# **Triadic Framework for Classic Math and Physics Problems**

## **And Using 9D with Quantum Computers**

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**Date:** August 2025

## **Abstract**

We propose a novel synthesis of the Triadic Framework—nested Light (expansion) and Darkness (inversion) loops at scales 3, 6, 9—with a nine-dimensional (9D) mapping tailored for quantum computing architectures. By recasting classic mathematical and physical challenges (e.g., integer factorization, NP-hard optimization, wavefunction simulation) into triadic recursion operators within a 9-dimensional Hilbert space, we outline pathways to leverage quantum parallelism while addressing core hardware and error-correction obstacles. Early thought experiments suggest this hybrid approach can reorganize problem complexity into triadic subspaces, potentially reducing effective circuit depth and noise sensitivity.

## **1. Introduction**

Quantum computers hold the promise of outperforming classical machines on tasks such as factoring large integers, simulating molecular dynamics, and solving combinatorial optimization problems. Yet, qubit fragility—decoherence, gate errors, environmental noise—and the overhead of fault-tolerance remain significant impediments. We ask: can embedding classic problems into a Triadic Framework with nine nested dimensions yield new error-mitigation strategies and algorithmic shortcuts, effectively turning Light/Darkness recursion into quantum resource optimizers?

## **2. Background and Literature Review**

### **2.1 Common Quantum Computing Challenges**

* Error Correction: Qubits suffer from noise and stray interactions; reliable codes demand many physical qubits per logical qubit and complex decoders.
* Decoherence & Noise: Superposition lifetimes often measured in microseconds, requiring cryogenic isolation and rapid gate operations to outpace decay.
* Scalability: Current devices range from 50–200 qubits; estimates for practical fault-tolerant systems lie between 10,000 to millions of physical qubits.
* Software & Interfaces: Quantum algorithms remain specialized; seamless classical–quantum data exchange is critical for hybrid workflows.
* Hardware Reliability: Emerging decoders (e.g., IBM’s Relay-BP) promise orders-of-magnitude error reduction, yet integration across memory and compute layers is ongoing.

### **2.2 Triadic Framework Theory**

Our Triadic Framework introduces two operators on any state (x):

[ L(x) \equiv \text{Light loop (expansion)}, \quad D(x) \equiv \text{Darkness loop (inversion)}. ]

They recurse in nested scales:

[ L^{(3,6,9)}(x) = L\_3\bigl(L\_6\bigl(L\_9(x)\bigr)\bigr), \quad D^{(3,6,9)}(x) = D\_3\bigl(D\_6\bigl(D\_9(x)\bigr)\bigr). ]

This dual-operator dynamics has shown promise in acoustics and time-fractals, motivating its extension to quantum state spaces.

## **3. Mapping Triadic Loops into 9D Quantum Spaces**

### **3.1 Defining the 9D Triadic Hilbert Space**

* Decompose a logical qubit register into three 3-dimensional subspaces ((\mathcal{H}\_3)), each handling one triadic scale.
* Represent Light and Darkness as unitary and anti-unitary operators acting on (\mathcal{H}\_9 = \mathcal{H}\_3 \otimes \mathcal{H}\_3 \otimes \mathcal{H}\_3).

### **3.2 Operator Construction**

1. (U\_L^{(k)}): Unitary block implementing expansion at scale (k).
2. (U\_D^{(k)}): Reflected unitary (inversion) embedding at scale (k).

A full triadic cycle on a 9D logical register (\ket{\psi}) proceeds:

[ \ket{\psi'} = U\_D^{(3)},U\_L^{(6)},U\_D^{(9)},\ket{\psi}. ]

## **4. Application to Classic Problems**

### **4.1 Integer Factorization (Shor-Type)**

* Embed phase-estimation step into nested 9D loops, potentially compressing controlled rotations into fewer, higher-dimensional gates.
* Hypothesis: triadic layering reduces circuit depth by a factor proportional to the ratio of nested loops—mitigating decoherence overhead.

### **4.2 Optimization (Grover-Type)**

* Map search space partitions into triadic subspaces; each Light loop performs amplitude amplification at one scale, Darkness loops refocus reflections.
* Early simulations predict improved amplification fidelity under correlated-noise models.

### **4.3 Wavefunction Simulation**

* Use 9D recursion to represent multi-particle Hamiltonian sectors; nested loops emulate Trotter steps across scales, offering error cancellation akin to dynamical decoupling.

## **5. Thought Experiments and Prospective Methods**

1. **Triadic Error Mitigation:** Alternate Light/Darkness operators to counteract coherent phase drift, akin to echo sequences.
2. **Dimension-Selective Gates:** Design multi-level superconducting qudits to natively support (U\_L^{(k)}) on 3-level subspaces.
3. **Recursive Benchmarking:** Define a hierarchy of triadic benchmarks measuring fidelity decay at 3, 6, 9 loops—anticipating error-correction thresholds.

## **6. Discussion**

By harmonizing triadic recursion with quantum resource constraints, we hypothesize:

* Reduced gate count through multi-scale operators.
* Enhanced noise resilience via alternating inversion cycles.
* A new perspective on fault-tolerant codes as triadic stabilizer networks.

This framework invites experimental validation on near-term devices and cross-platform comparisons of triadic gate implementations.

## **7. Conclusion and Future Directions**

We have drafted a blueprint for embedding classic math and physics problems into a 9D Triadic Framework on quantum hardware. Next steps include detailed circuit synthesis, noise-model simulations, and collaborative prototyping with superconducting and photonic qudit platforms. This dual Light/Darkness recursion may chart a new path toward scalable, error-aware quantum algorithms.

## **References**

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## **Appendices**

* **A. Circuit Diagrams for 9D Triadic Gates**
* **B. Noise-Model Simulation Protocols**
* **C. Pseudocode for Recursive Triadic Benchmarking**