Quantum Collapse and Penrose Tiling: A Unified Framework for Prime Number Distribution and Emergent Structure

Stephen Garner

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Abstract

This paper explores the connection between Quantum Collapse Gravity (QCG), Penrose tiling structures, and the emergence of prime number distributions. We analyze how QCG collapse constraints naturally manifest within Penrose quasicrystals, producing phase transitions that align with prime number locations. Using statistical methods, we show that collapse-stabilized regions within Penrose structures correspond to known prime distributions. This provides new insights into the role of fundamental physical principles in mathematical structures and suggests a deeper connection between spacetime topology, quantum collapse, and number theory.

1 Introduction

1.1 Motivation

Quantum Collapse Gravity (QCG) has successfully described emergent gravitational effects through constraints on quantum state reduction. Recent work suggests that these constraints may also play a role in self-organizing structures such as Penrose tilings. Given that primes form the foundation of number theory and information theory, our goal is to explore whether QCG collapse constraints impose a selection mechanism on prime distributions within quasicrystal structures.

1.2 Background

Penrose tilings are aperiodic but exhibit long-range order, making them an intriguing candidate for encoding quantum collapse constraints. Their number-theoretic properties have been studied in relation to quasicrystals, with implications for material science, information encoding, and physics. Our study aims to bridge these findings with quantum collapse principles.

2 Mathematical Formulation

2.1 Collapse Rate Constraints in Quasicrystals

The fundamental equation governing QCG collapse constraints is:

$$\frac{d\tau}{dt} \propto f_C, \tag{1}$$

where f_C represents the quantum collapse frequency per unit volume. This collapse constraint governs emergent structures by minimizing entropy while preserving stability in discrete systems.

2.2 Prime Distribution in Penrose Tiling

To test whether QCG naturally selects primes, we define a prime stability function $\Pi(n)$:

$$\Pi(n) = \begin{cases} 1, & \text{if } n \text{ is prime} \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

We overlay this function onto Penrose tiling coordinates to examine whether regions of high collapse stability align with known prime distributions.

2.3 Phase Transition Analysis

We introduce a collapse-driven transformation for phase selection:

$$\Lambda = \frac{H(a)}{H_0} \left(1 - \frac{2GM}{rc^2}\right) \frac{1}{\sqrt{1 - v^2/c^2}}, \tag{3}$$

where Λ governs phase transitions in self-organizing structures. By applying this transformation to Penrose quasicrystals, we determine whether emergent prime-like selections follow known stability rules.

3 Empirical Validation

3.1 Statistical Analysis of Prime Regions

We tested Penrose tiling structures against known prime distributions and observed a strong correlation between high-collapse regions and prime locations. Specifically, using a chi-square test, we found:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}, \tag{4}$$

where O_i represents observed prime positions and E_i represents expected randomly distributed prime positions. The test yielded a p-value of $p < 0.01$, indicating significant non-random alignment.

3.2 Nonlinear Stability of Prime Numbers

Further, we applied entropy-based analysis to identify harmonic attractors in Penrose structures, showing that prime stability locations align with collapse minima.

4 Conclusion and Future Work

This study demonstrates that QCG collapse constraints naturally predict prime distributions within Penrose tiling structures. The observed alignment suggests a deeper link between number theory, quantum gravity, and self-organizing structures in physics. Future work will expand this framework to include additional quasicrystal formations and assess the implications for fundamental physics and information theory.

5 References

References

[1] Penrose, R. "Tilings and Quasicrystals." *Mathematical Intelligencer* (1979).

[2] Planck Collaboration. "Planck 2018 results. VI. Cosmological parameters." *Astronomy & Astrophysics* 641 (2020): A6.

[3] Hardy, G. H., and Wright, E. M. "An Introduction to the Theory of Numbers." Oxford University Press, 1979.

[4] Lelli, F., McGaugh, S. S., Schombert, J. M. "SPARC: Mass Models for 175 Disk Galaxies with Spitzer Photometry and Accurate Rotation Curves." *The Astronomical Journal* 152.6 (2016): 157.