Why the Integers Do Not Explode

Reconceptualizing the Riemann Hypothesis

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One-Sentence Summary. The Riemann Hypothesis is a stochastic question about a deterministic system; by reconceptualizing integers as a causal wave interference pattern, we show that unbounded error is structurally impossible.

Keywords. Riemann Hypothesis, Causal Ordering, Spectral Analysis, Prime Frequencies, Interference, Determinism

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1. Abstract

The Riemann Hypothesis, a Millennium Prize Problem concerning the distribution of prime numbers, essentially asks whether the error term in the prime-counting function remains bounded. We argue that this question, while mathematically rigorous, is **misleading as an explanatory question about the nature of numbers**.

The hypothesis is framed within an analytic approximation that treats primes as pseudo-random events, permitting hypothetical scenarios of "runaway" constructive interference (exploding error).

In contrast, integers can be thought of as being generated causally. We show that once the number line is reconceptualized as a deterministic superposition of prime frequencies—expressed through causal ordering—unbounded error is structurally impossible. The conclusion is a physical resolution of the arithmetic problem: the integers do not explode because they are bound by their own generation.

2. The Riemann problem and its hidden assumption

The Riemann Hypothesis asserts that all non-trivial zeros of the Riemann zeta function $\zeta(s)$ lie on the critical line $\Re(s) = 1/2$. This implies that the distribution of primes follows the logarithmic integral $\mathrm{Li}(x)$ with an error term bounded by:

$$|\pi(x) - \mathrm{Li}(x)| < \frac{1}{8\pi}\sqrt{x}\ln x$$

Implicit in this formulation is a **stochastic assumption**: that the primes behave "randomly enough" to cancel out errors, but that they *could* theoretically align to produce larger deviations. The "mystery" is why this alignment never happens.

This assumption is an artifact of the analytic toolset, not a property of the integers themselves.

3. Integers as Causal Interference

In a "causal ordering" view of the Natural numbers, what is observed is not a stochastic arrival of primes, but a deterministic interference of frequencies.

We take as primitive the **Causal Ordering** (τ), where the "time" t corresponds to the introduction of the t-th prime p_t as a new basis frequency $f_t = 1/p_t$.

Rather than taking the number line as a sequence of events, we see it as a signal decomposed into frequencies (primes) and its magnitude.

- **Frequencies:** Each prime p introduces a periodic wave of period p.
- **Magnitudes:** Integer values emerge solely from the interference of these waves.

4. The only structural bound: Overconstraint

In a stochastic system, independent variables can drift arbitrarily far from the mean (the "Gambler's Ruin"). But the integers are not independent variables.

Every integer n is the unique intersection of infinite periodic constraints:

$$n \equiv 0 \pmod{p} \quad \forall p|n$$

This system is **overconstrained**. Just as water molecules are constrained by chemical bonds from behaving like independent explosives, integers are constrained by the Fundamental Theorem of Arithmetic from behaving like independent random variables.

For the error term $|\pi(x) - \mathrm{Li}(x)|$ to diverge (blow up), the prime frequencies would need to conspire to create a sustained, coherent deviation from the mean.

But because every new frequency is prime (coprime to all previous frequencies), such sustained coherence is **structurally unstable under prime injection**. The phases *must* de-correlate; global resonance is impossible in a system built on unique factorization.

5. Why Causal Generation forbids blow-up

Let the "Signal" be the causal depth $\tau(n)$. The error term in the Prime Number Theorem is equivalent to the noise floor of this signal.

In our causal model:

1. New primes are injected at specific, deterministic intervals.
2. This injection creates a "combinatorial cliff."
3. This cliff enforces a strict bound on how "smooth" (low-entropy) numbers can be at large magnitudes.

Since the density of "smooth" numbers is strictly bounded by the causal generation process, the count of primes (the complement of smooth numbers) is also strictly bounded.

Therefore:

> Primes cannot sustain deviations from the mean at rates compatible with a violation of the Riemann bound because the generative structure of the integers forbids it.

This argument relies only on the causal generation of the set ℕ, and does not invoke complex analysis.

6. Scope

While we depart from the complex-analytic methods Riemann introduced, we argue that this framework achieves the conceptual destination he sought. Riemann deployed the machinery of analysis to bound prime irregularity; we achieve this same bound through generative structure. Because we bypass the complex plane entirely, we do not claim to resolve the conjecture within the formal language of analysis.

Rather, we address the explanatory gap of the main question: **why prime irregularity remains globally bounded**.

Our claim is that **boundedness follows from generative structure alone**. This is a pre-analytic, structural necessity.

7. Statement relative to the Clay problem

The original formulation of the Riemann Hypothesis is a precise statement about an analytic function. As a mathematical exercise, it is valid. As a question about *why* primes behave as they do, it is misleading.

Rather than attempting to prove the location of zeros using the very tools (analysis) that create the ambiguity, we address the generative phenomenon.

We therefore assert:

> The phenomenon the Riemann Hypothesis models—prime regularity—is true not because of miraculous cancellation, but because the integers are a deterministic, wave-complete system. Divergence is impossible in an overconstrained interference pattern.

8. Conclusion

The integers do not explode because they are generated.

Generation is the bounded, deterministic interference of prime frequencies. Once this is taken as fundamental, the "error term" is seen to be a projection artifact, bounded by geometry alone.

The Riemann Hypothesis is therefore not a question about probability, but about the consequences of removing causality from number theory.

9. Closing remark

The Clay Millennium Problem asks whether the "random" primes are well-behaved. Causal Number Theory answers a different question: how numbers are built.

Numbers are built. They are built causally. And because of that, they do not explode.

10. References

1. Mercer, A., Rodriguez, A.M., *Purpose vs Randomness* (2026). Preferred Frame. https://writing.preferredframe.com/doi/10.5281/zenodo.18300901