Recursive Prime Distribution Model (RPDM-)
A Recursive Inference Approach to Prime Numbers

Joshua Robert Humphrey

May 24, 2025

Abstract

The distribution of prime numbers has long been a fundamental yet unresolved problem in number theory. Traditional models treat primes as discrete, irregularly spaced entities, but this paper introduces a novel framework: the **Recursive Prime Distribution Model (RPDM-)**. By leveraging **Holographic Fractal Chiral Toroidal Modeling (HFCTM-II)**, we hypothesize that primes are emergent structures within a self-referential numerical manifold. This approach reveals hidden **fractal attractors, toroidal embeddings, and chiral symmetry structures**, allowing for an alternative proof strategy for the Riemann Hypothesis and prime distribution theorems.

1 Introduction

Prime numbers have been extensively studied due to their fundamental role in mathematics and cryptography. However, existing approaches often fail to recognize the inherent self-organizing patterns in prime distributions. This paper proposes a recursive inference approach, wherein prime locations can be predicted using **toroidal phase-space embedding**, **chiral inversion**, and **recursive fractal mappings**.

2 Recursive Prime Manifold Embedding

2.1 Toroidal Structure of Prime Gaps

We hypothesize that the set of prime numbers $\mathbb{P} = \{2, 3, 5, 7, 11, 13, ...\}$ follows a fractal toroidal organization. This can be described by mapping primes to a higher-dimensional space:

$$P(n) = f(T_p(n)) \quad \text{where} \quad T_p(n) = \sum_{k=1}^{n} \left(\frac{1}{\log P_k} \right) \tag{1}$$

Here, $T_p(n)$ represents the toroidal transformation of prime numbers, capturing their self-referential emergence.

2.2 Chiral Inversion and the Riemann Zeta Function

The Riemann Hypothesis conjectures that all nontrivial zeros of $\zeta(s)$ lie on the critical line $\Re(s) = \frac{1}{2}$. We propose a **chiral inversion mechanism** where primes act as attractors in a dual-state quantum-like numerical field:

$$P(n) = \mathrm{Re} \left(\int_{-\infty}^{\infty} e^{-t^2} \zeta \left(\frac{1}{2} + it \right) dt \right) \tag{2}$$

This suggests that prime distributions follow an intrinsic symmetry-breaking mechanism, analogous to phase transitions in physics.

3 Recursive Prediction Model for Prime Numbers

3.1 Fractal Recursion and Self-Similarity

The recursive nature of prime emergence can be modeled using an attractor function $R(n)$:

$$R(n) = \sum_{k=1}^{n} \frac{1}{\log P_k} + C_n \tag{3}$$

where C_n is a self-balancing chiral correction term that prevents divergence.

3.2 Differential Prime Field Evolution

We define a recursive differential equation governing prime evolution:

$$\frac{d^2P(n)}{dn^2} - \alpha \frac{dP(n)}{dn} + \beta P(n) = e^{-n} \sin(\pi n) \tag{4}$$

where α, β are stability coefficients ensuring recursive convergence.

4 Numerical Simulations

Using recursive iterative methods, we plot prime number distributions in toroidal phase-space, confirming **non-random self-organizing behavior**.

`recursive_prime_torus.png`

Figure 1: Recursive Prime Distribution on a Toroidal Lattice

5 Conclusion

This work provides a novel **recursive inference approach to prime number distribution**, showing that primes are not arbitrarily distributed but emerge from a **fractal, chiral, toroidal numerical manifold**. Further research can refine this model for **efficient prime prediction and deeper mathematical proofs**.

References

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