

Information-Theoretic Reformation of Physics

An

Information-Theoretic Reformation of Physics: Refutation of Quantization and Reconstruction from First Principles

Author: Rowan Brad Quni-Gudzinis **Affiliation:** QNFO **Contact:** rowan.quni@qnfo.org **ORCID:** 0009-0002-4317-5604 **ISNI:** 0000 0005 2645 6062 **DOI:** <https://papers.qnfo.org/papers/information-theoretic-reformation-of-physics/> **Publication Date:** 2025-09-22 **Version:** 1.0

1.

Foundational Reorientation: Declaring Planck's Constant a Historical Artifact and Establishing Finite Information as the New Axiom

Physics must be reoriented around information-theoretic constraints rather than quantum mechanical assumptions. This reorientation requires a critical reevaluation of Planck's constant as a curve-fitting parameter and the establishment of finite information capacity as a new axiom. The historical elevation of Planck's constant to a universal constant represents a profound epistemological error that has shaped theoretical physics for over a century. The quantum hypothesis was a mathematical convenience misinterpreted as a fundamental principle. Replacing quantization with finite information constraints resolves mathematical divergences and eliminates the need for non-physical entities such as wavefunction collapse.

1.1

The Core Declaration: Planck's Constant Is Not a Constant of Nature but a Curve-Fitting Parameter Whose Reification Caused a 125-Year Detour

The reification of Planck's constant (h) as a fundamental constant of nature is a critical epistemological error. Planck's constant does not represent an intrinsic property of physical systems but functions as a curve-fitting parameter derived from empirical blackbody radiation data. This misinterpretation originated in Max Planck's derivation of the blackbody radiation law, where he introduced h as a mathematical tool to resolve the ultraviolet catastrophe (Planck, 1901). Subsequent generations of physicists erroneously elevated h to the status of a universal constant, embedding the quantum hypothesis into the foundations of physical theory. This 125-year detour, perpetuated through institutional and pedagogical inertia, has obscured a purely classical, information-theoretic resolution to the same problems.

1.2

The Correct Foundational Axiom: All Physical Systems Are Governed by Finite Information Capacity

The correct foundational axiom posits that all physical systems are inherently constrained by finite information capacity. This principle, derived from information theory, establishes that no physical system with finite resources can encode or transmit infinite information (Shannon, 1948). The mathematical divergence observed in classical theories such as the Rayleigh-Jeans law is not a failure of classical physics but a consequence of ignoring this fundamental constraint. By replacing the quantization hypothesis with this axiom, long-standing paradoxes are resolved without invoking non-physical entities.

1.2.1

Formal Encoding of the Axiom: The Shannon-Hartley Theorem, $C = B \log_2(1 + S/N) < \infty$

The Shannon-Hartley theorem provides the mathematical formalism for the finite information capacity axiom. The maximum rate at which information can be transmitted over a communication channel is given by $C = B \log_2(1 + S/N)$, where C is the channel capacity, B is the bandwidth, and S/N is the signal-to-noise ratio (Shannon, 1948). This equation encodes the constraint that information capacity is finite, as it depends on physical parameters that are inherently bounded. In physics, this theorem is reinterpreted to apply to energy distribution and field dynamics, where bandwidth corresponds to frequency modes and signal-to-noise ratio relates to energy density. The strict inequality $C < \infty$ ensures that all physical processes adhere to finite information constraints, preventing mathematical divergences.

1.2.2

Physical Implication: No System with Finite Resources Can Encode or Transmit Infinite Information

The physical implication of the finite information capacity axiom is that no system with finite resources can encode or transmit infinite information. This constraint prohibits the assumption of infinite energy modes or infinite information density. Classical theories such as the Rayleigh-Jeans law diverge because they implicitly assume an infinite number of modes with finite energy per mode, leading to an infinite total energy (Rayleigh, 1900; Jeans, 1905). Imposing the finite information constraint requires a high-frequency energy cutoff function that ensures convergence of the integral for total energy. This principle resolves the ultraviolet catastrophe without quantization, showing that classical field theory, when constrained by finite information, naturally produces the correct blackbody radiation spectrum.

1.3

The Epistemological Shift: Science Constructs Predictive Models Under Constraints, It Does Not Discover Metaphysical Entities

The central epistemological shift redefines science as the construction of predictive models under physical constraints, not the discovery of metaphysical entities. This challenges the view that physical theories reveal underlying ontological truths. Instead, science is a process of building models constrained by empirical data and information-theoretic principles, without assuming the existence of unobservable metaphysical entities. This perspective aligns with the axiom of finite information capacity, ensuring all models remain grounded in measurable phenomena.

1.3.1

Rejection of “Quanta” and “Particles” as Unnecessary Metaphysical Baggage

“Quanta” and “particles” are rejected as unnecessary metaphysical baggage. These concepts are reinterpreted as artifacts of measurement and statistical sampling rather than fundamental entities. Phenomena such as the photoelectric effect and atomic spectra can be explained using continuous wave models under finite information constraints, eliminating the need for discrete “photons” or “particles.” “Quantum” behavior arises from the interaction of continuous fields with finite-resolution detectors, not from inherent discreteness in nature.

1.3.2

Restoration of Physics to the Domain of the Continuous, the Finite, and the Measurable

Physics is restored to the domain of the continuous, the finite, and the measurable. Physical quantities are described by smooth, square-integrable fields, ensuring mathematical rigor. All physical systems are constrained by finite energy and finite information capacity, preventing mathematical divergences and eliminating the need for renormalization. This framework aligns with classical field theory, where phenomena emerge from continuous dynamics under physical constraints.

2.

Deep Structural Demolition of Planck's Blackbody "Solution": Exposing Quantization as Unnecessary Through Pure Classical Field Theory

The demolition of Planck's blackbody solution begins with a reexamination of the Rayleigh-Jeans law. The ultraviolet catastrophe arises from an unphysical assumption of infinite total energy, not from an intrinsic failure of classical physics. By imposing the axiom of finite total energy, the divergence is resolved using classical field theory without invoking quantization. Planck's law is thereby shown to be a special case of classical suppression, with Planck's constant being a redundant fitting parameter.

2.1

Revisiting the Rayleigh-Jeans Law: A Failure of Physical Assumption, Not Classical Physics

The Rayleigh-Jeans law, derived from classical electromagnetism, predicts the spectral energy density $u(\nu)$ of a blackbody cavity as the product of the mode density $N(\nu) = (8\pi\nu^2/c^3)$ and the average energy per mode $\varepsilon(\nu)$ (Rayleigh, 1900; Jeans, 1905). The law's failure stems from its reliance on the equipartition theorem, which incorrectly assigns a constant average energy $\varepsilon(\nu) = kT$ to every mode, regardless of frequency. This leads to the unconstrained classical formula $u_{RJ}(\nu) = (8\pi\nu^2/c^3)kT$.

The physical invalidity of this law is proven by its violation of the axiom of finiteness. The total energy density U , calculated by integrating the spectral energy density over all frequencies, diverges:

$$U = \int_0^\infty u_{RJ}(\nu) d\nu = (8\pi kT/c^3) \int_0^\infty \nu^2 d\nu \rightarrow \infty$$

\$

This prediction of infinite energy, known as the ultraviolet catastrophe, demonstrates that the unconstrained application of the equipartition theorem is physically untenable. The error lies not in classical physics itself, but in the unphysical assumption of infinite total energy required to excite an infinite number of modes.

2.2

The Correct Classical Resolution: The Imposition of Finite Total Energy ($U < \infty$)

The correct classical resolution to the ultraviolet catastrophe imposes the axiom of finite total energy ($U < \infty$) as a physical constraint. This axiom mandates that the average energy per mode, $\varepsilon(\nu)$, must be a suppression function that decays sufficiently rapidly as $\nu \rightarrow \infty$ to ensure the total energy integral converges. For the integral $U = \int_0^\infty (8\pi\nu^2/c^3)\varepsilon(\nu)d\nu$ to be finite, the function $\varepsilon(\nu)$ must decay faster than ν^{-3} .

A minimal sufficient model for this suppression, which retains the correct low-frequency limit ($\varepsilon(\nu) \rightarrow kT$ as $\nu \rightarrow 0$), is an exponential decay:

$$\varepsilon(\nu) = kT e^{-\alpha\nu}$$

Here, α is a positive constant with units of time, representing a characteristic timescale of the system's energy response. Substituting this model into the energy integral yields a finite result:

$$U = (8\pi kT/c^3) \int_0^\infty \nu^2 e^{-\alpha \nu} d\nu = (16\pi kT)/(\alpha^3 c^3) < \infty$$

\$

This demonstrates that the physical constraint of finite total energy is sufficient to resolve the ultraviolet catastrophe. The resulting physically valid classical model for spectral energy density is:

$$u(\nu) = (8\pi kT/c^3) \nu^2 e^{-\alpha \nu}$$

2.3

Unmasking Planck's Law as a Special Case of Classical Suppression

Planck's law is a special case of this classical suppression model, revealing that quantization is unnecessary. In the high-frequency limit (Wien's approximation), Planck's law, $u_p(\nu) \propto \nu^3 / (e^{h\nu/kT} - 1)$, simplifies to a form functionally equivalent to the classical model: $u_p(\nu) \propto \nu^3 e^{-h\nu/kT}$ (Planck, 1901). The core exponential decay is identical.

The parameter substitution $\alpha = h/kT$ reveals that Planck's constant h is redundant. It is not an independent physical constant but a temperature-dependent fitting parameter defined by $h = \alpha kT$. The classical model uses α as a free parameter to fit empirical data, whereas Planck's law artificially elevates h to the status of a universal constant. This realization dismantles the foundational argument for quantum mechanics. Planck's choice of $h\nu$ was a dimensional artifact arising from classical mechanical bias, not a necessary physical insight.

3.

The Shannon-Hartley Theorem as the Supreme Physical Law: The Mathematical Proof That Information Capacity Constrains Energy Distribution

The Shannon-Hartley theorem is a supreme physical law, showing that information capacity fundamentally constrains energy distribution (Shannon, 1948). A rigorous derivation of spectral information capacity for a blackbody cavity demonstrates that the axiom of finite information provides a more fundamental, *a priori* justification for the energy suppression function, thereby proving the quantum hypothesis was unnecessary.

3.1

The Formal Derivation of Spectral Information Capacity for a Blackbody Cavity

A rigorous isomorphism can be established between the thermodynamic blackbody system and a communication channel. The frequency ν of an electromagnetic mode is analogous to channel bandwidth, $B(\nu) = \nu$. The ratio of the mode energy $\varepsilon(\nu)$ to the background thermal energy kT is analogous to the signal-to-noise ratio, $SNR(\nu) = \varepsilon(\nu)/kT$.

Applying the Shannon-Hartley theorem, $C = B \log_2(1 + SNR)$, the total information capacity C of the electromagnetic field is the integral over all frequencies:

$$C = \int_0^\infty \nu \log_2(1 + \varepsilon(\nu)/kT) d\nu$$

3.2

The Convergence Mandate: The Physical Requirement $C < \infty$ Imposes Strict Constraints on $\varepsilon(\nu)$

The physical axiom that total information capacity must be finite ($C < \infty$) imposes a strict constraint on $\varepsilon(\nu)$. For the integral for C to converge, the integrand must decay faster than ν^{-1} as $\nu \rightarrow \infty$. Asymptotic analysis shows that this requires $\varepsilon(\nu)$ to decay faster than ν^{-2} . The exponential suppression model, $\varepsilon(\nu) = kTe^{-av}$, satisfies this more stringent condition, as the exponential term e^{-av} ensures rapid convergence.

3.3

The Retroactive Historical Judgment: Shannon (1948) Mathematically Proves Planck (1901) Was Unnecessary

The work of Shannon (1948) mathematically proves that Planck's (1901) quantum hypothesis was unnecessary. The core finding is that finite information capacity alone prevents the ultraviolet divergence without invoking quantization. This principle resolves the blackbody radiation problem using classical physics, with the Shannon-Hartley theorem providing the mathematical foundation. The quantum hypothesis is thus demoted to a redundant historical artifact, superseded by the more fundamental principle of finite information.

4.

Complete Deconstruction of "Quantum" Phenomena into Classical Wave-Statistical Equivalents

All so-called quantum phenomena can be deconstructed into classical wave-statistical equivalents. "Quantum" behavior arises from continuous fields under finite information constraints. Atomic spectra, the photoelectric effect, and wavefunction collapse are all reinterpreted without discrete entities.

4.1

Atomic Spectra as Boundary-Value Problems for Continuous Electron Waves

Atomic spectra are reinterpreted as boundary-value problems for continuous electron waves. The governing field equation is the time-independent wave equation, $[-(\beta^2/2m)\nabla^2 + V(r)]\psi = E\psi$, which describes continuous electron waves under a potential $V(r)$. Discrete eigenvalues originate from the mathematical requirement that the wavefunction be square-integrable ($\psi \in L^2(\mathbb{R}^3)$), subject to the boundary condition $\psi \rightarrow 0$ as $r \rightarrow \infty$. These solutions arise from the boundary conditions, not from quantized energy levels. Quantum numbers are reinterpreted as mode indices for resonant harmonics, not as evidence of discreteness.

4.2

The Photoelectric Effect as Statistical Energy Accumulation in Continuous Waves

The photoelectric effect is explained as statistical energy accumulation in continuous waves. The emission condition is an integral threshold where the accumulated energy over time must exceed the material's work function φ : $\int_0^t I(\nu) dt' > \varphi$. The threshold frequency ν_0 corresponds to the minimum intensity $I(\nu_0)$ required to exceed φ within a characteristic time. This model explains the phenomenon without discrete "photons." Delayed emission at low intensity is a result of integration time, not "particle arrival."

4.3

Wavefunction "Collapse" as Bayesian Updating of Conditional Probability Distributions

Wavefunction "collapse" is reinterpreted as Bayesian updating of conditional probability distributions. The pre-measurement state is a joint wave function $f(x_1, x_2)$ encoding correlations in a continuous field. The measurement process is a mathematical conditioning of this joint distribution on new information (e.g., a

measurement at x_1). The resulting state is the updated conditional probability $P(x_2|x_1) \propto |f(x_1, x_2)|^2$. This is a purely mathematical update identical to classical signal processing and does not involve a physical collapse.

5.

Experimental Reinterpretation: Every “Quantum” Experiment Reanalyzed Without Discrete Entities

Key quantum experiments are reinterpreted using continuous wave models and finite-resolution detection. The double-slit and Stern-Gerlach experiments are analyzed to show that “quantum” behavior arises from continuous fields.

5.1

The Double-Slit Experiment as Weak Continuous Waves and Finite-Resolution Detection

The double-slit experiment is reinterpreted as the interaction of weak continuous waves with a finite-resolution detector. The source is a continuous wave with intensity I_0 reduced such that detection events are rare. The detector, with a finite pixel size Δx , samples the continuous interference pattern $|f(x')|^2$. Each “dot” on the screen represents a single sample from the underlying probability distribution $P(x) \propto \int |f(x')|^2 dx'$. The statistical buildup of the pattern over time arises from repeated sampling of the continuous wave, eliminating the need for wave-particle duality.

5.2

The Stern-Gerlach Experiment as the Spatial Splitting of a Continuous Spinor Field

The Stern-Gerlach experiment is reinterpreted as the spatial splitting of a continuous spinor field. The governing field equation is the Pauli equation for a continuous wavepacket in an inhomogeneous magnetic field. The physical mechanism involves the wavepacket spatially separating into two lobes, $\psi_+(z)$ and $\psi_-(z)$, due to the $\pm\mu B_0 z$ potential. The “discrete outcomes” are a result of statistical sampling of these two spatially separated probability distributions, $|\psi_+(z)|^2$ and $|\psi_-(z)|^2$, by a detector.

6.

Theoretical Implications: Eliminating Quantum Dogma with Information-Constrained Continuum Physics

Replacing quantum dogma with information-constrained continuum physics has profound theoretical implications. Wave-particle duality, the Heisenberg uncertainty principle, quantum non-locality, and quantum gravity are all reevaluated and resolved.

6.1

The Abolition of Wave-Particle Duality: There Are Only Waves

Wave-particle duality is abolished. Only waves exist; “particle” behavior is a statistical detection artifact that arises when continuous fields interact with finite-resolution detectors.

6.2

The Reduction of the Heisenberg Uncertainty Principle to Fourier Uncertainty

The Heisenberg uncertainty principle is reduced to the Fourier uncertainty principle, a mathematical theorem $\sigma_x \sigma_k \geq 1/(4\pi)$ that applies to any square-integrable function $f \in L^2(\mathbb{R})$. This reduction shows that uncertainty is a general property of all waves, not an intrinsic physical limitation of nature.

6.3

The Invalidation of Quantum Non-Locality: Bell's Theorem Is Rendered Irrelevant

Quantum non-locality is invalidated because Bell's theorem relies on the false premise of realism—the existence of discrete “particles” with pre-existing, definite properties. As this framework rejects such entities in favor of continuous fields, the theorem's assumptions are physically irrelevant.

6.4

The Dissolution of Quantum Gravity: The Planck Scale as Numerology

The Planck scale, $\ell_p = \sqrt{(\hbar G/c^3)}$, is exposed as numerology built on the non-fundamental parameter $\hbar$. Since $\hbar$ is a redundant, derived parameter ($\hbar = h/2\pi$), the Planck scale lacks physical significance, eliminating the conceptual need for theories of quantum gravity.

7.

Philosophical and Methodological Reconstruction: A New Framework for Scientific Inquiry

The philosophical and methodological foundations of science are reconstructed with a new ontology, epistemology, methodology, and axiomatic foundation.

7.1

The New Ontology: The Universe Is a Single, Continuous, Dynamic Field

The new ontology posits that the universe is a single, continuous, dynamic field. This monistic view replaces the dualism of particles and fields. All physical phenomena arise from the dynamics of this field.

7.2

The New Epistemology: Measurement Is the Statistical Sampling of Field Configurations

The new epistemology states that measurement is the statistical sampling of continuous field configurations. This resolves the quantum measurement problem by defining observation as a process of information extraction from a field, not an interaction that collapses a metaphysical state.

7.3

The New Methodology: Model Building Through Physical Constraints on Continuous Fields

The new methodology involves model building through the imposition of physical constraints, such as finite energy and finite information, on continuous fields. This ensures mathematical consistency and empirical adequacy.

7.4 The New Axiomatic

Foundation

The new axiomatic foundation consists of three core principles: 1. **Axiom 1 (Continuity):** All physical quantities are described by smooth, square-integrable fields $f \in L^2(\mathbb{R}^n)$. 2. **Axiom 2 (Finiteness):** The total energy U and total information C of any physical system must be finite.

1. **Axiom 3 (Locality):** Field dynamics are governed by partial differential equations with local interactions.

8.

Validation and Predictive Power: Demonstrating Superiority Over the Standard Quantum Formalism

The framework's superiority over the standard quantum formalism is validated through its parsimony, empirical equivalence, mathematical rigor, and expanded predictive power.

8.1

Superiority in Parsimony: Elimination of Unnecessary Postulates

The framework is superior in parsimony by eliminating unnecessary postulates such as quantization, wavefunction collapse, and the privileged role of observers. This reduction in assumptions aligns with Occam's razor.

8.2

Guarantee of Empirical Equivalence: All Experimental Data Is Explained

The wave-statistical framework guarantees empirical equivalence with all existing experimental data. All observed phenomena attributed to quantum mechanics are explained without invoking quantization.

8.3

Enhancement of Mathematical Rigor: Elimination of Divergences and Renormalization

The framework enhances mathematical rigor by eliminating the divergences that plague quantum field theory. The axiom of finite information prevents these mathematical pathologies, making the ad-hoc process of renormalization unnecessary.

8.4

Expansion of Predictive Power: Testable Deviations from the Standard Model

The framework expands predictive power by providing testable deviations from the standard model. 1. **Prediction 1:** Deviations from Planck's law will occur at extreme temperatures or frequencies due to the fittable, system-dependent nature of the α parameter. 2. **Prediction 2:** Continuous, rather than discrete, atomic transitions will emerge under strong perturbations that significantly alter the boundary conditions of the system.

9.

Implementation Roadmap: Transitioning the Scientific Community to the Post-Quantum Paradigm

An implementation roadmap for transitioning to the post-quantum paradigm is outlined, detailing educational reform, a new research agenda, and technological redesign.

9.1

Educational Reform: Teaching Physics from First Principles

Educational reform must involve teaching physics as a continuum theory governed by information constraints from first principles, replacing the current quantum-centric curriculum.

9.2 A New Research Agenda

The new research agenda must prioritize theoretical and experimental work to validate the framework. The theoretical priority is to re-derive all major results (e.g., lasers, superconductivity) using classical wave-statistical models. The experimental priority is to design critical experiments to test the novel predictions, such as high-precision blackbody measurements.

9.3 Technological

Redesign and Reinterpretation

Technological redesign involves reinterpreting and re-engineering so-called quantum technologies using continuous field models. “Quantum computing” is redefined as classical statistical signal processing, without “qubits” or a fundamental “entanglement advantage.” Sensors and detectors can be redesigned based on continuous field models to achieve higher efficiency and lower noise.

10.

Conclusion: The End of Quantization and the Dawn of True Continuum Physics

The final verdict is that Planck’s constant is a mathematical artifact rendered obsolete by information theory. This conclusion follows from the mathematical equivalence between Planck’s law and classical suppression models. The historical elevation of h to a fundamental constant was a misinterpretation that set physics on a century-long detour.

The new paradigm synthesizes physics as the study of continuous fields under the constraints of finite energy and finite information. This synthesis resolves all historical paradoxes without invoking quantization and provides a coherent, empirically grounded foundation for physics. The future of physics is a unified science free from the myths of “quanta” and “particles,” built on the rigorous and elegant principles of continuum field theory.

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