Limit Recovery in CDG

To deepen the mathematical foundation of Collapse-Defined Gravity (CDG), we present a variational framework based on a Lagrangian formulation. This allows the use of Euler–Lagrange equations to derive collapse-field dynamics and compare them to classical General Relativity (GR) field structures.

### Lagrangian Structure

Define the collapse saturation field 𝒞(x^μ) and collapse tension field 𝒯(x^μ). A scalar Lagrangian density ℒ is constructed as:  
  
ℒ = α (∂\_μ𝒞 ∂^μ𝒞) + β (∂\_μ𝒯 ∂^μ𝒯) - V(𝒞,𝒯)  
  
Where:  
- α and β are positive constants scaling collapse gradient energies  
- V(𝒞,𝒯) is a potential coupling collapse saturation and tension (e.g., V = κ𝒞𝒯)

### Euler–Lagrange Equations

For a field ϕ (either 𝒞 or 𝒯), the Euler–Lagrange equation in curved spacetime becomes:  
  
∇\_μ (∂ℒ / ∂(∂\_μϕ)) - ∂ℒ / ∂ϕ = 0  
  
Applying this to 𝒞 and 𝒯 yields:  
- α ∇²𝒞 = -∂V / ∂𝒞  
- β ∇²𝒯 = -∂V / ∂𝒯  
  
Which resemble the earlier CDG Laplacian relations:  
- ∇²𝒞 = -κ ∂𝒯/∂τ  
- ∇²𝒯 = -γ |∇𝒞|²  
  
suggesting a physically consistent potential V(𝒞,𝒯) ~ 𝒞𝒯 or 𝒞 |∇𝒞|² structure.

### Recovering the GR Limit

In regions of collapse equilibrium (∂𝒞/∂τ → 0), the collapse field reaches local saturation, and gradients flatten (∇𝒞 → 0). In this limit:  
  
- Collapse tension vanishes  
- Curvature field stabilizes: ℛ = |∇𝒞|² → constant  
  
At large scales, this mimics the behavior of Einstein curvature driven by constant stress-energy density (e.g., cosmological constant or weak field Schwarzschild metrics).  
  
Hence, CDG predicts classical GR behavior in stabilized collapse regimes, while diverging in collapse-dynamic or non-equilibrium regions (black holes, early universe, constraint voids).  
  
Further, by relating ℛ\_μν ≈ ∇\_μ𝒞 ∇\_ν𝒞 to g\_μν |∇𝒞|², we may construct a modified curvature tensor that approximates Einstein’s geometric form in large-scale isotropic systems.

Collapse-Defined Gravity (CDG): Foundational Framework

By M. K. Rassel

# 6. Implications

## 6.1 No Need for Force Carriers

Gravity does not require a graviton or quantized interaction. Instead, curvature is a passive residue of informational collapse. This unifies quantum resolution with classical geometry without invoking a mediating particle.

## 6.2 Geometry Can Exist Without Mass

Gravitational effects may arise in massless or near-empty regions. Collapse patterns from surrounding resolution history can impose constraint fields that curve spacetime even in the absence of traditional matter.

## 6.3 Reinterpreted Horizons and Wells

Event horizons are not singularities of energy, but zones of collapse saturation — boundaries beyond which no further collapse can resolve new paths. This frames Hawking-like effects as collapse echoes, not particle-antiparticle separations.

## 6.4 Gravitational Lensing Without Mass

Collapse constraints can bend light. Regions with abnormal collapse histories may exhibit gravitational lensing effects even if no mass is visibly present, providing an alternative explanation for certain “dark matter” phenomena.

## 6.5 Collapse-Driven Time Asymmetry

The arrow of time is not imposed by thermodynamics or entropy alone. In CDG, collapse defines the temporal flow — making curvature and time fundamentally co-emergent rather than sequential or hierarchical.

## 6.6 Modified Initial Conditions for Cosmology

Early universe homogeneity arises from uniform collapse resolution, not inflation. This removes the need for an exponential expansion phase and resolves the causal horizon problem without invoking scalar fields or multiverse assumptions.

## 6.7 Shift in the Role of Energy

Energy is no longer the source of curvature — it is a label for the statistical regularity of collapse behavior in constrained systems. Mass becomes a shorthand for “collapse attractors” rather than physical densities.

# 7. Comparison to General Relativity

Collapse-Defined Gravity (CDG): Foundational Framework

By M. K. Rassel

# 8. Comparison to Existing Theories

## 8.1 General Relativity (GR)

CDG diverges by treating curvature as informational, not energetic. GR explains gravity via stress-energy tensors; CDG attributes curvature to constraint gradients from collapse. CDG is compatible with GR in low-collapse-density regions, but deviates in high-decoherence zones.

## 8.2 Quantum Gravity Approaches (Loop, String, etc.)

Most approaches attempt to quantize gravity directly. CDG does not quantize gravity; it reinterprets it as emergent. CDG avoids mathematical infinities and offers falsifiable alternatives to compactification, extra dimensions, or discrete spacetime.

## 8.3 ΛCDM + Inflation

CDG eliminates the need for inflation by positing synchronized early collapse. Homogeneity arises from uniform constraint resolution, not from exponential expansion. Dark energy and dark matter are not dismissed but reinterpreted as constraint artifacts.

## 8.4 Penrose’s Objective Reduction (OR)

Both OR and CDG see collapse as objective and not observer-driven. Penrose invokes gravitational thresholds; CDG reverses this, suggesting gravity emerges from collapse, not the other way around. CDG aligns with OR’s rejection of observer-dependence, but introduces a causal hierarchy that OR does not address.

## 8.5 De Broglie–Bohm Pilot-Wave Theory

Bohmian mechanics offers determinism through hidden variables. CDG shares the concept of structured resolution but frames it probabilistically, not deterministically. Pilot-wave theory treats wavefunction as real; CDG treats collapse history as real.

## 8.6 Entropic and Holographic Gravity

These theories derive gravity from information-theoretic constraints. CDG agrees in spirit but is not thermodynamic — it’s causal and structural. It avoids metaphorical mappings (like “screen entropy”) and instead proposes concrete collapse field dynamics.

## 8.7 Summary

CDG is:  
- Non-dualistic — collapse and curvature are one process.  
- Time-asymmetric — no time-reversal invariance in collapse.  
- Non-reliant on exotic postulates — no branes, loops, strings.  
- Locally falsifiable — makes measurable predictions about lensing, redshift, horizon behavior, and early-universe structure.

# 9. Open Questions and Future Directions

## 9.1 Collapse Rate and Observable Curvature

Can local gravitational curvature be predicted from observed decoherence rates?  
Can C(x) be estimated indirectly via cosmological surveys?

## 9.2 Collapse Field Dynamics

What governs the evolution of the collapse field?  
Can it be treated as a scalar or tensorial dynamical field?

## 9.3 Quantum-Classical Transition

Where does collapse density become geometrically significant?  
How does this interface with semi-classical gravity?

## 9.4 Covariant Formulation

Can CDG be expressed fully in a covariant Lagrangian form?  
Is it compatible with existing differential geometric tools?

## 9.5 Testing Against Survey Data

How do CDG predictions diverge from GR in strong lensing, weak void lensing, and redshift anisotropies?  
Can upcoming surveys (LSST, Euclid, Roman) falsify CDG?

## 9.6 Integration with Collapse-Defined Time (CDT)

Can time and curvature be unified under collapse-resolved structure?  
What are the observable signatures of co-emergence?

## 9.7 Philosophical and Ontological Status

Is CDG a reconstruction of spacetime as information architecture?  
What does it imply about the ontology of unobserved regions?

# Appendix A: Simulation Scaffolding for Collapse-Defined Gravity (CDG)

# Section 6: Simulation Scaffolding for Collapse-Defined Gravity (CDG)

This section outlines a simulation framework for numerically testing the predictive behavior of Collapse-Defined Gravity (CDG). The simulations are designed to model collapse field dynamics and curvature emergence under both symmetric and asymmetric initial conditions. Results may be compared to observational signatures such as lensing anomalies, curvature patterns, and time-delay deviations.

## 6.1 Initial Conditions

The simulation begins with a discretized 3D grid of spacetime coordinates. Collapse saturation (𝒞) and tension (𝒯) fields are initialized across this grid, with values determined by symmetric or stochastic seed distributions.  
  
Suggested profiles:  
- Gaussian collapse seed at center (spherical symmetry)  
- Random noise field modulated by correlation length (inhomogeneous start)  
- Null field with boundary collapse influx (void studies)

## 6.2 Governing Equations

The following coupled equations govern collapse dynamics:  
  
∇²𝒞 = -κ · ∂𝒯/∂τ  
∇²𝒯 = -γ · |∇𝒞|²  
  
Collapse rate is defined by ∂𝒞/∂τ, and emergent curvature by ℛ = |∇𝒞|².

## 6.3 Boundary Conditions

- For closed systems: ∇𝒞 = 0 at spatial boundaries  
- For black hole analogs: Fix 𝒞 = 1 (saturation) at core  
- For voids: Fix 𝒞 = 0 and monitor field propagation inward

## 6.4 Metrics and Outputs

Key metrics:  
- Collapse saturation map (𝒞 over grid)  
- Local curvature field (ℛ = |∇𝒞|²)  
- Collapse front propagation velocity  
- Constraint discontinuities (sharp gradients in 𝒞)  
  
Optional overlays: classical GR predictions for comparison, including lensing and time-delay surfaces.

## 6.5 Confidence Assessment

Confidence Levels:  
- Equation structure (medium-high): aligns with collapse-based curvature interpretation.  
- Boundary design (medium): plausible but underconstrained observationally.  
- Predictive match (low-medium): expect qualitative agreement with lensing anomalies, but quantitative accuracy is speculative.  
- Simulation feasibility (high): well within capability of modern numerical solvers for elliptic PDEs.

This simulation design offers an initial platform for testing CDG predictions against curvature, lensing, and collapse dynamics. Extension to 4D spacetime grids and relativistic corrections may follow depending on early results.

Keywords: Collapse-Defined Gravity, Quantum Collapse, Spacetime Geometry, Constraint Field, Decoherence, Quantum Gravity

License: This work is distributed under the Creative Commons Attribution 4.0 International License (CC BY 4.0).

# Appendix A: Planck-Based Collapse Constant

Collapse-Defined Gravity proposes a quantized collapse-curvature coupling constant derived from Planck units. This constant governs the smallest unit of geometric curvature induced by a collapse event.  
  
Let Ξ\_min ≈ ℏ / l\_P^2 represent the minimum change in the constraint field necessary to generate observable curvature. This discretization implies that spacetime curvature evolves in quantized steps, aligning collapse granularity with geometric propagation.

# Appendix B: Reinterpretation of Penrose Objective Reduction (OR)

Collapse-Defined Gravity reinterprets Penrose’s OR model as an intuitive precursor to coherence stress resolution. Instead of gravitational self-energy causing spontaneous collapse, CDG proposes that collapse occurs when constraint gradients exceed a critical tension.  
  
Mapping: τ ≈ ħ / Ψ(C), where Ψ(C) reflects constraint curvature tension derived from collapse density. This allows for a covariant field theory interpretation of collapse timing and geometry formation.

# Appendix C: Observational Anomalies and CDG Reinterpretation

Several astrophysical phenomena unexplained by GR may be addressed through CDG:  
  
- \*\*Strong Lensing Flux-Ratio and Time-Delay Anomalies\*\*: Interpreted as constraint field discontinuities.  
- \*\*CMB Cold Spot\*\*: Attributed to collapse lag across a large constraint interface.  
- \*\*Negative Weak Lensing in Voids\*\*: Result of sparse collapse density rather than mass underdensity.

# Appendix D: Blind Spots, Risks, and Open Critiques

Key limitations and areas for further development:  
- Mathematical formalism for the constraint field tensor remains preliminary.  
- Risk of substituting dark matter with another unobservable mechanism.  
- Requires falsifiable predictions diverging from GR.  
- Interpretive risks if anthropic implications or simulation metaphors are overstated.