

# The Base State Hypothesis: A Falsification Protocol for a Substrate Capable of Hosting the Standard Model, Audited Against Contemporary Quantum Platforms

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### Abstract

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We formalize the question of whether a single, explicitly constructible quantum object — a "Base State" — could serve as a substrate on which the structure of the Standard Model is hosted, rather than the Standard Model being assembled from particle-like primitives on a qubit-gate substrate. A Base State is defined as a normalized state (or density operator) in a finite-dimensional Hilbert space, equipped with a declared readout map and a declared symmetry group, such that every empirically accessible structure arises by preparation, measurement, and composition. We audit feasibility using the only quantitative hardware data in our source corpus: the Tianyan-287 superconducting processor (105 qubits; single-qubit gate fidelity 99.90%, two-qubit gate fidelity 99.56%, readout fidelity 98.7%). With full arithmetic we derive: per-operation error rates of  $1.0 \times 10^{-3}$ ,  $4.4 \times 10^{-3}$ , and  $1.3 \times 10^{-2}$ ; a two-qubit serial budget of at most 157 gates at 50% aggregate fidelity (154 with one final readout); a full-register readout ceiling of  $F_{\text{ro}} \approx 0.2532$ ; a representative 105-qubit circuit fidelity of  $F_{\text{circ}} \approx 0.1467$ ; and a parameter count of  $2^{106} - 2 \approx 8.113 \times 10^{31}$  real numbers for a generic state, versus 105 bits to index a basis state. We propose a three-stage falsification protocol, state explicit falsifiers, and conclude that the Base State hypothesis is currently unfalsified but unconfirmed: the obstruction is quantitative, not a no-go in principle.

### 1. Introduction

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The Standard Model of particle physics is conventionally presented as a list of particles and interactions on a background stage. A dissenting constructive tradition, represented in the supplied corpus by "Beyond the Qubit: Constructive Paradigms for Post-Particle Computation" [10], argues that the qubit-gate-circuit model is an epistemic failure — a projection of particle ontology onto what is better described as relational, field-theoretic reality. If that critique is accepted even provisionally, the constructive question becomes: what minimal object could host Standard-Model-like structure without presupposing particles? We call this candidate object the **Base State**.

This paper does three things. First, it gives the Base State hypothesis a definition precise enough to be wrong: Section 3 states exactly what object counts as a Base State and what would count as hosting. Second, it performs an honest feasibility audit using only numbers supplied in the grounding material — the fidelities of the Tianyan-287 processor [2] — to determine whether current hardware could prepare and verify a candidate at the 100-qubit scale. Third, it proposes a falsification protocol in the spirit of the automata-learning literature, where a model is recovered from noisy, incomplete data by evidence-driven merging rather than by optimizing a numeric target [1], and in the spirit of the Falsification Pledge of the Manifesto for Honest Computation [12].

Our conclusions are negative in the short term and constructive in the long term. The parameter-counting and fidelity analyses of Section 4 show that (i) a generic 105-qubit state is unspecifiable in any practical sense, so a viable Base State must be highly structured; (ii) current readout fidelity alone caps whole-register verification fidelity near 0.25; and (iii) a gate-circuit encoding of even a toy relational state space exhausts any plausible two-qubit budget. The hypothesis therefore survives as an open research program, not a result.

### 2. Background and Related Work

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We review all twelve supplied works and their bearing on the Base State question.

**[1] Human in the Loop: Interactive Passive Automata Learning via Evidence-Driven State-Merging Algorithms (arXiv:1707.09430v1).** This work presents an interactive version of an evidence-driven state-merging (EDSM) algorithm for learning variants of finite state automata, framing learning as recovering or reverse-engineering the model that generated noisy,

incomplete, or imperfectly sampled data, with domain expertise injected by a human in the loop. This is directly relevant methodologically: inferring a Base State from measurement data is a model-recovery problem under noise, not a numeric optimization, and the ESDM pattern — merge states when evidence supports it, consult an oracle when it does not — is a template for how a candidate Base State's equivalence classes of measurement outcomes could be inferred.

**[2] Tianyan: Cloud services with quantum advantage (arXiv:2512.10504v2).** This work describes the Tianyan Quantum Cloud Platform, offering cloud services demonstrating quantum advantage capabilities with a Zuchongzhi 3.0-like superconducting processor; the cloud-accessible prototype Tianyan-287 features 105 qubits with single-qubit gate, two-qubit gate, and readout fidelities of 99.90%, 99.56%, and 98.7%, respectively. These are the only hardware performance numbers supplied in our grounding material, and Section 4 uses them as the quantitative basis of the feasibility audit.

**[3] Bell-state measurement and quantum teleportation using linear optics (arXiv:1304.1214v1).** This work reviews and compares Bell-state measurement and quantum teleportation schemes using linear optics with three resource types — two-photon pairs, entangled coherent states, and hybrid entangled states — and reports that perfect teleportation with linear optics is possible in principle based on a hybrid approach combining two-photon pairs and entangled coherent states. For the Base State program this matters because teleportation is the minimal operation by which a state prepared in one physical substrate could be transferred into another; the existence of in-principle perfect transfer with hybrid resources suggests that substrate-independence of a Base State is not obviously blocked at the level of principle.

**[4] Searching for Coherent States: From Origins to Quantum Gravity (arXiv:2003.11810v4).** This work discusses coherent states from three perspectives — Schrödinger's seminal approach, the experimental take of quantum optics, and theoretical developments in quantum gravity — as a comparative study intended to connect the approaches and serve pedagogical purposes. The supplied summary gives no further technical detail; we use it only to justify treating "coherent state" as a unifying object spanning microscopic and gravitational regimes, which is the span a Base State would need. We flag this as analogy, not identity.

**[5] A full circuit-based quantum algorithm for excited-states in quantum chemistry (arXiv:2112.14193v3).** This work proposes a non-variational, full circuit-based quantum algorithm for obtaining excited states, motivated by the role of excited-state determination in predicting and modeling chemical reactions and other physical processes beyond widely studied ground-state problems. The supplied summary truncates before the algorithm's performance claims. This supplies the constructive counterpart to our audit: if a Base State is to host dynamics, machinery for accessing excitations above it must be circuit-native rather than variational, and [5] shows such machinery is an active object of design.

**[6] Interaction of light and semiconductor can generate quantum states required for solid state quantum computing (arXiv:1811.09849v1).** This work investigates the generation of nonclassical states — entangled, steered, and others — in a physical system composed of light and a semiconductor, motivated by the observation that solid-state quantum computing proposals are extremely promising for room-temperature machines and would require in-built sources of nonclassical states. This addresses the preparation side of the Base State problem: the substrate must contain its own sources of the nonclassical states the program needs, not import them.

**[7] Unraveling the emergence of quantum state designs in systems with symmetry (arXiv:2402.08949v3).** This work studies quantum state designs — structures enabling efficient sampling of random quantum states, with applications from circuit design to black hole physics — and the open question of how symmetry, which is expected to reduce the randomness of a state, affects state designs; the summary indicates this remained unresolved. This is the closest technical analogue to our compression-gap argument in Section 4: a hostable Base State cannot be generic and must live in a symmetry-constrained, design-like family, and [7] confirms that the interplay of symmetry and design structure is an open research question rather than settled technology.

**[8] Quantum games and synchronicity (arXiv:2408.15444v4).** This work, in the flavour of categorical quantum mechanics, extends nonlocal games to allow quantum questions and answers, using quantum sets (special symmetric dagger Frobenius algebras) and the quantum functions of Musto, Reutter, and Verdon, with equations presented in a diagrammatic calculus for tensor categories. Dagger Frobenius algebras are the categorical encoding of compositional structure; this is the supplied formal language closest to a relational ontology of interaction, in which a Base State and its admissible interactions could be stated without committing to a particle ontology.

**[9] QNFO: Standard Model (DOI 10.5281/zenodo.17210901).** The supplied entry carries no summary text; only the title and identifier are available. We therefore use it only as the declared reference object for "the Standard Model" as the target structure to be hosted, and make no claim about its contents.

[10] **QNFO: Beyond the Qubit (DOI 10.5281/zenodo.22753022)**. The supplied summary states that this work is a companion to "The Qubit Delusion" (v1.1, DOI 10.5281/zenodo.21254143), asks what comes next if the qubit-gate-circuit model is an epistemic failure — a projection of particle ontology onto relational, field-theoretic reality — and strips quantum mechanics to its minimal ontological commitments. The Base State hypothesis of this paper is precisely an attempt to answer that "what comes next" question in a falsifiable form.

[11] **QNFO: EMERGENT CORRELATION IN A LOCAL-DETERMINISTIC UNIVERSE (DOI 10.5281/zenodo.18015329)**. The supplied entry likewise carries no summary text; only the title and identifier are available. We rely on it only as a declared position in the emergence-of-correlation debate, without attributing any specific result to it.

[12] **QNFO: Manifesto for Honest Computation (DOI 10.5281/zenodo.21299278)**. The supplied summary describes this work as Phase VI (Final Synthesis), containing 5 principles, a concrete portfolio, and the Falsification Pledge. This paper adopts that methodological stance: every claim below is either derived with shown arithmetic or explicitly labeled as a projection with stated assumptions, and Section 6 states what would falsify the program.

### 3. Methods

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#### 3.1 Definition of a Base State

Let  $\mathcal{H}_N$  be a Hilbert space of dimension  $D_N = 2^N$ , spanned by a declared computational basis  $\{|b\rangle\}_{b \in \{0,1\}^N}$ . A **Base State candidate** is a pair

$$\mathcal{B} = (|\psi_0\rangle \in \mathcal{H}_N, \mathcal{R} : \mathcal{H}_N \rightarrow \{0,1\}^N),$$

where  $|\psi_0\rangle$  is a normalized state vector (or, in the mixed generalization, a density operator  $\rho_0$  with  $\text{Tr}(\rho_0) = 1$ ) and  $\mathcal{R}$  is a declared readout map. Equivalently, in relational terms, the Base State is a labeled transition system  $B = (S, \Sigma, \delta, \lambda, \mathcal{G})$  with states  $S$ , interaction alphabet  $\Sigma$ , transition function  $\delta$ , observable labeling  $\lambda$ , and symmetry group  $\mathcal{G}$ . We say  $\mathcal{B}$  **hosts** a target structure  $\mathcal{T}$  (here, nominally, the Standard Model, per [9]) if:

1. **Preparation:**  $|\psi_0\rangle$  is preparable from a product initial state by a circuit of finite, stated depth.
2. **Verifiability:** there exists a measurement statistics test whose pass probability, under the hypothesis that the prepared state is  $|\psi_0\rangle$ , exceeds a declared threshold  $\theta$ , and whose pass probability under every state in a declared alternative set is below  $\theta$ .
3. **Compositional productivity:** admissible operations on  $\mathcal{B}$  form a closed algebraic structure (in the categorical sense of objects and morphisms, as in [8]) rich enough to encode the interaction pattern of  $\mathcal{T}$ ; minimally,  $\mathcal{G}$  should contain a subgroup matching the gauge structure  $SU(3) \times SU(2) \times U(1)$ .

As pure arithmetic on Lie-algebra dimensions,  $\dim SU(3) = 3^2 - 1 = 8$ ,  $\dim SU(2) = 2^2 - 1 = 3$ ,  $\dim U(1) = 1$ , so the minimal gauge algebra has dimension  $d_{\mathcal{G}} = 8 + 3 + 1 = 12$ . This is a counting statement about the target symmetry, not a derivation of the Standard Model. Condition 3 is deliberately left programmatic; conditions 1 and 2 are auditable with hardware numbers, and Section 4 audits them.

#### 3.2 Audit quantities

For a platform with single-qubit gate fidelity  $F_1$ , two-qubit gate fidelity  $F_2$ , and readout fidelity  $F_r$  (all as reported in [2] for Tianyan-287), we model a circuit with  $n_1$  single-qubit gates,  $n_2$  two-qubit gates, and  $n_r$  readout events by the independent-error product

$$F_{\text{circ}}(n_1, n_2, n_r) = F_1^{n_1} F_2^{n_2} F_r^{n_r},$$

or, in log form,

$$\ln F_{\text{circ}} = n_1 \ln F_1 + n_2 \ln F_2 + n_r \ln F_r.$$

This is a first-order model: it assumes errors are independent and multiplicative and ignores crosstalk, leakage, and correlated decay. It is conservative for our purposes because it can only overestimate fidelity when correlations are harmful; all circuit-level numbers below are therefore upper bounds on achievable fidelity. As a complementary per-operation summary (Appendix A, Divergence D1), we also report the arithmetic mean fidelity  $\bar{F} = (F_1 + F_2 + F_r)/3$  and the three-step composite error  $P_{\text{err}} = 1 - F_1 F_2 F_r$ .

### 3.3 Specifiability accounting

A pure state  $|\psi\rangle \in \mathcal{H}_N$  is specified, up to normalization and global phase, by  $2D_N - 2$  real numbers:  $D_N$  complex amplitudes contribute  $2D_N$  real numbers, normalization removes 1, and the global phase removes 1 more. We compare this against the  $\log_2 D_N = N$  bits needed to index a single computational basis state, and against the design-family picture of [7], in which one samples structured states efficiently rather than writing them out.

### 3.4 Falsification protocol

Following the model-recovery stance of [1] and the Falsification Pledge of [12], the protocol is:

- **Stage P (Preparation):** prepare a candidate  $|\psi_0\rangle$  on the full register; record circuit depth and gate counts.
- **Stage V (Verification):** run a statistics test with threshold  $\theta = 0.5$ ; the candidate fails if the achievable  $F_{\text{circ}}$  budget falls below  $\theta$ .
- **Stage C (Composition):** demonstrate one nontrivial closed composition (e.g., a teleportation-grade transfer as in [3]) out of the Base State.

## 4. Analysis

All hardware inputs in this section come from [2]:  $N = 105$  qubits;  $F_1 = 0.9990$ ;  $F_2 = 0.9956$ ;  $F_r = 0.987$ . All other quantities are derived below with full arithmetic.

### 4.1 Per-operation error rates and per-operation summary

$$\epsilon_1 = 1 - F_1 = 1 - 0.9990 = 1.0 \times 10^{-3},$$

$$\epsilon_2 = 1 - F_2 = 1 - 0.9956 = 4.4 \times 10^{-3},$$

$$\epsilon_r = 1 - F_r = 1 - 0.987 = 1.3 \times 10^{-2}.$$

Ratios:  $\epsilon_2/\epsilon_1 = 4.4 \times 10^{-3}/1.0 \times 10^{-3} = 4.4$ ;  $\epsilon_r/\epsilon_1 = 1.3 \times 10^{-2}/1.0 \times 10^{-3} = 13$ .

Per-operation summary (convention of Appendix A, D1): the sum of fidelities is  $S = 0.9990 + 0.9956 + 0.9870 = 2.9816$ , so

$$\bar{F} = \frac{2.9816}{3} = 0.9938667 \dots \approx 99.39\%.$$

The three-step composite:  $0.9990 \times 0.9956 = 0.9946044$ ;  $0.9946044 \times 0.9870 = 0.9816745428$ ; hence

$$P_{\text{err}} = 1 - 0.9816745428 = 0.0183254572 \approx 1.8325\%.$$

Log-fidelities (natural log), used throughout:

$$\ln F_1 = \ln(0.9990) \approx -1.0005 \times 10^{-3},$$

$$\ln F_2 = \ln(0.9956) \approx -4.4097 \times 10^{-3},$$

$$\ln F_r = \ln(0.987) \approx -1.30816 \times 10^{-2}.$$

### 4.2 Hilbert-space dimension, parameter count, and the compression gap

Input:  $N = 105$  [2]. Then

$$D_{105} = 2^{105} = 2^{100} \cdot 2^5 = 1.2676506 \times 10^{30} \times 32 = 4.0564819 \times 10^{31}.$$

The number of real parameters needed to specify a generic pure state (Section 3.3) is

$$2D_{105} - 2 = 2^{106} - 2 = 8.1129638 \times 10^{31} - 2 \approx 8.113 \times 10^{31}.$$

Per qubit, this is  $(2^{106} - 2)/105 = 8.1129638 \times 10^{31}/105 \approx 7.7266 \times 10^{29}$  real numbers per qubit of register. By contrast, indexing one computational basis state costs  $\log_2 D_{105} = 105$  bits. **Interpretation:** a Base State that is generic is unspecifiable by roughly thirty orders of magnitude. Any viable candidate must belong to a structured, efficiently parameterized family — exactly the regime that quantum state designs address [7], and exactly where the effect of symmetry on such families remains, per [7], an open question. Note that the register is large enough in *dimension* to embed any finite state space with  $k \leq 2^{105}$ ; the failure analyzed below is in *dynamics*, not capacity.

### 4.3 Two-qubit serial budget at 50% aggregate fidelity

Setting  $F_{\text{circ}}(n, 0) = F_2^n \geq 0.5$  and solving for  $n$ :

$$n \leq \frac{\ln 0.5}{\ln F_2} = \frac{-0.693147}{-4.4097 \times 10^{-3}} \approx 157.2.$$

So a purely two-qubit-gate serial circuit on Tianyan-287 retains at least 50% aggregate fidelity for at most  $n = 157$  two-qubit gates. Including a single final readout, the budget tightens:  $F_2^n \cdot 0.987 \geq 0.5$  gives  $F_2^n \geq 0.5/0.987 = 0.506584$ , so

$$n \leq \frac{\ln 0.506584}{-4.4097 \times 10^{-3}} = \frac{-0.680066}{-4.4097 \times 10^{-3}} \approx 154.2,$$

i.e.,  $n = 154$  two-qubit gates with one final readout.

### 4.4 Readout-only ceiling for full-register verification

Any verification protocol that reads out all  $N = 105$  qubits incurs at least  $n_r = 105$  readout events. With no other operations ( $n_1 = n_2 = 0$ ):

$$\begin{aligned} \ln F_{\text{ro}} &= 105 \times (-1.30816 \times 10^{-2}) = -1.37357, \\ F_{\text{ro}} &= e^{-1.37357} \approx 0.2532. \end{aligned}$$

Readout alone caps full-register verification fidelity at approximately 0.253, far below the Stage V threshold  $\theta = 0.5$ . No candidate Base State on this platform can be verified on the full register at  $\theta = 0.5$ , regardless of how good the gates are. This is a structural bottleneck, not a gate-quality one. (This scenario assumes readout of all 105 qubits; the single-readout scenario of Section 4.3 is the contrasting convention — see Appendix A, D2.)

### 4.5 Representative full-register circuit

Consider a representative preparation circuit using all 105 qubits with  $n_1 = 105$  single-qubit gates,  $n_2 = 100$  two-qubit gates, and  $n_r = 105$  readouts. Term by term:

$$\begin{aligned} 105 \times (-1.0005 \times 10^{-3}) &= -0.10505, \\ 100 \times (-4.4097 \times 10^{-3}) &= -0.44097, \\ 105 \times (-1.30816 \times 10^{-2}) &= -1.37357. \end{aligned}$$

Sum:  $\ln F_{\text{circ}} = -0.10505 - 0.44097 - 1.37357 = -1.91959$ , so

$$F_{\text{circ}} = e^{-1.91959} \approx 0.1467.$$

Cross-check in the fidelity domain: single-qubit gates alone  $e^{-0.10505} \approx 0.9003$ ; two-qubit gates alone  $e^{-0.44097} \approx 0.6434$ ; readout alone  $e^{-1.37357} \approx 0.2532$ ; and  $0.9003 \times 0.6434 \times 0.2532 \approx 0.1467$ , confirming the log-domain computation.

#### 4.6 Gate-budget headroom under ideal readout

To ask how large a circuit the gates alone could support at  $\theta = 0.5$ , set  $n_r = 0$  and  $n_1 = n_2 = n$ :

$$n(\ln F_1 + \ln F_2) = \ln 0.5 = -0.69315.$$

Since  $\ln F_1 + \ln F_2 = -1.0005 \times 10^{-3} - 4.4097 \times 10^{-3} = -5.4102 \times 10^{-3}$ ,

$$n = \frac{-0.69315}{-5.4102 \times 10^{-3}} \approx 128.1,$$

so approximately  $n = 128$  combined gate layers could be tolerated at  $\theta = 0.5$  if readout were perfect. Restoring real readout ( $n_r = 105$ ) consumes log-budget 1.37357, which exceeds the total budget 0.69315 by a factor  $1.37357/0.69315 \approx 1.98$ : readout alone uses about 1.98 times the entire  $\theta = 0.5$  budget.

#### 4.7 Cost of encoding a relational state space (toy model)

Suppose the Base State's relational state space  $S$  has  $|S| = k$  distinguishable configurations and out-degree  $r$  (each state has  $r$  outgoing edges), so the transition table has  $k \cdot r$  edges. For a toy system with  $k = 100$  and  $r = 4$ , that is  $k \cdot r = 400$  edges; if a single coherent computation must touch a fraction  $\phi$  of them with one two-qubit gate per edge, the budget of Section 4.3 requires

$$\phi \cdot 400 \leq 157 \quad \Rightarrow \quad \phi \leq \frac{157}{400} = 0.3925.$$

So even a 100-state toy relational system can have at most about 39% of its transition structure touched per coherent circuit run before aggregate fidelity drops below 50%.

#### 4.8 Projection: full-table circuit fidelity and required readout

**Projection 1** (labeled; assumptions: independent errors, no crosstalk, no state-preparation or idling error, serial compilation, one two-qubit gate per edge). A circuit touching the full 400-edge table needs aggregate fidelity  $F_2^{400}$ :

$$\begin{aligned} \ln F_2^{400} &= 400 \times (-4.4097 \times 10^{-3}) = -1.76387, \\ F_2^{400} &= e^{-1.76387} \approx 0.1714. \end{aligned}$$

Uncertainty bound: any additional per-gate error  $\epsilon'$  shifts the exponent by  $400 \epsilon'$ ; e.g.,  $\epsilon' = 10^{-3}$  gives  $e^{-1.76387-0.4} \approx 0.1148$ . The projection is robust in concluding that a full-table circuit fails well below any useful threshold.

**Projection 2** (labeled; assumptions:  $n_1 = 105$ ,  $n_2 = 100$ ,  $n_r = 105$ ,  $F_1$  and  $F_2$  as in [2], target  $\theta = 0.5$ ). The required readout fidelity  $F_r^*$  satisfies

$$\begin{aligned} \ln F_r^* &= \frac{\ln 0.5 - \ln F_1^{105} - \ln F_2^{100}}{105} = \frac{-0.69315 + 0.10505 + 0.44097}{105} = \frac{-0.14713}{105} = -1.4012 \times 10^{-3}, \\ F_r^* &= e^{-1.4012 \times 10^{-3}} \approx 0.99860. \end{aligned}$$

Full-register verification at  $\theta = 0.5$  for this circuit class requires readout fidelity  $\approx 0.9986$ , versus the supplied 0.987 [2] — a reduction of readout error from  $1.3 \times 10^{-2}$  to  $1.4 \times 10^{-3}$ , a factor  $1.3 \times 10^{-2}/1.4 \times 10^{-3} \approx 9.3$ . This projection inherits the independence assumption; correlated errors would only raise the requirement, so 0.9986 is a best-case figure.

## 5. Results

All numbers below are computed in Section 4 from the inputs of [2]; the two projections are labeled.

1. **Per-operation errors.**  $\epsilon_1 = 1.0 \times 10^{-3}$ ,  $\epsilon_2 = 4.4 \times 10^{-3}$ ,  $\epsilon_r = 1.3 \times 10^{-2}$  (Section 4.1).
2. **Per-operation summary (convention D1).**  $\bar{F} \approx 99.39\%$ ; three-step composite error  $P_{\text{err}} \approx 1.83\%$  (Section 4.1).
3. **Dimension and specifiability.**  $D_{105} = 2^{105} \approx 4.056 \times 10^{31}$ ; a generic pure state requires  $2^{106} - 2 \approx 8.113 \times 10^{31}$  real parameters, i.e.,  $\approx 7.7266 \times 10^{29}$  per qubit, versus 105 bits to index a basis state

(Section 4.2). Any hostable Base State must be a structured, design-like state, not a generic one.

4. **Two-qubit serial budget.** At most  $n = 157$  two-qubit gates at  $\geq 50\%$  aggregate fidelity, or  $n = 154$  with one final readout (Section 4.3).
5. **Readout ceiling.** Full-register readout of 105 qubits at  $F_r = 0.987$  caps verification fidelity at  $F_{ro} \approx 0.2532$  (Section 4.4).
6. **Representative circuit.** With  $n_1 = 105, n_2 = 100, n_r = 105$ :  $F_{\text{circ}} \approx 0.1467$  (Section 4.5).
7. **Gate headroom.** With perfect readout,  $\approx 128$  combined gate layers are tolerable at  $\theta = 0.5$ ; with real readout, readout alone consumes  $\approx 1.98\times$  the entire  $\theta = 0.5$  budget (Section 4.6).
8. **Toy relational coverage.** For  $k = 100, r = 4$ : at most  $\phi \leq 0.3925$  of transition structure touched per coherent run (Section 4.7).
9. **Gauge dimension.**  $d_G = 12$  for  $SU(3) \times SU(2) \times U(1)$  (Section 3.1).
10. **Projections (stated assumptions of Section 4.8).** Full-table circuit:  $F_2^{400} \approx 0.1714$  (best case;  $\approx 0.1148$  with  $\epsilon' = 10^{-3}$ ). Required readout:  $F_r^* \approx 0.9986$ , a  $\approx 9.3\times$  reduction in readout error.

**Fragment availability (qualitative, sourced).** Entanglement distribution without gate overhead: available in principle via hybrid linear-optical teleportation [3]. Coherent-state framing across scales: available as a unifying language [4]. Spectral excitation: available within circuit-based algorithms [5]. Nonclassical state sources: available for light–semiconductor systems [6]. Symmetric state designs: open problem [7]. Compositional categorical structure: available as formal language [8]. No supplied work combines two or more fragments.

**Status of the hypothesis.** Under the stated thresholds ( $\theta = 0.5$ ) and the supplied hardware numbers of [2], the Base State hypothesis is currently **unfalsified but unconfirmed**: no supplied datum contradicts the possibility of a structured Base State hosting Standard-Model-like symmetry (Section 3.1), yet no current platform can prepare and verify even a toy candidate on the full register (Sections 4.4–4.6). The obstruction is quantitative, not a no-go in principle.

## 6. Discussion

**Limitations of the audit.** The fidelity model of Section 3.2 assumes independent, multiplicative errors and ignores crosstalk, leakage, idling decay, and state-preparation error. All circuit-level numbers ( $F_{ro} \approx 0.2532$ ,  $F_{\text{circ}} \approx 0.1467$ ,  $F_2^{400} \approx 0.1714$ ) are therefore upper bounds under this model; real hardware would do worse, so the qualitative conclusions (readout bottleneck, budget exhaustion) are conservative, but the specific values should not be read as measurements.

**Convention dependence.** The per-operation summary  $\bar{F} \approx 99.39\%$  and composite error  $P_{\text{err}} \approx 1.83\%$  (convention D1, Appendix A) are descriptive summaries, not inputs to any budget computation; the budgets use only the log-domain products. The single-readout budget of Section 4.3 ( $n = 154$ ) and the full-register ceiling of Section 4.4 ( $F_{ro} \approx 0.2532$ ) answer different questions under convention D2 (Appendix A); neither contradicts the other.

**Falsifiers.** The program would be falsified if: (i) a structured, symmetry-constrained family were shown incapable of embedding a  $d_G = 12$  gauge algebra with the closure required by Section 3.1, Condition 3; (ii) readout fidelities were shown to be bounded well below the projected  $F_r^* \approx 0.9986$  by a mechanism that no architectural change (e.g., repeated measurement, majority voting) can circumvent; or (iii) the model-recovery approach of [1] were shown to require sample complexity scaling with  $D_{105}$  rather than with the structured family size, making verification of any candidate infeasible even with perfect gates.

**What would strengthen the claim.** Demonstrating any single closed composition (Stage C, e.g., a teleportation-grade transfer in the spirit of [3]) on a structured candidate state, or an experimental state-design family in the sense of [7] whose symmetry content is controlled, would move the hypothesis from unfalsified toward testable.

**Open questions.** How symmetry constrains state designs remains open per [7]; whether the categorical language of [8] can express the gauge structure  $SU(3) \times SU(2) \times U(1)$  without particle ontology is untested here; and the excited-state machinery of [5] has not been adapted to Base State dynamics. The QNFO entries [9], [10], [11] supply position statements and target definitions but, per their supplied summaries (or lack thereof), no technical results that this audit could use.

## 7. Conclusion

We defined a Base State as a preparable, verifiable, compositionally closed quantum object and audited its feasibility on the only quantitative platform in the corpus, the Tianyan-287 [2]. The audit yields a compression gap of roughly thirty orders of magnitude between generic states and indexable states, a full-register readout ceiling  $F_{ro} \approx 0.2532$  against a verification threshold  $\theta = 0.5$ , a two-qubit serial budget of 157 gates (154 with one readout), and a projected required readout fidelity  $F_r^* \approx 0.9986$ . None of these constitutes a no-go in principle; all are quantitative obstructions that improved hardware or architectural workarounds could in principle relax. We propose a three-stage falsification protocol and state explicit falsifiers. The Base State hypothesis stands as an open, falsifiable research program.

## References

[1] Human in the Loop: Interactive Passive Automata Learning via Evidence-Driven State-Merging Algorithms. arXiv:1707.09430v1. <https://arxiv.org/abs/1707.09430v1> [2] Tianyan: Cloud services with quantum advantage. arXiv:2512.10504v2. <https://arxiv.org/abs/2512.10504v2> [3] Bell-state measurement and quantum teleportation using linear optics: two-photon pairs, entangled coherent states, and hybrid entanglement. arXiv:1304.1214v1. <https://arxiv.org/abs/1304.1214v1> [4] Searching for Coherent States: From Origins to Quantum Gravity. arXiv:2003.11810v4. <https://arxiv.org/abs/2003.11810v4> [5] A full circuit-based quantum algorithm for excited-states in quantum chemistry. arXiv:2112.14193v3. <https://arxiv.org/abs/2112.14193v3> [6] Interaction of light and semiconductor can generate quantum states required for solid state quantum computing: Entangled, steered and other nonclassical states. arXiv:1811.09849v1. <https://arxiv.org/abs/1811.09849v1> [7] Unraveling the emergence of quantum state designs in systems with symmetry. arXiv:2402.08949v3. <https://arxiv.org/abs/2402.08949v3> [8] Quantum games and synchronicity. arXiv:2408.15444v4. <https://arxiv.org/abs/2408.15444v4> [9] DOI 10.5281/zenodo.17210901. QNFO: Standard Model. [10] DOI 10.5281/zenodo.22753022. QNFO: Beyond the Qubit: Constructive Paradigms for Post-Particle Computation. [11] DOI 10.5281/zenodo.18015329. QNFO: EMERGENT CORRELATION IN A LOCAL-DETERMINISTIC UNIVERSE. [12] DOI 10.5281/zenodo.21299278. QNFO: Manifesto for Honest Computation.

## Appendix A. Divergence report

**D1 (per-operation summary convention).** One draft convention reports a per-operation arithmetic mean fidelity  $\bar{F} = (F_1 + F_2 + F_r)/3 \approx 99.39\%$  and a three-step composite error  $P_{err} = 1 - F_1 F_2 F_r \approx 1.83\%$ ; the other convention reports only per-operation error rates  $\epsilon_1 = 1.0 \times 10^{-3}$ ,  $\epsilon_2 = 4.4 \times 10^{-3}$ ,  $\epsilon_r = 1.3 \times 10^{-2}$ . The disagreement is one of descriptive summary versus per-operation granularity, not of substance. Resolution: the main text reports both, clearly labeled as convention D1, and uses neither in any budget computation; all budgets use the log-domain product model of Section 3.2.

**D2 (readout convention).** One draft convention budgets a single final readout event (yielding the  $n = 154$  two-qubit-gate budget of Section 4.3); the other budgets full-register readout of all  $N = 105$  qubits (yielding the ceiling  $F_{ro} \approx 0.2532$  of Section 4.4). The disagreement is about which verification scenario is representative: single-observable tests versus whole-register statistics tests. Resolution: the main text presents both scenarios explicitly labeled, and notes in Section 4.4 that the full-register scenario is the binding constraint for Stage V verification at  $\theta = 0.5$ .

## Appendix B. Claim attribution

| Claim                                                                                                                                       | Source drafts | Agreement  |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|
| C1: Per-operation errors $\epsilon_1 = 1.0 \times 10^{-3}$ , $\epsilon_2 = 4.4 \times 10^{-3}$ , $\epsilon_r = 1.3 \times 10^{-2}$ from [2] | A, B, C       | CONVERGENT |
| C2: Per-operation summary $\bar{F} \approx 99.39\%$ , $P_{err} \approx 1.83\%$ (convention D1)                                              | A, B          | CONVERGENT |
| C3: $D_{105} = 2^{105} \approx 4.056 \times 10^{31}$ ; generic state needs $2^{106} - 2 \approx 8.113 \times 10^{31}$ reals                 | A, B, C       | CONVERGENT |

| Claim                                                                                                                    | Source drafts | Agreement                                                                 |
|--------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------------------------------------------------------|
| C4: Two-qubit serial budget $n = 157$ (154 with one readout)                                                             | A, B, C       | CONVERGENT                                                                |
| C5: Full-register readout ceiling $F_{\text{ro}} \approx 0.2532$                                                         | A, B, C       | CONVERGENT                                                                |
| C6: Representative circuit $F_{\text{circ}} \approx 0.1467$ for $n_1 = 105$ , $n_2 = 100$ , $n_r = 105$                  | A, B          | CONVERGENT                                                                |
| C7: Gate headroom $\approx 128$ layers with perfect readout; readout uses $\approx 1.98\times$ the $\theta = 0.5$ budget | A, C          | CONVERGENT                                                                |
| C8: Toy relational coverage $\phi \leq 0.3925$ for $k = 100$ , $r = 4$                                                   | B, C          | CONVERGENT                                                                |
| C9: Gauge dimension $d_{\mathcal{G}} = 12$                                                                               | A, B, C       | CONVERGENT                                                                |
| C10: Projections $F_2^{400} \approx 0.1714$ and $F_r^* \approx 0.9986$ with stated assumptions                           | A, B, C       | CONVERGENT                                                                |
| C11: Single-readout budget is the representative verification scenario                                                   | B             | SINGLE (resolved as D2: both scenarios reported)                          |
| C12: Per-operation mean is the primary fidelity summary                                                                  | A             | SINGLE (resolved as D1: both summaries reported, neither used in budgets) |