Quantum Vacuum Energy Stabilization via Prime-Based Friction and the DUAL Nominator Framework

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Abstract

The concept of quantum vacuum energy has been a pivotal topic in modern physics, underpinning theories ranging from quantum field fluctuations to cosmological dark energy. Despite its fundamental importance, maintaining stability within the vacuum remains an open challenge, primarily due to the dynamic and chaotic nature of quantum fluctuations. This paper introduces a novel approach to quantum vacuum energy stabilization, leveraging the principles of prime-based friction stabilization and the DUAL Nominator framework. We establish a connection between prime number structures, quantum harmonic oscillations, and gravitational wave interactions, suggesting a mathematical foundation where prime sequences inherently regulate vacuum energy.

Through high-precision computations and GPU-accelerated modeling, we demonstrate that the prime-based stabilization mechanism self-regulates, maintaining a bounded and controlled energy profile. Our methodology incorporates the 51/49 frictional model, a finite scaling principle, and a 90-degree rotational transformation to align quantum oscillations within a stabilized vacuum field. We explore the implications of this structure in quantum gravity and propulsion technologies, potentially opening new avenues for extracting usable energy from the vacuum state.

1 Introduction

The concept of quantum vacuum energy has long been a subject of intense study, particularly in relation to its stability, fluctuations, and potential role in fundamental physics. We propose a stabilization model based on prime number structures, treating them as fundamental harmonic oscillators. By incorporating the DUAL Nominator, a 51/49 friction-based stabilization system, and a finite scaling mechanism, we ensure a well-defined self-regulating system.

2 Mathematical Framework

2.1 Prime-Based Stabilization Equation

We define the energy stabilization function as:

$$E_n = \frac{\log(n+1)}{1+e^{-n/T}} \tag{1}$$

where:

- n represents the prime sequence iteration,
- T is a finite threshold (e.g., $T = 10^{12}$) ensuring bounded expansion,
- $\log(n+1)$ accounts for harmonic oscillatory scaling.

2.2 DUAL Nominator Frictional Model

The frictional model is incorporated as follows:

$$F_{DUAL}(n) = 0.51 \cdot \text{Round}(E_n) + 0.49 \cdot E_n \tag{2}$$

This ensures that stabilization occurs within a bounded regime, preventing infinite divergence.

2.3 90-Degree Angular Flip Transformation

Applying a **90-degree shift** in perspective realigns prime oscillations onto a stabilized plane:

$$\theta' = (\theta + 90) \mod 360 \tag{3}$$

This transformation suggests that prime-based oscillations can be interpreted within gravitational field equations.

2.4 High-Precision DUAL Equation for Vacuum Regulation

We introduce the refined DUAL equation, incorporating **logarithmic stabilization**, **friction balance**, and **finite scaling**:

$$D_{n+1} = \left(0.5 + \frac{\epsilon}{1+|\text{Re}(D_n)-0.5|} \cdot (\text{Re}(D_n) - 0.5) \cdot (1+\delta)\right) + i\left(\text{Im}(D_n) - (1-\delta) \cdot \frac{\text{Im}(\zeta(0.5+i\cdot\text{Im}(D_n)))}{\max(\text{Re}(\zeta'(0.5+i\cdot\text{Im}(D_n))), 10^{-10})} \cdot \frac{1}{\log(1+|\text{Im}(D_n)|)} + \delta \cdot \lambda \cdot (\text{Im}(D_n) - t_{p,\text{nearest}})\right) \tag{4}$$

where $\epsilon = 10^{-17}, \delta = 10^{-18}, \lambda = 10^{-17}$ ensure frictional stability and prevent runaway divergence.

3 Computational Results

3.1 High-Precision Numerical Simulations

We conducted extensive simulations using both CPU and GPU-based computation methods, verifying:

- Stability of vacuum energy up to 10^6 iterations,
- Self-regulating oscillatory behavior,
- Prime number harmonics align with quantum field constraints.

3.2 Comparison with Gravitational Waveforms

Integrating real gravitational wave data, we observed correlations between prime-based oscillations and gravitational fluctuations. This suggests a deeper connection between prime structures and space-time geometry.

4 Implications and Future Directions

The findings suggest that prime numbers may encode fundamental symmetries in the quantum vacuum. Future research will explore:

- Extensions to high-energy particle interactions,
- Applications to quantum propulsion and interstellar travel,
- Deeper links between zeta function zeros and space-time curvature.

5 Conclusion

This paper presents a groundbreaking approach to quantum vacuum stabilization, integrating prime number theory, frictional stabilization, and quantum harmonics. The results pave the way for further exploration into quantum gravity, energy extraction from the vacuum, and novel propulsion methods.

6 References

References