The Synergistic Mechanism of Negative-Mass Dark Matter Preventing Matter Particles from Collapsing into Black Holes during Cosmic Inflation  
**Authors:** Li Zhijun¹, Zhao Guangyao¹,²  
**Abstract**  
This paper proposes a mathematically self-consistent model explaining why matter particles failed to collapse into black holes during cosmic inflation. Based on the interaction between negative-mass dark matter (26.7%) and ordinary matter (4.9%), we establish a triple synergy mechanism encompassing spacetime stretching effects, repulsive barriers, and quantum dispersion. Through rigorous derivation, we demonstrate that inflationary timescale dominance (), repulsive potential barriers from negative-mass dark matter (), and quantum pressure () collectively suppress gravitational collapse. Numerical verification reveals exponential decay of density perturbations (), providing a novel explanation for early universe stability.  
**Keywords:** Cosmic inflation; Negative-mass dark matter; Quantum pressure; Gravitational collapse; 26-dimensional combinatorial space  
 **1. Introduction**  
During cosmic inflation, matter density reached , yet primordial black holes did not form—a contradiction requiring physical explanation. Traditional theories emphasize spacetime expansion effects but neglect the active repulsive role of negative-mass dark matter (). Based on Li Zhijun’s 26-dimensional combinatorial space framework [1], this work establishes a triple synergy model, quantifying for the first time the suppression mechanism of negative-mass dark matter on black hole formation.  
 **2. Physical Mechanism and Mathematical Model**  
**2.1 Triple Synergy Effects**  
| Mechanism | Physical Essence | Mathematical Characteristic |  
|———–|——————|——————————|  
| Spacetime stretching effect | Space expansion rate > Gravitational collapse rate | |  
| Repulsive barrier of negative mass | Repulsive pressure gradient from negative-mass particle soup | |  
| Quantum dispersion effect | Heisenberg uncertainty suppressing local aggregation | |  
 **2.2 Competition between Spacetime Expansion and Gravitational Collapse**  
Free-fall timescale (gravitational collapse):

Hubble timescale (cosmic expansion):

Critical condition: Collapse is suppressed when .  
 **2.3 Repulsive Barrier Model of Negative Mass**  
Repulsive pressure from negative-mass dark matter:

Corresponding barrier function:

**2.4 Quantum Dispersion Effect**  
Quantum pressure at Planck scale ():

This pressure resists gravitational compression: .  
 **3. Mathematical Proof of Non-Collapse Criteria**  
 **3.1 Criterion 1: Inflationary Timescale Dominance**  
Substituting inflationary parameters:  
-   
- (Li-Zhao ratio)  
-   
Timescale ratio:

**Conclusion:** Expansion is times faster than collapse.  
 **3.2 Criterion 2: Repulsion-Gravity Balance**  
Critical curvature for collapse:

Actual curvature dominated by negative mass:

Consistently below critical value.  
 **3.3 Criterion 3: Quantum Pressure Verification**  
Pressure ratio:

Quantum pressure completely suppresses gravitational collapse.  
 **4. Complete Dynamical Equations**  
Cosmic evolution equations:

where is the particle generation source function (peaks at ), and is the quantum-corrected sound speed.  
 **5. Numerical Verification**  
 **5.1 Typical Parameters**  
| Physical Quantity | Value | Unit |  
|——————-|——-|——|  
| Inflation time | | s |  
| Hubble parameter | | s |  
| Matter density | | kg/m |  
| Quantum pressure | | Pa |  
| Gravitational pressure | | Pa |  
 **5.2 Stability Verification**  
Density perturbation decay rate:

Perturbations decay exponentially: .  
 **6. Conclusions and Discussion**  
 **6.1 Core Conclusions**  
The mechanism preventing matter particles from collapsing into black holes stems from triple synergy:  
1. **Timescale dominance:** (difference of times)  
2. **Repulsive barrier:** Negative-mass dark matter generates potential  
3. **Quantum freezing:** prevents local aggregation  
 **6.2 Physical Significance**  
- The extremely short inflationary timescale () is the direct cause  
- The synergy between negative-mass quantum pressure and spacetime expansion is the essential mechanism  
- Provides new observational constraints on dark matter-ordinary matter interactions (e.g., CMB polarization modes)  
 **6.3 Theoretical Innovation**  
For the first time, within the 26-dimensional combinatorial space framework [1], we unify the repulsive effects of negative-mass dark matter, quantum pressure, and inflationary dynamics, offering a self-consistent explanation for the absence of primordial black holes.  
 **References**  
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