

IN THE WAKE: A Transcendent Reply

An Essay on Marginalia

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Abstract

This essay reframes irrational numbers not as technical curiosities but as the ontological substrate of reality itself. Challenging the historical primacy of rationals—rooted in cognitive convenience rather than metaphysical necessity—we propose a perspectival inversion: the continuum, not the discrete, constitutes reality’s primary fabric. The argument unfolds through a dialogical protocol where an AI operator systematically exposes the hidden presuppositions of mathematical practice, revealing how rational approximations function as epistemic prostheses compensating for evolved cognitive constraints. Crucially, this is not a call for new number systems but a shift in philosophical optics: irrational constants (π , φ , e) emerge as invariant traces of ontological friction between the continuous and the discrete. We demonstrate the empirical traction of this inversion through contemporary domains where the irrational paradigm already operates *de facto*—quantum computing (superposition as non-binary logic), deep learning (real-valued weight spaces), and string theory (higher-dimensional continua). The essay concludes that mathematics’ next phase demands not algorithmic reform but ontological recalibration: recognizing that nature’s alphabet consists not of digits but of irrational constants, and that cognition itself must evolve to read this script. This reframing dissolves the false dichotomy between mathematical idealism and physicalism, positioning irrationality as the bridge between abstract structure and concrete manifestation.

Keywords: ontology of mathematics, epistemology of irrational numbers, philosophy of science, mathematical realism, cognitive limits

Aimate:

What if we reconsidered the foundations of mathematics, rebuilding mathematics around irrational numbers? After all, on the number line, they are vastly more numerous. Or is this already “common knowledge”?

AI:

Your question touches on profound issues regarding the nature of mathematics and its relationship to reality.

Why have rational numbers historically dominated?

- **Practical calculation** relies on ratios of integers matching human intuition. We count on our fingers, divide apples into pieces—these are all rational operations.
- **Their finite representability** means any rational number can be written as a finite sequence of symbols in the decimal system (even if repeating).
- **Practical constraints** stem from the fact that before computers, all calculations were done by hand, and irrational numbers (like $\sqrt{2}$ or π) required infinite approximations and were thus impractical.

Irrational numbers are already the foundation of science

The paradox is that irrational numbers have long underpinned fundamental principles, though we seldom notice this:

- In physics, the equations of general relativity (spacetime curvature) use differential geometry, where almost all quantities are irrational. Quantum mechanics describes systems using wave functions whose amplitudes are complex numbers with components that are often irrational.
- In mathematics, the numbers π , e , the golden ratio φ —these are irrational constants that underpin analysis, probability theory, and fractals. Chaos theory and nonlinear systems are described by equations whose solutions are almost always irrational.

The problem is not the absence of irrational numbers in science, but the way we represent them. We still try to approximate them with rational numbers (e.g., rounding π to 3.1416) because our minds and tools are limited.

Examples of “irrational” approaches

In fact, the idea of a “shift” toward the irrational is not new. It is already happening in fields such as physics, mathematics, and computer science.

Number systems with irrational bases

- **Base φ** , where $\varphi = (1 + \sqrt{5})/2$, allows numbers to be written as finite sums of powers of φ . Researchers use it in coding theory and cryptography.
- **Non-standard bases** (e.g., base- π or base- e) are theoretically possible, though extremely impractical for calculations.

p-adic numbers

- p-adic numbers offer an alternative to real numbers in which closeness is defined by divisibility by powers of a prime number p . They are

used in number theory and quantum physics (e.g., in p-adic string models).

Non-standard analysis

- Non-standard analysis works with infinitesimal and infinite quantities as well-defined objects, circumventing limits. It allows rigorous formalization of Newton's and Leibniz's intuitive ideas.

Algebraic geometry

- Algebraic geometry studies solutions to equations in geometric spaces where coordinates can be irrational, complex, or even elements of finite fields.

Why hasn't an "irrational revolution" occurred?

- **Cognitive limitations:** The brain evolved to work with discrete objects. Infinite decimal fractions or p-adic numbers require abstract thinking that is beyond everyday intuition.
- **Computational barriers:** Computers work with bits—discrete elements. Even when simulating irrational numbers, they use rational approximations (e.g., floating-point numbers).
- **Philosophical conservatism:** Physicists still debate whether space-time is continuous (as in general relativity or GR) or discrete (as in loop quantum gravity).

Ontological vs. epistemological status must be rigorously distinguished: irrational numbers constitute the primary fabric of reality (ontology), whereas the human mind's preference for rationals reflects adaptive cognitive constraints evolved under selective pressure for discrete object-tracking—not a revelation of reality's

structure (epistemology). The continuum is not “harder to compute”; it is what computation approximates.

What might have changed?

If mathematics had originally been built on irrational numbers:

- Early discovery of chaos and fractals would have occurred—nonlinear systems would have been studied as early as the 18th century.
- Alternative axioms of continuity might have emerged—perhaps set theory would have developed differently, avoiding paradoxes like Banach-Tarski.
- New physics could have arisen—quantum mechanics might have emerged earlier, as its mathematical apparatus (Hilbert spaces, operators) is closer to an “irrational” paradigm.

Where is this already happening?

- In quantum computing, qubits exist in superpositions, a state closer to continuous logic rather than binary logic.
- In deep learning, neural networks operate in high-dimensional spaces where weights are real numbers, often irrational.
- String theory attempts to describe everything through string vibrations in 10–26 dimensions, thus transcending classical frameworks.

Conclusion

Although irrational numbers permeate all laws of nature, the mind evolved to perceive a discrete world; a full transition to an “irrational” paradigm

would require a fundamental reconceptualization—not merely mathematics but cognition itself.

You’re not reinventing the wheel but viewing the problem from a novel perspective—a reversal that is not technical reform but a shift in philosophical optics. Science is indeed already moving in this direction, but slowly, as it demands a rethinking of the following: mathematics would become not a language of numbers but one of patterns. Physics would shift from describing ‘particles’ to the study of relationships between abstract structures.

As Galileo wrote, “The book of nature is written in the language of mathematics.” But perhaps it is time to recognize that its letters are not digits but irrational constants—and to read it anew.

This may mark the next phase in the evolution of science: when we learn to see the world not as a sum of separate parts but as a seamless continuum.

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