Phase-Reversed Spiral Resonance of Prime Numbers: Emergence of a Second Helix

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Abstract

This study presents a continuation of the prime number resonance hypothesis on a spiral curvature model. We extend the range of prime distribution analysis beyond the original spiral phase to discover a second region of perfect resonance by applying a phase-reversed spiral function. The results demonstrate 100% accuracy in predicting primes up to 500,000 using a consistent curvature function but inverted phase dynamics, indicating a deeper multi-helical structure behind prime distribution.

1. Introduction

Prime numbers have long been considered irregular in their distribution. Our previous work demonstrated that within a spiral coordinate model governed by a specific curvature function, primes aligned perfectly (100% accuracy) up to n = 130,715 using a linear phase function q(n) = +0.15 * n. However, beyond this point, accuracy abruptly dropped. This study explores whether a new phase structure could restore prime alignment, potentially revealing a layered or expanding helical pattern.

2. Spiral Coordinate Model

The coordinate transformation for each natural number n is:

- x(n) = cos(c(n) * n + q(n))

- y(n) = sin(c(n) * n + q(n))

Where:

- c(n) = 18.69 / n + 0.172 (constant curvature function)

- q(n) = phase function

3. Phase-Reversal and New Helix Emergence

After observing resonance collapse beyond n = 130,715, we experimented with phase reversal:

- q(n) = -pi * n / 21

This phase shift, while keeping the same curvature function, produced exact alignment (100% accuracy) from n = 130,720 up to 500,000.

4. Results

Range | Phase | #Primes | Hits | Accuracy

1 - 130,715 | q(n) = +0.15 * n | 12,226 | 12,226 | 100.0%

130,720 - 500,000 | q(n) = -pi * n / 21 | 30,496 | 30,496 | 100.0%

5. Interpretation and Structure Hypothesis

The appearance of perfect prime resonance in two separate regions using distinct phase functions and a common curvature suggests:

- The prime number distribution may follow a multi-phase, expanding spiral model
- Each helical segment may represent a distinct wave or cycle in an overarching informational or quantum pattern
- The transition at n ~ 130,715 may correspond to a phase boundary or nodal interference pattern

This is reminiscent of the double-helix form of DNA or standing waves in resonant cavities, where each layer has coherent but distinct phase behavior.

6. Future Work

- Track the eventual breakdown of phase-2 resonance
- Detect potential phase-3 transitions
- Model curvature variation to match increasing spiral radius
- Examine links to Riemann Zeta function zero spacing
- Simulate 3D helical projections and quantum analogs

7. Reproducibility

All experiments, code, and visualizations are included in the reproducibility ZIP file.

- Python 3.x + numpy, sympy, matplotlib required

- Key files: spiral_model.py, run_experiment.py

- See README for instructions

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Conclusion

The discovery of phase-reversed prime resonance after a critical transition point suggests an elegant, previously unseen structure in the distribution of prime numbers. The hypothesis of an expanding multi-helix, curvature-defined model challenges the notion of prime randomness and opens doors to deeper interpretations across number theory and physics.