



Quantum Superposition Effect of Gravitational Field, Negative Pressure and Dark Energy

Article Record

Dr. Gang Lee^{§*}
Independent Researcher
*Corresponding Author



RECEIVED

2026-05-15

ACCEPTED

2026-05-25

ONLINE PUBLISHED

2026-06-06

PUBLISHED

2026-06-23

PEER REVIEW

Double Blind

Abstract

This paper explains how dark energy is generated through a simplified model based on noncommutative quantum gravity.

Noncommutative quantum gravity

Dark energy

Quantum superposition

Negative pressure

Gravitational field

Feynman path integral

Energy-momentum field

AI USE STATEMENT

No generative AI was used for analysis or results.

FUNDING

No external funding was declared for this work.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY

Not applicable for this article.

ETHICS

No ethics committee approval was required for this article type.

CONSENT

Not applicable for this article.

TRIAL REG.

Not applicable.

Crossref DOI: 10.34257/GJSFRA257434

How to Cite: Lee (2026). Quantum Superposition Effect of Gravitational Field, Negative Pressure and Dark Energy. Global Journal of Science Frontier Research, 26(1), 10-11. DOI: 10.34257/GJS-FRA257434

LICENSE

© 2026 Global Journals. Open-access article under CC BY-NC-ND 4.0 International License.



Print ISSN 0975-5896



9 770975 589008

Online ISSN 2249-4626



9 772249 462017

Under the strict compliance and defined process of



METADATA CONTINUATION

AUTHOR CONTACT QR LEDGER

Dr. Gang Leeð*



ARCHIVAL RECORD

Quantum Superposition Effect of Gravitational Field, Negative Pressure and Dark Energy

Dr. Gang Lee^{§*}

§ Independent Researcher

Abstract

This paper explains how dark energy is generated through a simplified model based on noncommutative quantum gravity.

Keywords: Noncommutative quantum gravity, Dark energy, Quantum superposition, Negative pressure, Gravitational field, Feynman path integral, Energy-momentum field

* Corresponding Author
Dr. Gang Lee

DOI
10.34257/GJSFRA257434

1. Introduction

In the paper [1],[2],[3],[4],[5],[6] and [7], we introduce the non-commutative quantum gravity and its applications. In this paper, from a simplified model based on the theory of noncommutative quantum gravity, we have found a mechanism that can cause negative pressure in a system and generate dark energy.

2. Quantum Superposition effect of Gravitational Field, Negative Pressure and Dark Energy

In the paper [1] and [2] we introduce a wave packet approximate to the Dirac δ -function which can be explained as a semiclassical graviton. It can be written as follows

$$\xi^i(x, r) = \begin{cases} \xi^r = r + C^r(x) \exp(-\frac{r}{l_P}) \\ \xi^\theta = \theta(x) \\ \xi^\phi = \phi(x) \\ \xi^t = t + C^t(x) \exp(-\frac{|t|}{t_P}) \end{cases} \quad (2.1)$$

The dynamic variables of ξ^i are $C^i(x) = (C^r(x), \theta(x), \phi(x), C^t(x))$. Quantization only quantizes the dynamic variable $\hat{C}^i(x)$. Therefore, in this paper, for the sake of brevity, we directly consider $C^i(x)$ as the fundamental state function of gravitational field.

From the paper [1] we have the Lagrangian density of graviton is

$$\mathcal{L} = -\frac{\eta^{\mu\nu}}{2} \frac{\partial \xi^i(x, r)}{\partial x^\mu} \frac{\partial \xi^j(x, r)}{\partial x^\nu} \eta_{ij} \quad (2.2)$$

For simplicity, assume that the initial state has two gravitational fields $C_{(1)}^i$ and $C_{(2)}^i$, and $C_{(2)}^i = k \cdot C_{(1)}^i, k > 0, k \in \mathbb{R}$. Let the gravitational source of $C_{(1)}^i$ and $C_{(2)}^i$ be $j_{(1)}^i$ and $j_{(2)}^i$, respectively. If the gravity between $j_{(1)}^i$ and $j_{(2)}^i$ neglect as negligible, the joint propagator $K_{(1+2)}$ of $C_{(1)}^i + C_{(2)}^i$ in the Feynman path integral form can be written as follows

$$\begin{aligned} K_{(1+2)} &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] e^{i(S[C_{(1)}^i] + S[C_{(2)}^i])/\hbar} \\ &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i]/\hbar} \cdot e^{iS[C_{(2)}^i]/\hbar} \right) \end{aligned} \quad (2.3)$$

If $C_{(2)}^i = k \cdot C_{(1)}^i$, for the Lagrangian density (2.2), we have

$$S[C_{(2)}] = k^2 \cdot S[C_{(1)}] \quad (2.4)$$

Then

$$\begin{aligned} K_{(1+2)} &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i]/\hbar} \cdot e^{iS[C_{(2)}^i]/\hbar} \right) \\ &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{i(1+k^2)S[C_{(1)}^i]/\hbar} \right) \end{aligned} \quad (2.5)$$

The final state $\tilde{C}_{(1+2)}^i$ of $C_{(1)}^i + C_{(2)}^i$ is

$$\tilde{C}_{(1+2)}^i = \int d^4x K_{(1+2)} \cdot (C_{(1)}^i + C_{(2)}^i) \quad (2.6)$$

Consider the case where there is gravity between sources $j_{(1)}^i$ and $j_{(2)}^i$ of the initial state $C_{(1)}^i + C_{(2)}^i$. In this case, the Feynman path integral should be written as follows

$$K_{(1\oplus 2)} = \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i + C_{(2)}^i]/\hbar} \right) \quad (2.7)$$

where $\oplus$ denotes the quantum superposition of states.

For the Lagrangian density (2.2), if $C_{(2)}^i = k \cdot C_{(1)}^i$, we have

$$S[C_{(1)}^i + C_{(2)}^i] = (1+k)^2 \cdot S[C_{(1)}^i] \quad (2.8)$$

Then Eq. (2.7) can be written as follows

$$\begin{aligned} K_{(1\oplus 2)} &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i + C_{(2)}^i]/\hbar} \right) \\ &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{i(1+k)^2 S[C_{(1)}^i]/\hbar} \right) \end{aligned} \quad (2.9)$$

The propagator $K_{(1\oplus 2)}$ is not equal to $K_{(1+2)}$. Then the final states will be different

$$\tilde{C}_{(1\oplus 2)}^i \neq \tilde{C}_{(1+2)}^i \quad (2.10)$$

Therefore the sources of the final states will be different

$$J_{(1\oplus 2)}^i \neq J_{(1+2)}^i \quad (2.11)$$

Now let's analyze the meaning of Eq. (2.11). Recall Eq. (2.9), it can be written as

$$\begin{aligned} K_{(1\oplus 2)} &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i + C_{(2)}^i]/\hbar} \right) \\ &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{i(1+k)^2 S[C_{(1)}^i]/\hbar} \right) \\ &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i]/\hbar} \right)^{(1+k^2+2k)} \\ &= \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] \left(e^{iS[C_{(1)}^i]/\hbar} \cdot e^{iS[C_{(2)}^i]/\hbar} \cdot e^{iS[C_{(3)}^i]/\hbar} \right) \end{aligned} \quad (2.12)$$

where $C_{(3)}^i = \sqrt{2k} \cdot C_{(1)}^i$. The source of $C_{(3)}^i$ can be written as $J_{(3)}^i$. The measure of the Feynman path integral can be written as

$$\int \mathcal{D}[C_{(1)}^i + C_{(2)}^i] = \frac{1+k}{1+k+\sqrt{2k}} \int \mathcal{D}[C_{(1)}^i + C_{(2)}^i + C_{(3)}^i] \quad (2.13)$$

Factor $\frac{1+k}{1+k+\sqrt{2k}}$, as an overall constant factor, is independent of field configurations and external sources, so it can be reduced and eliminated via functional integration when calculating all physical observables, such as correlation functions, scattering cross sections. This factor has no observable physical effects. While it may perturb vacuum fluctuations, among other effects, we do not consider it in this paper. By comparing Eq. (2.5) and Eq. (2.12), we can see that $K_{(1+2)} \neq K_{(1\oplus 2)}$, therefore Eq. (2.12) isn't an algebraic rewriting of the same two-field system, a new physical degree of freedom is introduced in Eq. (2.12). Eq. (2.12) implies that there is an additional energy-momentum field $J_{(3)}^i$ in the final state, which is similar to the sources $J_{(1)}^i$ and $J_{(2)}^i$. And Eq. (2.12) also implies that the gravity between $J_{(1)}^i, J_{(2)}^i$ and $J_{(3)}^i$ can be neglected as negligible, indicating that the spacetime in the final state has expanded sufficiently.

The addition of energy-momentum field $J_{(3)}^i$ indicates an increase in total energy of the system, and the space is expanding, it means that the quantum superposition of the gravitational field does negative work during the expansion process, therefore the corresponding pressure p is a negative value. Written the energy density of the system as ρ . According to the Friedman acceleration equation and the Raychaudhuri equation, if $p < -\frac{\rho}{3}$, the negative pressure will cause gravitational repulsion. The negative pressure are rarely occurs, it is precisely the characteristic of dark energy, therefore the energy-momentum fields such as $J_{(3)}^i$ can be regarded as dark energy. So that dark energy is continuously generated by the quantum superposition effect of the gravitational fields, until the space expands to a sufficiently large final state where the gravity between the gravitational sources neglect as negligible.

According to the model proposed in this paper, dark energy originates from the conversion induced by the quantum superposition effect of the gravitational field. Therefore, it can be reasonably conjectured that dark energy only participates in gravitational interaction.

3. Conclusion

This paper calculate the quantum effects of gravitational fields by the Feynman path integration. The calculation results indicate that the quantum superposition of the gravitational fields will be converted into the additional energymomentum fields. The quantum superposition of gravitational fields produces negative work, increasing the energy of the system and resulting in a negative pressure in the system. When the negative pressure reaches a certain strength, it will cause gravitational repulsion, so the energy-momentum fields converted through quantum superposition can be understood as dark energy.

■ REFERENCES

- [1] A New Approach to Quantum Gravity DOI: 10.34257/GJSFRVOL20IS2PG1
- [2] Noncommutative Quantum Gravity and Symmetry of Klein-Gordon Equation DOI: 10.34257/GJSFRVOL22IS7PG19
- [3] Noncommutative Quantum Gravity and Dark Matter DOI: 10.34257/GJSFRVOL23IS4PG7
- [4] Macroscopic Effect of Quantum Gravity in General Static Isotropic Gravitational Field DOI: 10.34257/GJSFRVOL24IS2PG49
- [5] Calculation of Macroscopic Effect of Quantum Gravity in General Static Isotropic Gravitational Field DOI: 10.34257/GJSFRVOL24IS4PG75
- [6] The Role of Noncommutative Quantum Gravity in Galactic Dynamics and Dark Matter Phenomena DOI: 10.34257/GJSFRVOL25IS2PG13
- [7] Quantum Superposition and the Emergence of Negative Energy in Gravitational Fields DOI: 10.34257/GJSFRVOL25IS5PG19