A Quantum Field Theory Model of Gravity Induced by Negative Mass Dark Matter and Unified with Gauge Fields  
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**Abstract:** Based on the core hypothesis that gravity is induced by the repulsive effect of negative mass dark matter (NMDM), this paper constructs a quantum field theory model unifying graviton exchange with gauge fields. By introducing the ABC vortex field coupling mechanism, the NMDM repulsive potential is transformed into equivalent gravity, achieving unification between gravity and electromagnetic, weak, and strong forces. The model satisfies general covariance, gauge invariance, and quantum unitarity, predicting observable gravity-gauge field mixing effects and dark matter field mass signatures.  
1 Introduction  
In traditional gravitational theory, the graviton (spin-2 boson) mediates attraction, yet its quantization and unification with gauge fields face fundamental challenges. Li Zhijun, in *The ABC Mechanism in Cosmology*, proposed a groundbreaking perspective: gravity between positive-mass matter arises indirectly from the repulsive effect of negative mass dark matter (NMDM). The core hypotheses are:  
- NMDM particles have mass and are uniformly distributed in the cosmic background.  
- NMDM exerts a repulsive potential on positive-mass matter: (since ).  
- “Gravity” between two positive-mass objects is an indirect effect of relative clustering induced by NMDM repulsion.  
**Objectives of this paper:**  
1. Formulate the quantum field theory framework for NMDM-induced gravity.  
2. Achieve unification of gravity with gauge fields.  
3. Verify mathematical self-consistency and experimental observability.  
2 Quantum Field Theory Foundation of NMDM-Induced Gravity  
2.1 Field-Theoretic Derivation of Effective Gravitational Potential  
Assume NMDM is described by a scalar field , with its repulsive potential satisfying the modified Poisson equation:

where is the effective negative mass density of NMDM. After quantization, the propagator of the field is:

The corresponding graviton exchange amplitude is:

Newtonian gravity is recovered when .  
 2.2 Synergistic Mechanism of Graviton and Gravitino  
To eliminate quantum divergences, supersymmetric partners are introduced:  
- **Graviton (spin-2):** Mediates long-range gravity.  
- **Gravitino (spin-3/2):** Provides quantum corrections.  
The one-loop contribution satisfies:

where the gravitino loop diagram provides negative contributions, canceling ultraviolet divergences from NMDM repulsion.  
 3 Unified Model of Gravity and Gauge Fields  
3.1 Construction of Unified Action  
The total action comprises four parts:

**(1) Gravity and NMDM Sector:**

where the potential , and triggers symmetry breaking.  
**(2) Gauge Field Sector:**

**(3) Matter Field and Coupling Terms:**

where is the NMDM-matter Yukawa coupling.  
 3.2 Symmetry Breaking and Force Separation  
When acquires a vacuum expectation value :  
- **Gravity Separation:** The repulsive potential of the NMDM field transforms into an equivalent gravitational potential .  
- **Gauge Force Separation:** electroweak breaking occurs.  
The post-breaking effective Lagrangian is:

4 Verification of Mathematical Self-Consistency  
 4.1 General Covariance and Gauge Invariance  
- **Gravity Sector:** The action is invariant under diffeomorphisms.  
- **Gauge Sector:** Satisfies , , and gauge transformations.  
- **Coupling Terms:** is invariant under global supersymmetry transformations.  
 4.2 Anomaly-Free Quantum Corrections  
**(1) Graviton Self-Energy Correction**  
Divergent one-loop terms are canceled via -field renormalization:

Coefficients are determined by -field vacuum polarization:

**(2) Preservation of Gauge Symmetry**  
The -gauge field coupling term satisfies the Ward-Takahashi identity, ensuring commutation relations of gauge group generators remain unchanged.  
 4.3 Energy Scale Matching  
Renormalization group equations for coupling constants:

Unification is achieved at the GUT scale :

5 Experimental Observability Predictions  
 5.1 Gravity-Gauge Field Mixing Effect  
A novel interaction potential:

where is the mixing parameter.  
**Experimental Tests:**  
| **Experiment Type** | **Detection Precision** | **Constrained Parameter** |  
|—————————|————————–|—————————-|  
| Precision Torsion Balance | | |  
| Atom Interferometer | | |  
| THESEUS Gravitational Wave| THz Frequency Band | |  
5.2 Cosmological Tests  
**(1) Dark Energy Density**  
The NMDM field contributes to the cosmological constant:

**(2) Galaxy Rotation Curves**  
Modified gravitational potential:

Fits SPARC galaxy survey data with goodness-of-fit .  
 6 Conclusions and Outlook  
This paper establishes a gravity-gauge field unification model based on NMDM repulsion. Key achievements include:  
1. **Mechanistic Innovation:** NMDM repulsive potential transforms into equivalent gravity via ABC vortex field coupling.  
2. **Mathematical Self-Consistency:** Supersymmetric corrections eliminate quantum divergences; gauge groups unify at .  
3. **Experimental Predictions:** Gravity-gauge mixing effects are detectable via THz gravitational waves and atom interferometers.  
**Future Directions:**  
- Quantify the impact of NMDM field quantum fluctuations on primordial gravitational wave spectra.  
- Construct a holographic dual model within the AdS/CFT framework.  
- Design LHC upgrade experiments to detect NMDM particles with .  
  
 References  
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 Appendix  
**A.** Derivation of 26-dimensional Einstein Equations  
**B.** Topological Quantum Number Calculation for ABC Vortex Field  
**C.** Feynman Rules for Gravitino Loop Diagrams