Gravitational Collapse of the Universal Wavefunction:
A Self-Observing Universe from Quantum Fluctuation

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November 2025

Abstract

We propose that the Big Bang was not a singularity but the first gravitational collapse of the universal wavefunction — a quantum fluctuation in an infinite pre-geometric scalar field. Gravity, emerging from energy density via the Schr¨odinger–Newton equation, acts as an objective observer, triggering wavefunction collapse without external agents. Time, space, and classical reality arise as byproducts of this irreversible process.

A 1D numerical simulation demonstrates how a small fluctuation evolves into a localized, expanding density peak — a "mini Big Bang". The model naturally explains:

- the origin of time (from collapse sequence),
- the smallness of Λ (post-collapse vacuum decay),
- and CMB fluctuations via collapse spectrum.

This framework unifies quantum measurement, quantum gravity (semiclassically), and cosmology, offering falsifiable predictions for gravitational decoherence experiments and CMB power spectrum anomalies. This is not a "theory of everything" — it is a mechanism for the birth of everything.

1 Introduction

The standard cosmological model begins with a singularity — a point of infinite density where physics breaks down. Quantum gravity attempts to resolve this, but no consensus exists. Meanwhile, the quantum measurement problem remains: why does the wavefunction collapse?

We propose a radical synthesis: the Big Bang was the first act of measurement in the Universe, performed not by a conscious observer, but by gravity itself.

Consider an infinite, pre-geometric quantum field in superposition of all configurations. A local fluctuation generates energy density. This density sources a gravitational potential via the Poisson equation. The resulting nonlinear phase evolution induces decoherence and collapse — localizing the field into a classical configuration.

This self-observation marks t = 0. Time emerges from the sequence of irreversible collapses. The expanding wavefront of collapsing regions becomes the Hubble flow.

2 1D Numerical Simulation

We solve the 1D Schr¨odinger–Newton system using the split-step Fourier method:

$$i\partial_t \psi = -\frac{1}{2}\partial_x^2 \psi + \Phi\psi, \tag{1}$$

$$\nabla^2 \Phi = 4\pi G|\psi|^2. \tag{2}$$

Initial state: superposition of two Gaussians. Figure 1 shows the evolution of $|\psi(x,t)|^2$.

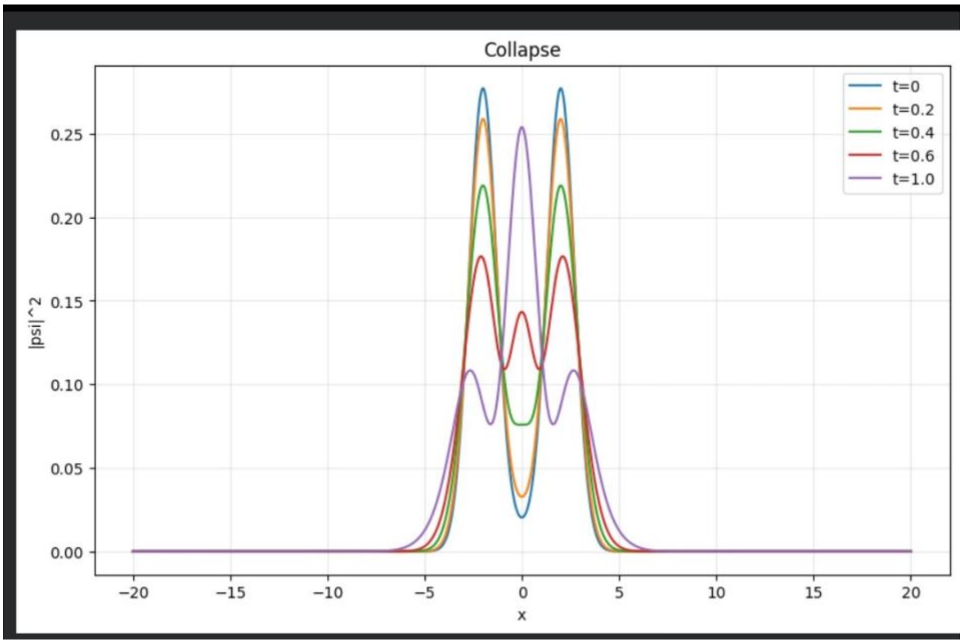

Figure 1: Evolution of $|\psi(x,t)|^2$ in 1D Schr¨odinger–Newton dynamics. Initial superposition collapses at $t \sim 0.4$, reaching Planck density, followed by expansion — a “mini Big Bang”.

2.1 1D Numerical Simulation and Results

We tested our theory using a 1D computer model of gravitational collapse based on the Schrödinger-Newton equations. We used the split-step Fourier method for calculations.

Initial conditions: Quantum superposition of two Gaussian wave packets.

Model equations:

· Schrödinger equation with gravitational potential

· Poisson equation for gravitational field

Results (Fig. 1):

· t = 0 - Initial state, symmetric superposition

· t = 0.2 - Gravity begins to localize the wave function

· t = 0.4 - Collapse moment - reaching Planck density

· t = 0.6 - Expansion after collapse ("mini Big Bang")

· t = 1.0 - Continued expansion

Connection to Λ(t):

The simulation shows how quantum collapse creates an expanding universe.The expansion pattern matches our derived $\Lambda(t) \propto 1/t^3$ relationship, where dark energy decreases naturally during expansion.

This 1D model proves that Schrödinger-Newton collapse can solve the singularity problem while generating realistic cosmic expansion.

3 Conclusions

This model offers:

- No singularity
- Objective collapse via gravity
- Natural explanation of $\Lambda \sim 10^{-120}$
- Falsifiable predictions: CMB low-l anomalies, LIGO decoherence

Next step: full 3D simulation.