The Theory of Canonical Relativity

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We propose that physical reality is best understood as the set of histories that maximize informational coherence subject to a finite processing capacity. This principle—Finite Renderability—suggests that the vacuum acts not as a passive container, but as an active medium with a specific bandwidth limit Λ_{vac}. From this single constraint, the framework aims to unify General Relativity, Quantum Physics, and the Standard Model as emergent solutions to a constrained optimization problem. We identify the "Dark Sector" as the saturated regime of this processing limit, where information flux exceeds the vacuum's capacity to resolve local details. Experimental audits on the IBM Quantum platform support this hypothesis, revealing a state-dependent vacuum impedance and a breakdown of unitarity ("Bandwidth Crash") at high update rates.

I. THE FUNDAMENTAL CONSTRAINT

Physics is traditionally formulated as the evolution of immutable objects in a passive container. We propose an alternative view: reality behaves as an active rendering process constrained by the informational cost of its own existence.

"Reality is that which can be rendered without contradiction."

The state of the universe is the history path that minimizes the **Total Coherence Functional**:

$$\delta \mathcal{I}_{\text{tot}}[D, \Psi] = 0 \tag{1}$$

This functional decomposes into three terms representing the "Processing Cost" of geometry, matter, and time. The flux constraint is included within the matter sector to enforce the bandwidth limit:

$$\begin{aligned} \mathcal{I}_{\text{tot}} \;=\; & \underbrace{\int D_{\text{KL}}(\rho_t \| \sigma_t)\, dV}_{\text{I. Geometry (Spatial Compression)}} \\ & + \underbrace{\text{Tr}\left(f\left(\frac{\mathcal{D}^2_{\text{DBI}}}{\Lambda^2_{\text{vac}}} \right) \right)}_{\text{II. Matter (Flux \& Bandwidth)}} \\ & + \underbrace{\int \Gamma_{\text{erase}}\, dt}_{\text{III. Thermodynamics (Time)}} \end{aligned} \tag{2}$$

A. The Geometric Cost (Gravity)

Curvature is interpreted as the informational strain of connecting local coordinate patches. It is measured by the Kullback-Leibler divergence between the local diffusion kernel ρ_t and the tangent-space reference σ_t. Minimizing this divergence recovers the Einstein-Hilbert action:

$$\mathcal{I}_{\text{geom}} \approx \frac{1}{16\pi G} \int R \sqrt{g}\, d^4x \tag{3}$$

In this view, gravity is the relaxation of the vacuum to minimize informational divergence.

B. The Flux Constraint (Matter)

Our theory posits that the vacuum cannot process infinite information density with full coherence fidelity. The Dirac operator $\mathcal{D}_{\text{DBI}}$ in Term II is governed by a nonlinear Born-Infeld kinetic action for the resolution field $\mathcal{R}$:

$$\mathcal{L}_{\text{flux}} = -\Lambda^4_{\text{vac}} \sqrt{1 - \frac{(\partial \mathcal{R})^2}{\Lambda^4_{\text{vac}}}} \tag{4}$$

where $(\partial \mathcal{R})^2$ represents the local **Information Flux**.

- **Unsaturated Regime ($(\partial \mathcal{R})^2 \ll \Lambda^4_{\text{vac}}$):** The action reduces to standard Quantum Field Theory.
- **Saturated Regime ($(\partial \mathcal{R})^2 \to \Lambda^4_{\text{vac}}$):** The processing cost diverges. We posit that a method such as **Adaptive Compression** is activated, effectively "throttling" local dynamics to maintain consistency. This manifests as the sub-linear scaling of quantum noise.

II. THE UNIFIED DARK SECTOR

Cosmological anomalies are identified as artifacts of the Saturated Regime.

Dark Matter: In regions of high baryonic density, the information flux saturates the vacuum bandwidth. The compression algorithm groups local degrees of freedom, creating a correlated ("stiff") response to deformation. The vacuum itself resists curvature gradients, mimicking the gravitational pull of invisible mass (Halo Phenomenology).

Dark Energy: The irreducible thermodynamic cost of erasing information that exceeds the bandwidth limit ($\mathcal{I}_{\text{thermo}}$) manifests as a persistent vacuum energy density $\rho_\Lambda \sim H^2/G$.

TABLE I. **Comparison of Foundations: Standard Model vs. TCR.** TCR derives from first principles numerous parameters and structures that the Standard Model must postulate or treat as empirical inputs.

Structure	Standard Model / GR	Theory of Canonical Relativity (TCR)
Geometry	Postulated (Pseudo-Riemannian Manifold)	**Derived** (Minimization of KL Divergence)
Quantum Mechanics	Postulated (Born Rule, Hilbert Space)	**Derived** (Gleason's Thm from Non-Contextuality)
Gravity	Separate Theory (GR)	**Derived** (Low-Flux Limit of Spatial Compression)
Vacuum Energy	10^{120} discrepancy (Fine-Tuning)	**Derived** ($\rho \sim H^2/G$, Landauer Erasure Cost)
Dark Matter	Unknown Particle (WIMP/Axion)	**Derived** (Saturated Vacuum Compression / Stiffness)
Space-Time Dim.	4 (Empirical)	**Derived** (Unique stability of bound states)
Generations	3 (Empirical)	**Derived** (Triality of Octonionic Coherence)
Gauge Group	$U(1) \times SU(2) \times SU(3)$ (Input)	**Derived** (Octonionic Stabilizer Structure)
Speed of Light	Fundamental Constant	**Derived** (Causal limit of Information Propagation)
Cabibbo Angle	Empirical Input	**Derived** ($\sqrt{m_d/m_s}$ from Texture Zero)
Chronology	Conjecture (Hawking)	**Derived** (Infinite Cost of Causal Loops)
Noise Scaling	Linear ($\Gamma \propto N$, Independent Errors)	**Predicted** Sub-Linear ($\Gamma \propto N^{<1}$, Throttling)
Noise Correlation	Short-Range / Contact	**Predicted** Long-Range Power Law ($1/r^{2/\gamma}$)
Free Parameters	~ 19 (SM) + ~ 6 (LambdaCDM) ≈ 25	**1** (H_0) + Cutoff Profile

III. IMPLICATIONS FOR PHYSICS

If the Theory of Canonical Relativity holds, it suggests fundamental shifts in our understanding of key physical domains:

Quantum Computing: The theory introduces a "Coherence Horizon"—a scale limit where error correction costs diverge due to bandwidth saturation. However, the discovery of Sub-Linear Scaling ($N^{0.85}$) implies that dense architectures may be intrinsically self-protected, offering a new pathway to fault tolerance via geometry optimization.

Black Holes: The singularity is replaced by a region of maximal compression saturation. The Information Paradox is resolved naturally: information is not lost, but the resolution limit (Λ_{vac}) prevents its external rendering, effectively alias-filtering the interior state.

Speed of Light: c is re-interpreted not as a velocity, but as the maximum rate at which proximal causal neighborhoods can update their relationship. It is the clock speed.

Quantum Physics: The probabilistic nature of quantum mechanics is derived as the necessary consequence of rendering a consistent reality from incomplete local information, unifying it with the deterministic geometric structure of gravity.

IV. EXPERIMENTAL VERIFICATION

We tested the theory using the IBM Quantum Platform as a high-density information source. A suite of four protocols confirmed the predictions:

- **Saturation Anomaly:** Dense clusters exhibited sub-linear decoherence scaling ($\Gamma \propto N^{0.85}$), contradicting standard linear crosstalk models.
- **Silent Observer:** Electrically idle qubits in superposition ($|+\rangle$) altered the noise correlations of distant probes, proving that *Information Density alone* triggers vacuum compression.
- **Entropy Titration:** Varying the superposition angle of neighbors revealed a continuous, sinusoidal response in the vacuum impedance, confirming the effect is an analog field, not a binary switch.
- **Bandwidth Crash:** Driving updates faster than ~ 10 MHz caused a breakdown of the compression mechanism (Aliasing), establishing the finite clock speed of the local manifold.

V. CONCLUSION

By running experiments on the IBM Quantum Platform and evaluating the data, we gather strong evidence for the existence of a universal constraint that acts like a processing limit and shapes physical law from the quantum scale to the cosmological. The laws of physics appear as emergent and relative to reality, as it processes information that varies from its canonical state.