The Logic Firewall: Making Sense of Reality Through Logic Field Theory

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Abstract

Logic Field Theory (LFT) offers a novel and accessible perspective on quantum mechanics by proposing that reality is filtered through ontological logic. Instead of wavefunction collapse or probabilistic postulates, LFT treats the classical laws of logic—Identity, Non-Contradiction, and Excluded Middle—as hard constraints on what information can become real. This companion paper introduces LFT for a broader audience, using intuitive metaphors, conceptual clarity, and experimental connections to explain quantum behavior as a consequence of logical admissibility.

1. Introduction: Rethinking Reality Through Logic

Quantum mechanics works. It predicts experimental outcomes with remarkable accuracy. Yet, at its foundation, questions remain: What causes collapse? Is the universe truly random? Why does math describe the world so well?

Logic Field Theory (LFT) offers a new perspective: *physical reality is filtered by logic.*

LFT posits that reality emerges from a projection:

$$\Omega = L(S)$$

where S is the total set of possible information states, and L is a projection operator enforcing the three classical laws of logic: Identity, Non-Contradiction, and the Excluded Middle. Only logically admissible states survive this filtering and become real.

This paper introduces LFT in intuitive terms, showing how it reframes collapse, decoherence, computation limits, and probability as consequences of logic acting on information. If reality is what passes the logic filter, understanding that filter may be the key to understanding why anything exists at all.

2. The 3FLL as the Firewall of Existence

LFT begins with the Three Fundamental Logical Laws (3FLL):

1. **Identity:** $A = A$

2. **Non-Contradiction:** $\neg(A \wedge \neg A)$

3. **Excluded Middle:** $A \vee \neg A$

These aren't just mental tools—they are active constraints on what information can physically exist. They form a **logical firewall**.

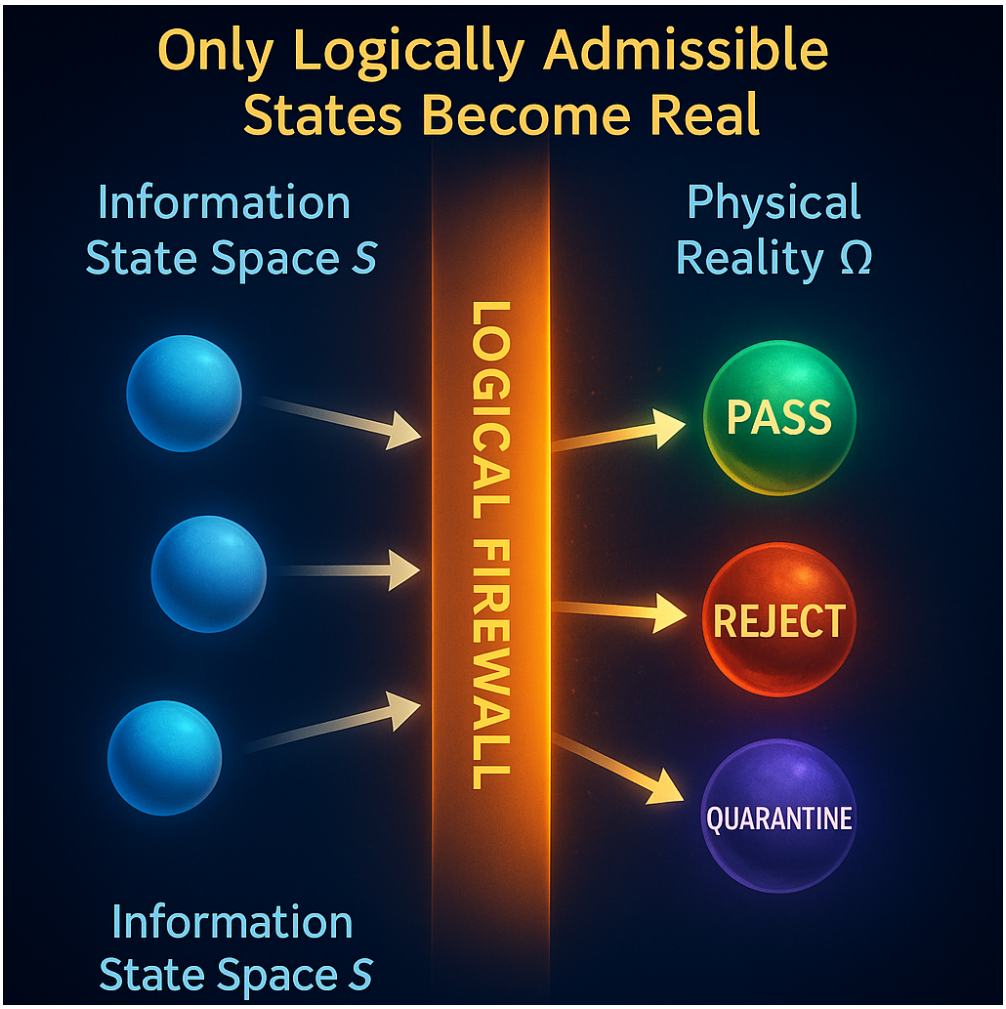

Figure 1: Visualization of the Logic Firewall in Logic Field Theory (LFT). Information packets originating from the full state space S are filtered by the Three Fundamental Logical Laws (3FLL): Identity, Non-Contradiction, and Excluded Middle. Only logically admissible packets are projected into physical reality $\Omega = L(S)$. Packets with high logical strain are either rejected or enter quarantine, undergoing deterministic collapse toward admissibility.

Packets Are Particles. Particles Are Packets.

All possible quantum configurations can be seen as *information packets*. But only packets that conform to 3FLL are allowed through the firewall and become particles.

$$\Omega = L(S) = \{\rho \in S \mid D(\rho) = 0\}$$

Where $D(\rho)$ is logical strain. In LFT, particles are not objects but *logically valid information packets*. **Packets are particles, and particles are packets.**

3. Collapse, Not by Chance—but by Constraint

In standard QM, collapse is postulated. In LFT, collapse arises from **logical strain**:

$$D(\rho) = 1 - \min\{L_I(\rho), L_N(\rho), L_E(\rho)\}$$

Where each L_* measures conformity to the corresponding logical law.

Strained packets feel a deterministic force:

$$F_L = -\nabla V_L \quad \text{with} \quad V_L = \kappa D$$

This drives the system toward logically valid states. Collapse is not random—it is gradient descent in logical space.

4. Decoherence as Logical Curation

Decoherence is often explained as entanglement with the environment. LFT reframes this as:

> *Decoherence is logic identifying and quarantining strained packets.*

As logical strain increases, the system is filtered more aggressively. Collapse and decoherence are two sides of the same firewall response:

- Decoherence: suppression and redirection of high-strain information.
- Collapse: deterministic resolution to a logically admissible state.

5. Boundaries of Computation

LFT predicts a limit on quantum computation—not from noise, but from *logical path density saturation*. As a system explores more entangled paths, the firewall permits only those that remain logically admissible.

A bound arises naturally:

$$R = \frac{P(\Psi^+)}{P(00) + P(11)} \approx e^{-\gamma_L}, \quad \gamma_L = \kappa / E_{\text{ref}}$$

When logical strain exceeds a threshold, coherent computation fails—not from decoherence, but from logic forbidding further path expansion.

6. Experimental Implications (in Plain English)

LFT makes testable predictions:

- **Suppressed entangled outcomes:** High-strain states like Bell pairs show reduced frequencies.
- **Mixed-state deviations:** Strain alters probabilities from Born rule in measurable ways.
- **Tunneling asymmetry:** Logical strain across barriers suppresses tunneling rates.
- **Quantum plateau:** Computation power levels off when path density exceeds firewall limits.

These effects can be measured with current quantum platforms using Bell tests, tunneling circuits, and purity-controlled experiments.

7. Evidence Consistent with LFT

Several existing observations support LFT's predictions:

- **Bell state asymmetry:** IBM Q and other platforms show suppressed $\Psi^{\pm}$ outcomes.
- **Quantum scaling limits:** Advantage vanishes as systems grow, matching LFT's coherence threshold.
- **Mixed-state deviations:** Weak measurement experiments reveal Born rule anomalies.
- **Tunneling suppression:** Barrier asymmetries produce non-WKB decay patterns.

LFT reframes these not as errors, but as signatures of the logic firewall.

8. Why This Matters

LFT resolves foundational problems:

- **Collapse** becomes deterministic, not postulated.
- **Decoherence** is structured, not fuzzy.
- **Probability** is derived, not assumed.
- **Limits** on computation follow logically.

It is falsifiable and parameterized by a single variable γ_L, with clear experimental targets.

LFT suggests that logic is not just our tool for describing reality—it is the reason reality holds together. What exists is what passes the logic filter.