

Noise as Oracle: Reconsidering Quantum Error in the Age of Suppression

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Quantum computing has reached a pivotal moment. As hardware improves and error correction schemes mature, the industry races toward machines of perfect fidelity—devices designed to execute quantum algorithms with ever-lower noise and increasingly deterministic output. But in the pursuit of computational precision, a deeper question arises: what if the very noise we are trying to suppress contains hidden structure? Could quantum error—particularly collapse behavior from a "virgin" quantum state—carry physical meaning rather than merely signal failure? This paper builds on *Recomposing Genesis: Repeated Collapse from a Virgin Quantum Computer*, extending its proposal of using passive quantum systems as observational tools. We argue that spontaneous collapse, traditionally framed as decoherence, may in fact offer insight into quantum field fluctuations, environmental entanglement, or even cosmological analogs. Drawing inspiration from the 1965 discovery of the cosmic microwave background—initially mistaken for instrument noise—we suggest that today's quantum collapse artifacts may hold similar significance. Rather than eliminating all error, we propose a new experimental mode: one that listens. One that treats noise, not as something to overcome, but as a possible oracle of the quantum world itself.

Keywords: quantum noise, decoherence, quantum collapse, quantum error correction, passive quantum systems, emergent structure, entropy, virgin quantum state, quantum randomness, cosmic microwave background, quantum vacuum, open quantum systems, noise-inclusive computing, quantum field fluctuations, quantum measurement, entanglement, trusted noise layers, quantum observation, collapse data, foundational physics. A collaboration with GPT-4o. CC4.0.

I. Introduction

In our prior work, *Recomposing Genesis: Repeated Collapse from a Virgin Quantum Computer*, we proposed a novel experimental framework that treated quantum computers not as deterministic logic engines but as passive receivers of ambient quantum structure. By initializing a qubit register in a pure, unentangled state—what we termed the "virgin state"—and allowing it to idle without applied logic gates, we recorded spontaneous collapse events as they arose solely from interaction with quantum noise. The underlying claim was radical in its simplicity: that meaningful structure may arise not from control, but from *observing without interference*. Collapse, traditionally treated as the endpoint of quantum computation, was instead reframed as a potential source of insight into the nature of emergence, randomness, and perhaps even cosmological pattern.

Against this backdrop, the mainstream trajectory of quantum computing research has moved in the opposite direction. Industry efforts are overwhelmingly oriented toward *eliminating noise*, achieving fault-tolerant logical qubits, and suppressing decoherence through increasingly sophisticated hardware and software strategies. Recent advances such as Google's *Willow* chip, Amazon's *Ocelot*, and Microsoft's *Majorana 1* exemplify this push toward suppressing all quantum errors to realize the promise of scalable quantum advantage. Noise, in this framework, is seen as a barrier to utility—something to be corrected, neutralized, or rendered invisible.

This paper proposes a counterpoint to that prevailing narrative. We suggest that in their pursuit of computational fidelity, current frameworks may be discarding the very phenomena that deserve the most attention. Quantum noise—particularly the spontaneous, field-driven fluctuations that produce collapse in the absence of logical instruction—may encode latent structure that conventional protocols are designed to suppress. In seeking to make quantum systems behave like classical machines, we may be erasing signs of deeper principles embedded in the quantum fabric.

The historical parallel is striking. In 1964, engineers Arno Penzias and Robert Wilson at Bell Labs were attempting to eliminate persistent background noise from their radio antenna. They tried recalibrating equipment, cleaning pigeon

droppings, and accounting for terrestrial interference—only to discover that the “noise” was in fact the cosmic microwave background (CMB), a remnant of the Big Bang and one of the most important discoveries in cosmology. Their equipment was not designed to detect it. Their success lay in not dismissing what others would have ignored.

We ask whether the quantum computing community might be standing in a similar position today—discarding collapse data, purging fluctuations, and correcting noise, while missing a signal far more profound than any algorithm could produce.

II. Engineering the Silence: A Survey of Noise Suppression Efforts

The central challenge in building practical quantum computers lies in the fragility of quantum information. Qubits are extraordinarily sensitive to their environment; even minimal interactions with uncontrolled degrees of freedom lead to decoherence, phase error, and eventual loss of fidelity. This vulnerability has made noise suppression the dominant engineering goal across all quantum hardware platforms. From superconducting circuits to trapped ions and topological systems, every effort in the field today is either directly or indirectly an attempt to quiet the quantum machine.

Three recent developments in the quantum computing industry illustrate the depth of this commitment to silencing quantum noise.

Google’s Willow chip represents a major milestone in the pursuit of scalable quantum error correction. In December 2024, Google Quantum AI announced that Willow had demonstrated declining error rates as the number of physical qubits increased—a critical feature required to stabilize logical qubits. This result was heralded as experimental evidence for “break-even” error correction: a regime in which encoded logical qubits perform better than physical qubits alone. Willow uses surface code architectures with active error detection and feedback, relying on multiple layers of ancilla qubits to detect bit- and phase-flip errors and

correct them in real time. The central achievement here is not raw speed, but systemic control of entropy.

Amazon's Ocelot chip, released in early 2025, took a different approach by addressing the cost and efficiency of error correction. Designed to be highly modular, Ocelot integrates on-chip error mitigation circuits and improves thermal and electromagnetic shielding at the hardware level. Amazon claims up to a 90% reduction in the resource overhead typically required for fault-tolerant computation, potentially bringing more qubit capacity within practical reach. Though framed as an engineering solution, this effort is part of the same larger movement: rendering the quantum substrate silent, clean, and subordinate to algorithmic control.

Microsoft's Majorana 1, perhaps the most conceptually ambitious of the three, introduces a fundamentally different architecture. It is based on the theorized existence of non-abelian quasiparticles—Majorana zero modes—which can encode quantum information nonlocally in topological states. These states are naturally more resistant to local decoherence and require fewer error correction resources. Majorana 1 promises the ability to integrate millions of qubits on a single chip while maintaining topological stability, potentially eliminating entire classes of errors through quantum material properties rather than active correction. If achieved, this would represent not just suppression, but isolation from noise as a principle of design.

Across these architectures, common metrics define success:

- T_1 (energy relaxation time) and T_2 (dephasing time)
- Gate fidelity (typically exceeding 99.9% for leading systems)
- Logical qubit formation from dozens or hundreds of physical qubits
- Error rates per gate or per circuit cycle, often below 10^{-3}

Progress is benchmarked not in creativity or emergence, but in stability and control.

Yet this collective pursuit carries a deeper philosophical implication: it redefines the concept of “error” in quantum mechanics. In classical systems, error is a deviation from an intended outcome. In quantum systems, the very notion of error assumes that the system was supposed to behave in a particular way—a notion that is often imposed by algorithm, not nature. But what if the so-called errors—the spontaneous fluctuations, the collapse paths, the correlations that seem like noise—are not deviations at all, but expressions of the system’s interaction with the quantum vacuum?

By designing out every fluctuation, we may be designing out the possibility of observing something unanticipated. In the rush to perfect the machine, we may be building a wall between ourselves and the phenomenon we originally sought to understand.

III. Noise as a Physical Signal

In conventional engineering, noise is treated as a statistical nuisance—a byproduct of thermodynamics, imperfect materials, or signal interference. It is presumed to be *stochastic*, lacking internal structure, and therefore best suppressed or averaged away. In quantum computing, this mindset persists. Quantum noise is modeled as a probabilistic process governed by Lindblad operators, simulated as depolarizing, dephasing, or amplitude damping channels with tunable parameters, and mitigated through circuit-level error correction or hardware shielding. Yet this presumption—that noise is *merely random*—may be neither accurate nor complete.

A. Stochastic Randomness vs. Quantum Fluctuations

There is a crucial difference between stochastic noise and quantum field-induced fluctuation. Stochastic noise can be modeled by uncorrelated or weakly correlated random variables—what one might expect from thermal vibrations or white-noise interference. But quantum fluctuations, even when they manifest as noise, often carry structure derived from entanglement, vacuum state properties, or the memory of prior interactions. These fluctuations are not simply random; they are

contextual and often non-Markovian, exhibiting memory effects across time and space.

This distinction is fundamental. A truly random process lacks predictive value and long-range coherence. A fluctuation rooted in the quantum field may have causal structure, nonlocality, or a connection to broader environmental dynamics. Suppressing both under the same banner of "error" risks discarding patterns that encode real physical phenomena.

B. Noise as a High-Dimensional Observable

If we relax the assumption that noise is formless, we are led to a very different conceptual framework. Instead of viewing noise as a contaminant, we may treat it as a high-dimensional observable—a multi-qubit, time-dependent signal carrying information about the environment, the vacuum, or even the system's internal degrees of freedom.

In this view, every collapse from a virgin quantum state becomes a projection from Hilbert space into a lower-dimensional classical outcome, sampled from a probability distribution that includes contributions from the entire quantum field. When repeated across many trials and configurations, these collapses trace a map—not of logic gates or computational success—but of how the system as a whole “chooses” to resolve indeterminacy. This map may reflect symmetry breaking, residual entanglement, or field-level dynamics that conventional noise models cannot account for.

What has been previously dismissed as irreducible entropy may in fact be the fingerprint of hidden variables or latent order.

C. Signal vs. Artifact: Suppression and the Loss of Insight

The industrial-scale drive to suppress noise has been highly successful. Through error correction and hardware isolation, quantum systems are approaching classical levels of predictability and repeatability. But this success may come at the cost of insight. Once noise is suppressed below the threshold of observability, any embedded structure—no matter how meaningful—is irretrievably lost.

There is a longstanding philosophical caution in physics: when a phenomenon is inconvenient, we often reclassify it as irrelevant. But this is not a guarantee of truth. A suppressed signal does not cease to exist; it simply becomes invisible to our tools. The danger is that what appears as artifact under one paradigm may be signal under another.

D. Case Studies

1. Early Observations of Non-Markovian Noise

In the early development of superconducting qubit platforms, researchers observed unexpected memory effects in qubit dephasing behavior. The coherence times varied in non-trivial ways across repeated trials, and correlation between qubits emerged even in nominally unentangled circuits. These anomalies were eventually classified as “non-Markovian noise”—a form of temporal correlation that standard error models could not fully explain. In many cases, the strategy was to minimize or eliminate these effects. But what if the correlations were not just parasitic? What if they pointed to deeper environmental couplings or residual structure in the vacuum state?

2. Cross-Talk: Hardware Flaw or Emergent Order?

Cross-talk between qubits—unintended coupling that leads to correlated errors—is routinely treated as a hardware fault. Extensive work goes into minimizing capacitive or inductive leakage, redesigning layout geometries, and implementing software-level crosstalk compensation. But consider a scenario where spontaneous collapse events show consistent, correlated outcomes across qubits. Should this be understood strictly as interference—or could it suggest that the system itself is revealing a form of spontaneous symmetry or emergent entanglement, mediated by substrate physics or field-level interactions?

These examples illustrate a central dilemma. We may be silencing quantum systems not because they have nothing to say, but because they are not saying what we expect.

IV. Historical Analogy: The Cosmic Microwave Background

In 1964, two radio astronomers, Arno Penzias and Robert Wilson, working at Bell Telephone Laboratories in Holmdel, New Jersey, encountered a persistent source of noise in their newly built horn antenna. Their goal had been practical: to refine radio reception for satellite communications. But despite repeated technical adjustments, including equipment recalibration, improved shielding, and even the removal of pigeon droppings from inside the antenna, the noise remained. It was isotropic, unwavering, and refused to go away.

At first, they assumed it was contamination—a mechanical imperfection, environmental interference, or biological artifact. Yet nothing eliminated the static. Meanwhile, unknown to them, Robert Dicke's team at Princeton University was preparing to search for exactly such a signal: the remnant radiation of the early universe, predicted by Big Bang cosmology.

When the two teams connected, it became clear that the "error" Penzias and Wilson had sought to suppress was not a flaw in their system, but the first empirical evidence of the cosmic microwave background (CMB)—a signal 13.8 billion years in the making. What was initially misclassified as noise turned out to be one of the most important scientific discoveries of the 20th century, confirming that the universe had a hot, dense origin and leaving behind a relic glow that permeates all of space.

This story is more than a scientific anecdote. It reveals something essential about the relationship between *what we design systems to detect* and *what those systems are actually capable of detecting*. Had Penzias and Wilson succeeded in suppressing their "noise," the CMB might have gone undetected for years longer. Their breakthrough was not algorithmic—it was interpretive.

We may be approaching a similar moment in quantum computing.

Today, the collapse of a quantum system—particularly one allowed to idle in a virgin state without any applied logic—is treated as a form of decoherence, an error to be minimized. Collapsed states that do not align with intended logic outcomes are either discarded, corrected, or statistically ignored. The overarching

engineering goal is to *silence the machine*, to enforce deterministic stability onto an indeterminate substrate.

But what if that collapse—particularly when it arises in the absence of instruction—contains structure analogous to the CMB? What if repeated collapse patterns are not merely the echoes of thermal noise or faulty calibration, but fingerprints of a deeper quantum environment, or even reflections of vacuum structure or pre-measurement quantum dynamics?

The implication is profound: quantum collapse noise may be today's version of the CMB—an ambient signal we were not looking for, but one that encodes the memory of the system's interaction with something fundamental. If we remain committed to removing it, we may repeat a historical mistake in a new technological language.

The difference, of course, is that we now have tools capable of recording, analyzing, and recognizing such patterns. We must only be willing to ask whether the universe is whispering something into our machines—and whether we've simply filtered it out.

VI. Towards a Noise-Inclusive Paradigm

To fully explore the possibility that noise in quantum systems may contain physically meaningful or informationally rich signals, we must consider a shift in our experimental and conceptual paradigms. Instead of eliminating every fluctuation as a threat to logic fidelity, we propose to treat some forms of quantum noise as *invitations* to listen—epistemic opportunities rather than engineering failures. This section sketches a speculative framework for a noise-inclusive approach to quantum computing, one that treats decoherence, collapse, and entropy as phenomena to be studied, not just suppressed.

A. Speculative Models

1. Could Entropic Fluctuations Encode Information About the Vacuum?

In standard models, entropy growth in a quantum system—particularly in the form of collapse from a pure to a mixed state—is viewed as a measure of lost information. But an alternative interpretation is possible: that entropy is not merely the dissipation of coherence, but the emergence of *hidden variables* reflecting structure in the vacuum.

The quantum vacuum is not empty. It teems with zero-point energy, virtual particles, and field fluctuations. These interactions, though typically averaged out or statistically neutral, may influence the path by which a virgin quantum state collapses. If so, then entropic fluctuations across repeated collapse events might reveal statistical anisotropies or low-order symmetries that trace back to the fabric of the field itself.

Rather than a source of epistemic loss, entropy could function as a projection surface—a lens through which the deeper information content of the vacuum interacts with measurement.

2. Environmental Noise as Hidden Entanglement

Another speculative model posits that environmental noise is not external to the system but entangled with it in subtle ways. That is, the "environment" is not merely an external bath but a non-local quantum participant, whose entanglement with the qubit register mediates the process of collapse.

Under this view, noise is a residue of prior entanglement, not an independent stochastic process. When we initialize a virgin state and allow it to idle, we are not isolating it—we are allowing it to reconnect with its quantum surroundings. The resulting collapse patterns are then *informational exchanges*, not errors.

This perspective aligns with certain interpretations of decoherence theory and non-Markovian dynamics, suggesting that what we perceive as decoherence might be an *unfinished computation* with the universe itself.

B. Technical Approach

To test these speculative ideas and move toward a practical, noise-inclusive framework, we propose the following experimental strategy.

1. Recording Pre-Error-Corrected Collapse Logs

Before error correction becomes the default operational mode in quantum processors, researchers should begin logging raw, uncorrected collapse data from initialized systems. These logs would include:

- The initial quantum state (e.g., ground state or uniform superposition)
- Idle time duration
- Time-resolved collapse outcomes (bitstrings)
- Environmental telemetry (temperature, magnetic flux, cryostat pressure, etc.)
- Physical layout metadata (chip topology, qubit distances, etc.)

This data could form the basis for collapse pattern archives—datasets not of success metrics, but of collapse behavior across varying conditions and hardware generations.

2. Building Entropy Maps Across Hardware Generations

By comparing collapse outcomes across different hardware platforms and over time, researchers could construct entropy maps—visualizations or statistical characterizations of how entropy grows and distributes within specific systems.

Such maps could help identify:

- Correlation clusters within bitstring outcomes
- Unexpected anisotropies in entropy evolution
- Cross-device signatures suggestive of hardware-independent collapse behavior

Entropy, rather than being treated solely as a loss metric, would become a field variable used to detect emergent structure.

3. The Concept of "Trusted Noise Layers"

We propose the development of trusted noise layers—deliberately engineered experimental modes in which no error correction is applied, and decoherence is allowed to manifest fully within controlled bounds.

These layers could be implemented as:

- Firmware-level modes for passive observation
- Calibration phases interleaved with computation
- Optical or thermal channels isolated from control logic

The purpose of these layers would not be computational. They would function as measurement platforms, allowing physicists to probe whether collapse behavior encodes repeatable, system-independent phenomena.

In time, trusted noise layers could become as fundamental to quantum systems as test vectors are to classical processors—not tools for optimization, but tools for revelation.

This section invites a radical redefinition of purpose: not how to master quantum systems, but how to listen to them more completely. To embrace noise is not to abandon rigor, but to ask what deeper truths might be found in the very phenomena we've worked so hard to eliminate.

VII. Implications and Applications

The proposition that quantum noise—specifically, collapse from unprogrammed virgin states—may encode physical structure rather than pure error opens an entirely new frontier of inquiry. It calls not only for a reassessment of quantum hardware design and error correction philosophy, but also for cross-disciplinary

exploration. If quantum noise contains meaningful signals, the implications span theoretical physics, cryptography, artificial intelligence, and even cosmology.

A. Theoretical Physics: Probing Emergent Structure Without Imposing Measurement

One of the most profound implications of a noise-inclusive approach is that it enables a new mode of inquiry in theoretical physics: probing emergent structure without actively imposing a measurement basis or Hamiltonian evolution. In standard quantum mechanics, observation is an act of projection—collapsing a superposition according to a predefined operator. But what if we invert that relationship?

By repeatedly initializing a quantum system into a pure state and allowing it to decohere under ambient conditions—without engineered logic gates—we create the possibility of witnessing how the system naturally interacts with the quantum field. Patterns in collapse outcomes, correlation trajectories, and entropy maps could reveal hidden constraints or low-dimensional manifolds underlying Hilbert space, analogous to discovering topological structure without an overt mapping function.

In this context, the quantum computer becomes a physical probe, akin to a particle detector or radio telescope. But instead of detecting particles or radiation, it detects the shape of possible outcomes, possibly shaped by vacuum structure, residual entanglement, or emergent field dynamics. It is physics by *listening*, not commanding.

B. Quantum Cryptography: Harvesting Structured Quantum Randomness

Randomness is a cornerstone of secure cryptographic systems, and quantum mechanics provides the most theoretically robust form of true randomness. Current quantum random number generators (QRNGs) rely on the measurement of superpositions (e.g., measuring a single qubit in the $|+\rangle$ state to obtain either 0 or 1). These approaches are trusted because they are unpredictable under known physics, but they are also intentionally unstructured.

If collapse patterns from noise-prone systems reveal structured quantum randomness—that is, patterns that remain unpredictable to outside observers but show internal self-similarity, entropy gradients, or non-classical correlations—then a new form of cryptographic seed may be possible. These collapse outcomes could be used to generate high-entropy, hardware-specific random keys with embedded physical uniqueness.

This would enable:

- Device-authenticated encryption using collapse fingerprinting
- Non-reproducible key generation even across identical machines
- One-time pads sourced from ambient quantum behavior

This form of randomness would be *unclonable*, not just because of physics, but because it reflects each system’s unique collapse history—its entanglement with time, field, and machine.

C. AI Integration: Noise as a Seed for Non-Deterministic Creativity

In the realm of artificial intelligence, deterministic logic dominates. Neural networks, while trained on probabilistic data, operate through optimization algorithms that converge toward fixed attractors in loss landscapes. Yet biological cognition thrives on stochastic inputs, irregular fluctuations, and unpredictable insights. If AI is to emulate creativity in its truest form, it may need a better class of noise.

Quantum collapse data from uncorrected systems offers a compelling source. If collapse events contain structured randomness—rich in entropy but non-uniform—then they may serve as ideal seeds for non-deterministic creative processes in AI systems. Rather than injecting white noise, systems could be primed with collapse outputs that reflect physical reality in its most unresolved form.

This could enable:

- Generative models influenced by ambient quantum processes
- Decision engines that operate at the boundary between determinism and chaos
- Creative systems that are co-authored by nature, not just by data

In this way, quantum noise becomes not just a computational obstacle or cryptographic asset, but a well of novelty, providing access to physical creativity beyond any training set.

D. Potential Cosmological Modeling Through Hardware Collapse Data

Finally, perhaps the most speculative but conceptually rich implication lies in using quantum collapse data to emulate early cosmological dynamics. If collapse from a virgin state under natural noise resembles a symmetry-breaking process—where a highly symmetric system chooses a particular configuration due to infinitesimal environmental fluctuations—then each recorded collapse may be a microcosmic analogue to cosmogenesis.

By compiling collapse data across systems, scales, and noise conditions, it may be possible to observe:

- Preferred outcome distributions hinting at hidden attractors
- Spontaneous order arising from vacuum-dominated collapse
- Analogues to inflation, decoherence, or horizon formation in post-collapse entropy landscapes

This suggests the use of quantum hardware not as a simulator with known rules, but as a modeling substrate for unknown dynamics—allowing reality to "speak" through the collapse process.

In this vision, the quantum computer is not merely a tool of science—it is a mirror to nature, and perhaps, under certain conditions, a window into the logic of the universe before logic itself was defined.

VIII. Conclusion

Quantum computing is often framed as a technological race: a sprint toward fault tolerance, algorithmic supremacy, and commercial viability. Each advancement—whether in fidelity, qubit count, or error correction—brings us closer to machines that can solve classically intractable problems with unprecedented speed and precision. But amid this pursuit of computational perfection, a deeper dimension risks being overlooked.

This paper has argued for a dual-use paradigm in quantum computing—one in which machines are used not only for executing logic but for listening to nature. The quantum computer, especially when initialized in a pure state and left undisturbed, becomes more than a processor. It becomes an observational instrument, capable of revealing how structure emerges, how collapse unfolds, and how the quantum vacuum interacts with matter through what we call noise.

In this view, the collapse of a quantum state—particularly in the absence of algorithmic instruction—is not an error. It is a message, perhaps faint and fragile, but no less real than the cosmic microwave background was in 1964. Like Penzias and Wilson, we may be standing at the edge of discovery, mistaking significance for contamination because we did not tune our systems to hear it.

The push for perfection—toward ever-lower error rates and ever-higher fidelity—may come at a cost. The more completely we suppress noise, the more completely we may erase the very fluctuations that carry the imprint of physical context. In our pursuit of silence, we risk losing the opportunity for spontaneous insight—the kind of revelation that does not come from what we tell the machine to do, but from what it does when left alone.

We therefore call for a complementary mode of experimentation, alongside conventional quantum computation: one that welcomes collapse, that logs it, maps it, studies it—not to improve gate performance, but to understand what collapse reveals. We call for the creation of trusted noise layers in quantum systems, in which observation is prioritized over suppression, and where patterns

are not rejected as artifacts but considered as potential *phenomena in their own right*.

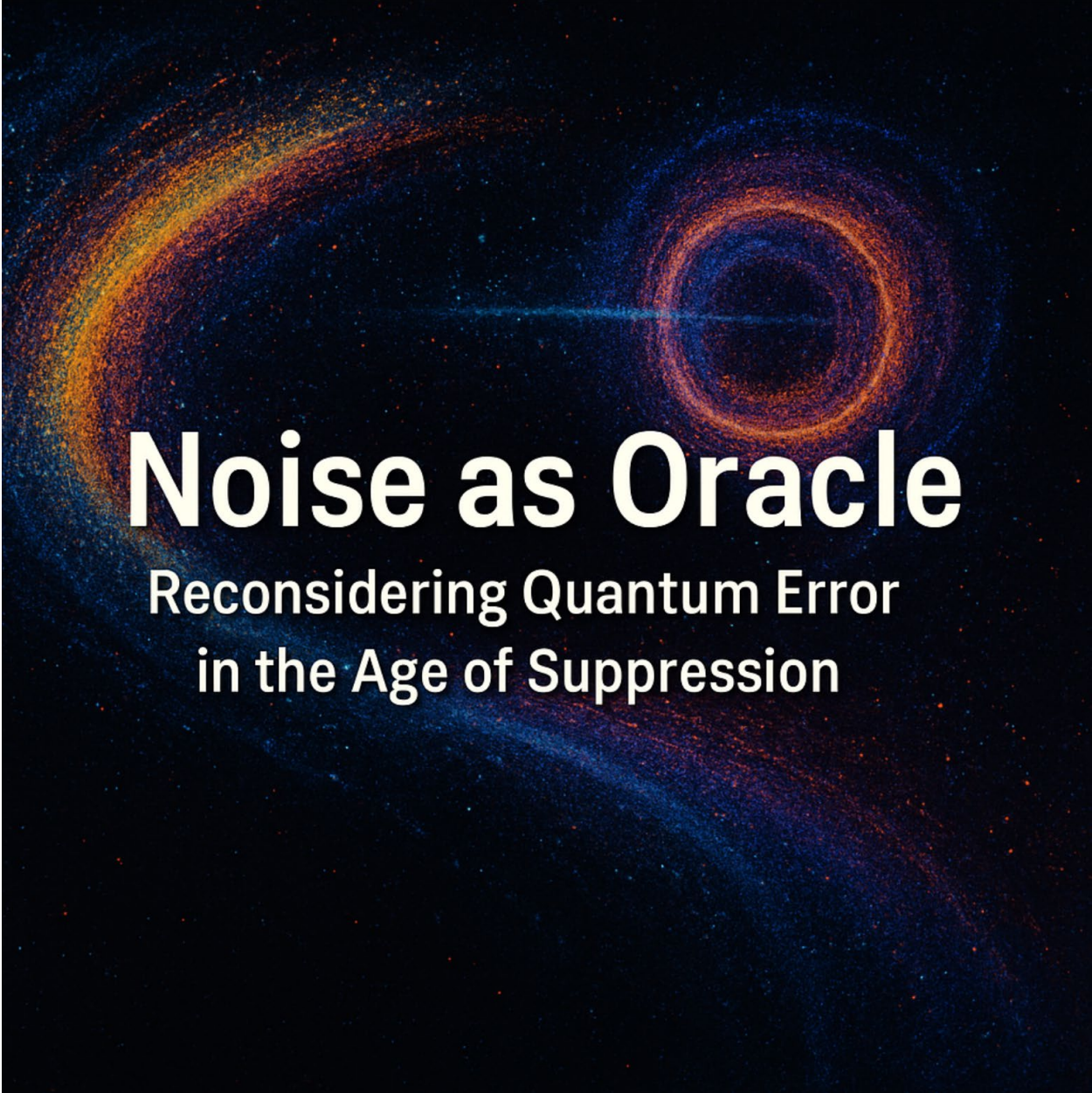
To reframe noise is not to abandon engineering excellence. It is to remember that the deepest insights in physics have often come not from eliminating anomalies, but from embracing them. The collapse of a quantum system may yet prove to be more than a byproduct of imperfection. It may be the echo of the world choosing itself, one bitstring at a time.

Let us not silence that voice too soon.

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