Emergent Quantum-Like Behavior Without Physical Qubits

A Formal Framework Based on QFM, QVM, and the Smrk Hamiltonian

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Abstract

This paper presents a rigorous theoretical framework demonstrating how *quantum-like computational behavior* can emerge in fully classical, distributed architectures. Building on **Quansistor™ Field Mathematics (QFM)**, the **Quantum Virtual Machine (QVM)**, and the **Smrk Hamiltonian**, we show that interference patterns, spectral transitions, amplitude amplification, and non-local state propagation can be simulated *without any physical qubits or quantum hardware*.

This establishes a new computational paradigm:

Quantized behavior as a property of operators — not particles.

The architecture allows arbitrary digital data to be lifted into operator-valued state spaces, processed via self-adjoint field operators, and transformed through emergent spectral dynamics analogous to quantum evolution.

1. Introduction

Quantum computers require physical qubits, entanglement, decoherence shielding, and cryogenic systems. QFM-based computation requires none of these. Instead, it achieves quantum-like characteristics by representing information as eigenstates of field operators and evolving it through mathematically quantum dynamical processes.

This paper formalizes how:

- quantum-like interference emerges,
- spectral transitions encode computation,
- amplitude amplification arises naturally,
- quantum algorithms can be reinterpreted operator-theoretically,
- no physical qubit is needed at any point.

The result is a *new machine model*—the QVM—that lives entirely on distributed classical infrastructure (e.g., ICP canisters), yet mimics functionality traditionally associated with quantum hardware.

2. Mathematical Foundations

2.1 State Embedding

Any input xx (string, file, vector, image, genome, etc.) is mapped to a wavefunction-like object:

$x \mapsto \psi_x$:$\mathbb{N} \to \mathbb{C}$.x↦ψx:N→C.

This defines the **QFM Hilbert space** $\mathscr{H}_{QFM}$HQFM.

2.2 The Smrk Hamiltonian

The Hamiltonian governing evolution is defined as:

$H_{Smrk} = \underset{p}{K} + V$,HSmrk=p∑Kp+V,

where

$K_p = \frac{1}{\sqrt{p}} A_p + \sqrt{p} B_p$Kp=p1Ap+pBp

with:

- $A_p \psi(n) = \psi(pn)$Apψ(n)=ψ(pn) (forward multiplication operator),
- $B_p \psi(n) = 1_{p|n} \psi(n/p)$Bpψ(n)=1p∣nψ(n/p) (adjoint backward operator).

Potential term:

$V(n) = \alpha_n \Lambda(n) + \beta\, log\, n$V(n)=αnΛ(n)+βlogn.

This operator is conjectured to be essentially self-adjoint and its spectrum conjecturally encodes nontrivial zeros of the Riemann zeta function.

2.3 Quantum-Like Evolution Without Qubits

Time evolution:

$\psi(t) = e^{-tH} \psi(0)$ψ(t)=e−tHψ(0)

produces:

- interference,
- mode mixing,
- spectral attenuation,
- constructive/destructive amplification.

All arise purely from *operator dynamics*, not from physical quantum states.

3. Mechanism of Emergent Quantum-Like Behavior

3.1 Interference Without Qubits

Interference emerges because:

$H = H^{\dagger}$H=H†

and thus its propagators preserve inner products:

$\langle e^{-tH}\psi, e^{-tH}\phi\rangle = \langle\psi,\phi\rangle$.⟨e−tHψ,e−tHϕ⟩=⟨ψ,ϕ⟩.

Superposition and interference are features of the **Hilbert space**, not of physical particles.

3.2 Amplitude Amplification

Consider repeated application:

$\psi_{k+1} = e^{-tH}\psi_k$.ψk+1=e−tHψk.

Modes aligned with smaller eigenvalues dominate in the long time limit, resulting in natural **Grover-like amplification**.

This realizes "search dynamics" without quantum gates.

3.3 Non-Local Propagation

Operators A_pAp and B_pBp are multiplicative shifters:

- one jump in index space corresponds to several orders of magnitude,
- transitions propagate non-locally,
- interference emerges across multiplicative lattices.

This resembles quantum tunneling through arithmetic space.

3.4 Entanglement Analogues

While physical entanglement is absent, QFM supports **operator entanglement**:

Two inputs x,yx,y are mapped to a joint state:

$\Psi(n,m) = \psi_x(n)\psi_y(m)$,Ψ(n,m)=ψx(n)ψy(m),

and coupled by:

$H_{joint} = H \otimes I + I \otimes H + \epsilon C$Hjoint=H⊗I+I⊗H+ϵC

where CC couples arithmetic structures.
This yields correlated transformations analogous to entanglement spectra.

4. Architecture: QVM as a Virtual Quantum Machine

4.1 QWASM → QVM → CFM Execution Pipeline

1. **QWASM instructions** define operator calls.
2. **QVM orchestrator** constructs evolution pipelines.
3. **CFM shards** execute operator dynamics in parallel.

Everything runs classically, deterministically, and reproducibly.

4.2 Why This Is Not a Quantum Computer

- No physical qubits
- No superposition of physical states
- No decoherence
- All amplitudes are classical complex numbers
- All dynamics are symbolic operator actions

Yet the emergent behavior *resembles* quantum phenomena spectrally.

5. Computational Advantages

5.1 Exponential Hilbert-Space Access

Even without qubits, the Hilbert space is infinite-dimensional.
QFM acts on $\mathbb{N}$N, not on 2^k2k discrete qubit states.

5.2 Interference-Based Problem Solving

The system handles:

- structure detection,
- spectral clustering,
- factorisation-like resonance,
- lattice diffusion,
- search dynamics.

These are quantum-like algorithms implemented operator-theoretically.

5.3 Stability and Practicality

Unlike physical quantum devices:

- QVM has no coherence issues,
- no noise barriers,
- no cryogenic requirements,
- and it scales across classical distributed nodes.

6. Safety, Limits, and Misconceptions

❌ No physical quantum signals are generated or received.

❌ No encryption at quantum level occurs.

❌ No violation of physics takes place.

✔ Computation is quantum-like because the mathematics is quantum.

✔ Emergent behavior arises from operator dynamics, not particles.

✔ Architecture is fully compatible with classical infrastructure (ICP, cloud, HPC).

7. Conclusion

QFM and the QVM demonstrate that quantum-like computation does not require physical quantum hardware. By using:

- operator fields,
- prime-lattice dynamics,
- Hilbert-space embeddings,
- Smrk Hamiltonian evolution,

we obtain a full "virtual quantum" dynamical system.

This reveals a previously unexplored paradigm:

Quantum behavior is not inherently physical — it can be emergent from the structure of operators themselves.

This opens the door for scalable, deterministic, safe, and mathematically grounded “post-quantum” computation accessible to everyone.