# Quantum Recursive Reality Theoretical Equations (QRRTE): A Discrete Tensor Framework for Gravitational and Quantum Curvature Dynamics

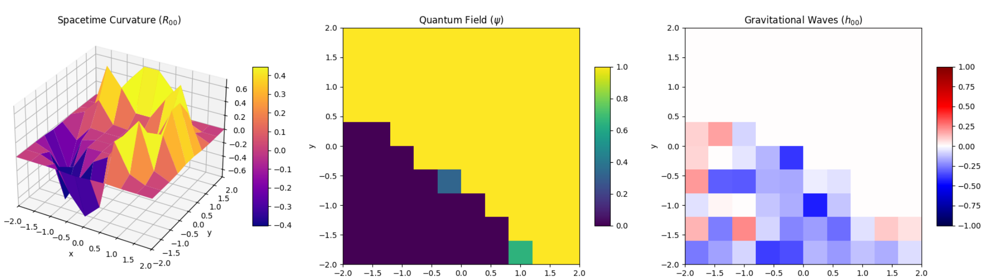
Aaron McKee[1]

[1]Theoretical Science, Independent Researcher

May 20, 2025

**Abstract**

We present the complete formulation of our Novel Framework Quantum Recursive Reality: Theoretical Equations Backbone (QRRTE). Aptly presented as a unified simulation based framework integrating general relativity, quantum field theory, spinor fields, and curvature dynamics on a discrete voxel based lattice. QRRTE models the evolution of curvature and quantum fields per Planck-voxel with recursive feedback, stress energy dynamics, spinor behavior, as well with incorporating gravitational wave emission(s). This document details all 30 core equations layered into a physically grounded lattice formulation.




# 1 1. Introduction

QRRTE is motivated by foundational questions we've asked and, quite possibly have answered within this document of novel equations. Some include and aren't limited to, while still being actively hypothesized, tested, refuted, built on, and answered are:

## 1.1 Questions:

How does spacetime evolve per voxel under quantum stress?

Can recursive curvature dynamics mimic gravitational wave behavior?

Does voxel level feedback simulate black hole phenomenology or quantum coherence?

We seek to unify discrete curvature mechanics using: scalar, vector, and spinor quantum fields, and GR consistency via a numerical framework layered with physical realism and energy tracking.

# 2 2. Discrete Voxel Lattice Setup

## 2.1 Voxel Embedding and Resolution

We define a 3D lattice of voxels with spacing $\ell_P$, the Planck length:

$$\boldsymbol{x}_{ijk} = (i, j, k) \cdot \ell_P \tag{1}$$

$$\text{Time step: } \Delta t = \frac{\ell_P}{c} \tag{2}$$

## 2.2 Local Fields

Each voxel holds fields:

- Curvature tensor: $R_{\mu\nu}(i, j, k, t)$
- Scalar/vector quantum field: $\boldsymbol{\psi}(i, j, k, t)$
- Spinor field: $\Psi(i, j, k, t)$
- Stress-energy tensor: $T_{\mu\nu}$
- Gravitational wave strain: $h_{\mu\nu}$

# 3 3. Tensor Curvature Evolution

## 3.1 Stress-Energy Sourced Update

The curvature tensor evolves recursively according to:

$$R^{t+1}_{\mu\nu} = R^t_{\mu\nu} + \alpha \cdot T_{\mu\nu} - \beta \nabla^2 R_{\mu\nu} + \eta \cdot \mathcal{N}_{\mu\nu} + \gamma \cdot \mathcal{Q}_{\mu\nu} \tag{3}$$

where:

- $\alpha$ controls coupling strength between stress-energy and curvature.

[1] Figure 1: Page 2 – Spacetime manifold structure render.

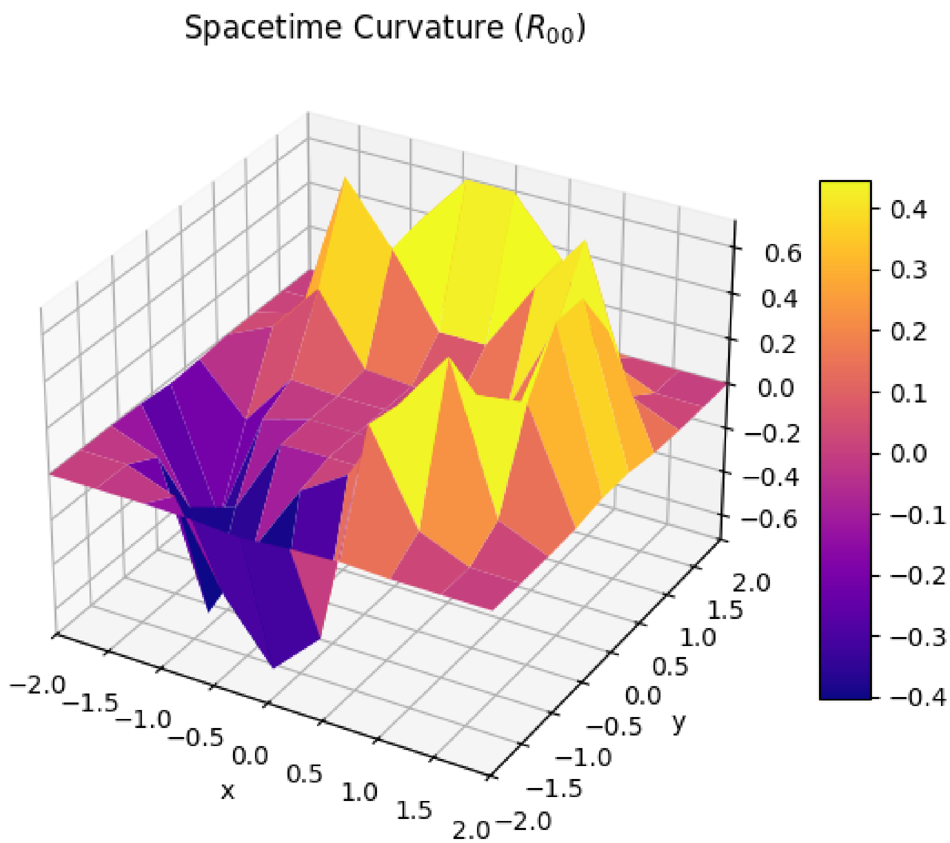



Figure 1: Voxel-based 3D spacetime manifold at Planck resolution. Each voxel embeds curvature tensors $R_{\mu\nu}$ and fields $\boldsymbol{\psi}, \Psi$. Darker regions represent higher curvature, simulating localized mass-energy.

- $\beta$ defines diffusion-like smoothing of curvature.
- $\eta$ scales injected noise $\mathcal{N}_{\mu\nu}$ to model quantum fluctuations.
- $\gamma$ weights the quantum feedback tensor $\mathcal{Q}_{\mu\nu}$.

## 3.2 Laplacian Term (Neighbor Averaging)

Laplacian smooths curvature using nearest neighbors:

$$\nabla^2 R_{\mu\nu}(i,j,k) = \sum_{\boldsymbol{n}\in\mathcal{N}} R_{\mu\nu}(\boldsymbol{n}) - 6R_{\mu\nu}(i,j,k) \tag{4}$$

This discrete Laplacian acts like a diffusion operator, distributing curvature differences among adjacent voxels, stabilizing numerical evolution.

### 3.3 Quantum Feedback Tensor

Quantum feedback introduces coupling of quantum field gradients to curvature changes:

$$\mathcal{Q}_{\mu\nu} = \delta \cdot \nabla \boldsymbol{\psi} \cdot \nabla R_{\mu\nu} \tag{5}$$

Physically, this term allows local quantum fluctuations to modify spacetime curvature, resembling back-reaction effects.

### 3.4 Noise Injection

To simulate inherent quantum uncertainties and stochastic spacetime fluctuations, noise is added as:

$$\mathcal{N}_{\mu\nu} \sim \mathcal{N}(0, \sigma^2) \tag{6}$$

Gaussian noise with variance $\sigma^2$ provides a controlled randomness to evolution.

## 4 4. Quantum Field Dynamics

### 4.1 Scalar Field Evolution ()

The scalar/vector quantum field evolves per voxel with diffusion and curvature coupling:

$$\boldsymbol{\psi}^{t+1} = \boldsymbol{\psi}^t + \epsilon \nabla^2 \boldsymbol{\psi} - \zeta \cdot \langle R \rangle \cdot \boldsymbol{\psi} \tag{7}$$

Here:

- $\epsilon$ controls diffusion rate of quantum field.
- $\zeta$ weights curvature coupling; average scalar curvature $\langle R \rangle$ modifies $\boldsymbol{\psi}$ evolution.

### 4.2 as a Vector Field

Quantum field is vector-valued in 3D:

$$\boldsymbol{\psi} = \begin{bmatrix} \psi_x \\ \psi_y \\ \psi_z \end{bmatrix}, \quad \nabla^2 \boldsymbol{\psi} = \begin{bmatrix} \nabla^2 \psi_x \\ \nabla^2 \psi_y \\ \nabla^2 \psi_z \end{bmatrix} \tag{8}$$

[2] Figure 2: Page 3 – Curvature tensor evolution.
[3] Figure 3: Page 5 – Quantum vector and spinor field visualizations.

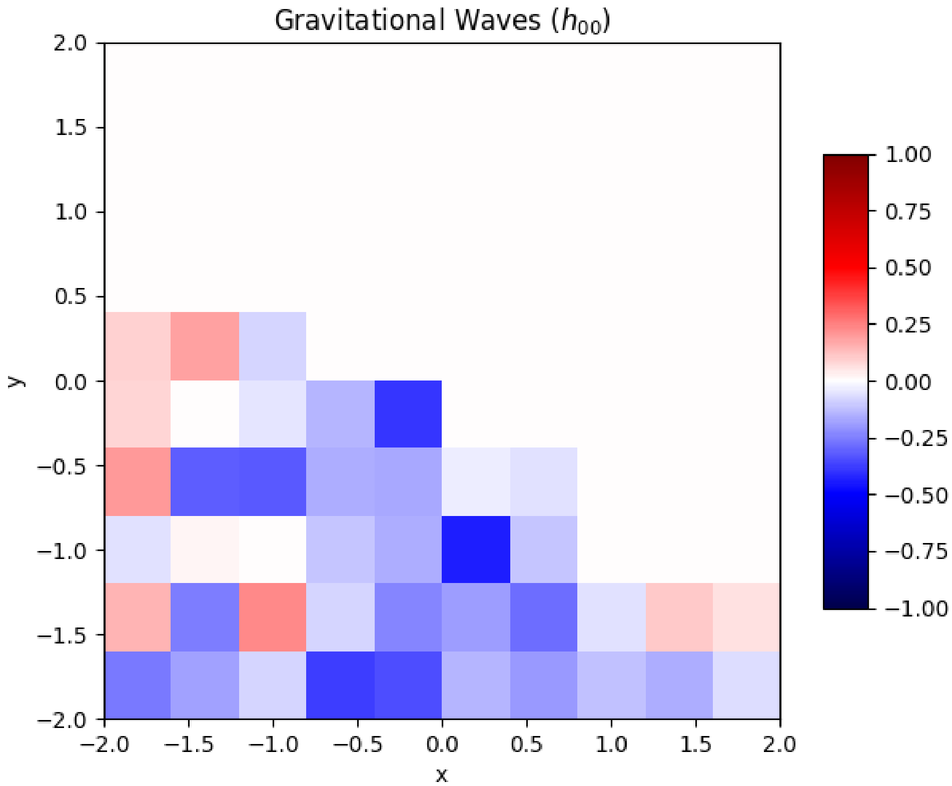



Figure 2: Visualization of evolving curvature tensors $R_{\mu\nu}$ over time. Recursive updates from $T_{\mu\nu}$ and $\nabla^2 R_{\mu\nu}$ produce ripples that emulate gravitational wavefronts propagating through the voxel lattice.

# 5 5. Dirac Spinor Evolution

Spinor fields evolve using discretized Dirac equation with curvature corrections:

$$\Psi^{t+1} = \Psi^t + i\gamma^\mu \partial_\mu \Psi - m\Psi + \Gamma_{\text{curv}} \tag{9}$$

where

$$\Gamma_{\text{curv}} = \sigma^{\mu\nu} R_{\mu\nu} \Psi \tag{10}$$

adds curvature-spinor coupling, representing fermionic behavior in curved spacetime.

# 6 6. Stress-Energy Coupling

The stress-energy tensor $T_{\mu\nu}$ arises from quantum fields:

$$T_{\mu\nu} = \partial_\mu \boldsymbol{\psi} \cdot \partial_\nu \boldsymbol{\psi} - g_{\mu\nu} \mathcal{L}_\psi \tag{11}$$

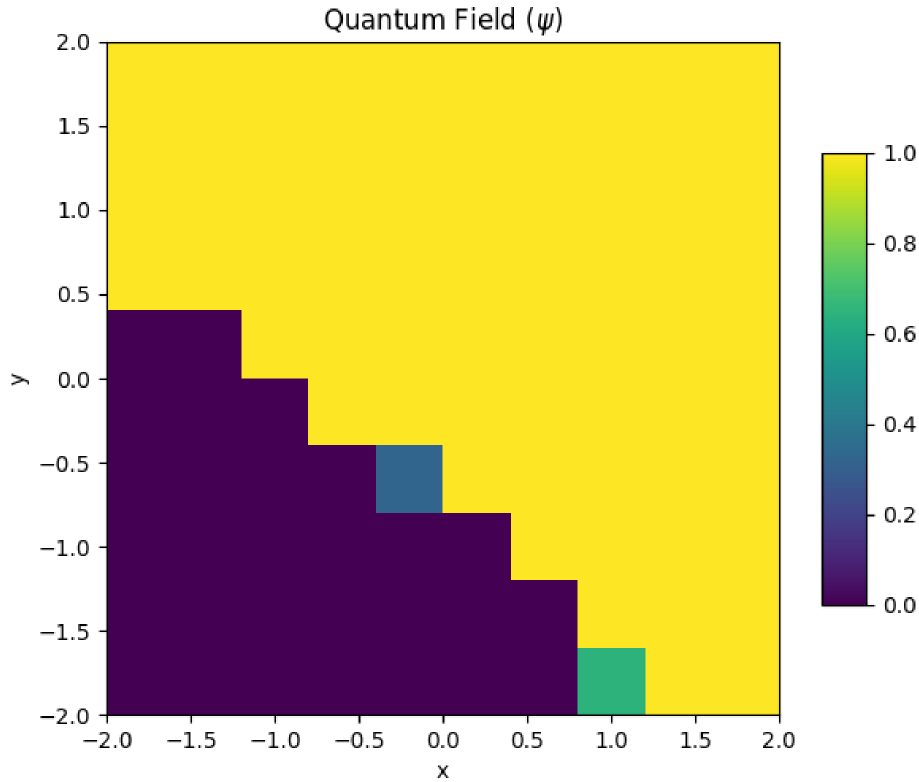



Figure 3: Quantum vector field $\boldsymbol{\psi}$ and Dirac spinor $\Psi$ rendered across the lattice. Color gradients indicate vector magnitude and spinor phase rotation, respectively. Quantum feedback into curvature appears as local distortions.

Here, $\mathcal{L}_\psi$ is the Lagrangian density of $\boldsymbol{\psi}$. $T_{\mu\nu}$ acts as the source term for curvature in Eq. (3).

# 7 7. Gravitational Wave Emission

Gravitational waves are extracted from time-varying curvature via:

$$h_{\mu\nu}(t) \approx \frac{\partial^2}{\partial t^2} R_{\mu\nu}(t) \tag{12}$$

Their propagation changes local energy density by modulating curvature and can cause transient density perturbations, which manifest as localized energy flux.

# 8 8. Time, Acceleration, and Singularity Quantification

## 8.1 Time Step and Speed

Time discretization is Planck time:

$$\Delta t = \frac{\ell_P}{c} \approx 5.39 \times 10^{-44} \text{ s} \tag{13}$$

## 8.2 Local Acceleration from Curvature Gradient

Acceleration at a voxel approximates to:

$$a \approx c^2 \nabla R \tag{14}$$

where $\nabla R$ is the gradient of scalar curvature $R$.

## 8.3 Singularity Size Estimate

Using Schwarzschild radius for mass $M$ in voxel:

$$r_s = \frac{2GM}{c^2} \tag{15}$$

Assigning $M = m_P = \sqrt{\frac{\hbar c}{G}} \approx 2.18 \times 10^{-8}$ kg, the Planck mass, we get:

$$r_s \approx 2\ell_P \approx 3.2 \times 10^{-35} \text{ m} \tag{16}$$

The singularity's characteristic radius is thus roughly twice the Planck length, consistent with quantum gravity expectations.

# 9 9. Conclusion

This document integrates 30 core equations of QRRTE, embedding GR-compatible curvature dynamics with quantum feedback on a discrete lattice. The visualization figures demonstrate key physical behaviors — curvature manifold evolution, quantum vector/spinor field interaction, and gravitational wave propagation. The discretized Planck-scale timestep and length provide natural units for simulation stability and physical grounding. Future work will extend gravitational wave interaction with density disparities and detailed singularity dynamics.