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A Proposal for Discrete Spacetime, Emergent Gravity, and the Quantum Measurement Problem

Chenggang Zhang[1, *]

[1] *Independent Researcher, Shanwei 516600, China*

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This brief note announces the construction of a new theoretical framework based on a "dynamic relational network" ontology, aiming to provide a unified description of the emergence of spacetime, matter, and gravity, while offering a novel perspective on the quantum measurement problem. In this framework, space is constituted by discrete nodes and links, matter manifests as excitation patterns propagating on the network, and gravity is interpreted as a macroscopic statistical effect arising from the inhomogeneous spatial distribution of network link density. A full-length paper containing the complete mathematical axiomatic system, derivations of the field equations, and physical applications will be published separately in the near future. This note serves to establish priority and to outline the core ideas and principal conclusions of the theory.

I. INTRODUCTION: TWO FUNDAMENTAL CHALLENGES IN CONTEMPORARY THEORETICAL PHYSICS

Modern theoretical physics confronts two profound challenges. The first is the **problem of quantum gravity**, namely the fundamental incompatibility between general relativity and quantum field theory. The former treats spacetime as a dynamical entity, whereas the latter is consistently built upon a fixed background spacetime. The ultraviolet divergences and other difficulties stemming from the assumption of a continuous spacetime strongly suggest that spacetime may possess a discrete microscopic structure at the Planck scale [1].

The second is the **problem of interpreting quantum mechanics**. Since the inception of quantum mechanics, no unified consensus has been reached on core issues such as the nature of the wave function and the "collapse" process during measurement [2]. Major interpretations—the Copenhagen interpretation, the many-worlds interpretation, and hidden variable theories—each suffer from their own limitations, a common deficiency being the lack of an ontological foundation rooted in the underlying structure of spacetime.

Currently, mainstream candidate theories of quantum gravity (e.g., loop quantum gravity, causal set theory) primarily address the first problem, whereas research on the interpretation of quantum mechanics largely proceeds independently of spacetime theory. Against this backdrop, a unified framework capable of simultaneously tackling both major challenges would be of considerable theoretical value.

II. CORE IDEA: THE DYNAMIC RELATIONAL NETWORK ONTOLOGY

The theoretical framework proposed here rests upon a simple yet fundamental ontology: **the most basic entity of the universe is neither matter nor spacetime, but pure relations.** These relations are concretely realized as a dynamically evolving network.

The basic constituents of this network are **nodes** and **links**. Nodes represent indivisible fundamental quanta of space, while links represent adjacency relations between them. The network admits no pre-existing, continuous spacetime background; on the contrary, continuous spacetime itself emerges as a statistical approximation of this relational network in the large-scale macroscopic limit.

Within this framework, the traditional concept of "matter" is thoroughly reinterpreted. Matter is no longer an entity existing independently of spacetime, but rather manifests as **complex probability amplitude excitation modes propagating on the network**. A particle is not a point-like object, but a localized excitation event on the network. Likewise, the concept of "gravity" undergoes a fundamental redefinition. Gravity is not a fundamental interaction of nature, but rather **a macroscopic statistical emergent effect resulting from the inhomogeneous spatial distribution of network link density**, whose essence can be understood as an entropic force. Furthermore, the seemingly mysterious measurement problem in quantum mechanics acquires a clear physical explanation within this framework: the so-called "wave function collapse" can be described as a large-scale decoherence and branch-selection process of the network topology following the coupling of the macroscopic measurement apparatus with the quantum system.

III. PREVIEW OF PRINCIPAL RESULTS

The full-length paper, which contains the complete mathematical derivations, will present the following core

* zhangchgang@163.com

results in detail:

- **Emergent gravitational equation**: Under the mean-field approximation and in the continuum limit, the dynamical equation for the network link density becomes strictly isomorphic in mathematical structure to the Poisson equation of Newtonian gravity, thereby naturally providing a microscopic foundation for gravitational phenomena.

- **Emergent quantum mechanical equation**: In the same limit, the propagation equation for the probability amplitude on the network rigorously evolves into the Schrödinger equation in curved spacetime.

- **Statistical origin of gravity**: The theory rigorously demonstrates that the gravitational constant can be derived from combinations of the microscopic dynamical parameters of the network, proving that gravity is a statistically emergent entropic force.

- **Topological basis for the interpretation of quantum mechanics**: The framework provides a physical substrate based on discrete spacetime structure for the orthodox probabilistic interpretation of quantum mechanics, and supplies a new explanation for the measurement problem that does not rely on the postulate of "physical collapse".

- **Self-consistency checks**: The framework not only recovers classical gravitational theory in the weak-field limit, but also provides novel, in-principle testable physical effects such as the "self-gravitational breathing of a wave packet."

IV. RELATION TO EXISTING THEORIES

This framework shares with theories such as **loop quantum gravity** the basic spirit of discrete spacetime, but its key distinction lies in the fact that it proceeds from a single ontology (the dynamic relational network) to provide a unified description of matter, spacetime, and gravity, rather than merely quantizing spacetime geometry. This opens a new pathway for resolving the difficulty of coupling matter fields in quantum gravity.

At the same time, the framework supplies a concrete microscopic dynamical model for **Verlinde's entropic gravity hypothesis**, thereby reducing gravity from a thermodynamic phenomenon to a more fundamental network statistical mechanics.

Regarding the interpretation of quantum mechanics, the **Network Dynamic Emergence Interpretation** it proposes possesses a clear physical mechanism and requires fewer philosophical presuppositions compared with traditional schemes such as the Copenhagen interpretation and the many-worlds interpretation.

V. OUTLOOK AND ANNOUNCEMENT

This note serves to announce the basic conception and principal conclusions of this theoretical work. A full-length paper containing the complete mathematical axiomatic system, detailed derivations, numerical simulation schemes, and potential astronomical observational predictions is in preparation and will be uploaded to arXiv shortly.

The author welcomes criticism, discussion, and collaboration from colleagues in the academic community, with the aim of jointly exploring the theoretical boundaries and physical implications of this framework.

[1] C. Rovelli, *Quantum Gravity*, Cambridge University Press, 2004.

[2] C. P. Sun, "The centenary of quantum mechanics: from microscopic quantum structures to macroscopic quantum effects," *Physics*, **55**, 1 (2026).