v0_6.1 Executive Summary
Systematic Signature Detection for Physics-Native Subspaces

Repository: tomstevns/qubits • Experiments: v0_6 and v0_6.1 • Date: December 2025

1. Purpose

This executive summary documents what v0_6.1 adds on top of earlier experiments (v0_3–v0_5): an evidence-oriented layer that tests whether "signature families" are reproducible and meaningfully associated with dynamical stability, rather than being one-off artifacts of random seeds or parameter choices.

2. What v0_6.1 Adds (relative to v0_6)

- Robustness sweep: verify that top signature families remain stable across reasonable variations of ε, thresholds, and binning resolution.
- Enrichment test: quantify how much specific signatures concentrate in the most stable candidates (top 1% / 5%), including bootstrap confidence intervals.
- Hold-out replication: split the seed space into two halves and measure whether the top families discovered in one half remain top families in the other.

v0_6.1 does not change the underlying discovery logic of v0_6; it adds statistical and reproducibility checks so the results are easier to read, harder to over-interpret, and more defensible in technical discussion.

3. Experimental Setup (High-Level)

Component	v0_6.1 Choice
System size	3 qubits (kept fixed for comparability and fast iteration).
Hamiltonian class	Random Pauli-sum Hamiltonians: $H = \Sigma_k c_k P_k$, with $P_k \in \{I, X, Y, Z\}^{\otimes n}$.
Spectral step	Diagonalize H; identify near-degenerate eigenpairs using $|E_i - E_j| < \varepsilon$.

Structure extraction	Compute dominant basis states, amplitude entropy, and a compact "signature key" (integer-binned descriptors).
Dynamics	Lightweight Trotterized time evolution; measure leakage as a stability proxy.
Aggregation	Group candidates into signature families and test robustness, enrichment, and hold-out replication.

4. Key Results (Evidence Layer)

The patched v0_6.1 output supports three independent claims: (i) parameter robustness, (ii) stability enrichment, and (iii) hold-out replication. The numbers below are intended to be copied directly into a write-up without hype.

Test	Observed value	Interpretation
Robustness sweep	Avg pairwise Jaccard overlap = 0.684 (top-10 family sets)	Top families remain similar across ε/threshold/binning choices; not a single-parameter artifact.
Enrichment (top 1% stable set)	Leading family enrichment ≈ 33×, bootstrap 95% CI [26.93, 39.40]	Specific families are strongly overrepresented among the most stable candidates (chance-level ≈ 1×).
Enrichment (top 5% stable set)	Top families show ≈ 16–19× enrichment; stable_rate ≈ 0.84–0.95 for leading families	Signal persists when the stable set is widened; not a razor-thin top-1% effect.
Hold-out replication	Jaccard = 0.695 (intersection 41, union 59)	Top families discovered in one half persist in the other half; reproducible ranking signal.

5. Interpretation (What v0_6.1 Establishes)

Within the tested Hamiltonian class and at 3 qubits, v0_6.1 provides strong evidence that certain structural signature families are systematically associated with lower leakage (greater dynamical stability). This goes beyond observing degeneracies: it indicates repeatable "classes" that persist under parameter variation and replicate under hold-out.

- Evidence of reproducible structure–stability correlation (not merely one-off spectral coincidences).
- Credibility strengthened by three independent checks: robustness, enrichment (with CI), and hold-out replication.
- Scope remains explicit: this is evidence within a defined Hamiltonian family and stability proxy.

6. Scope, Limitations, and What Is Not Claimed

- No claim of universality across all Hamiltonian classes or larger-qubit regimes.
- Leakage is a proxy derived from lightweight dynamics (not yet a full hardware-calibrated noise model).
- Not a qubit design or error-correction proposal; it is a discovery + evidence pipeline.
- Replication shown across seeds (hold-out), not yet across multiple physical backends.

7. Deliverables and Where to Start (for Readers)

Recommended reading order:

1. Start with this Executive Summary (v0_6_1_executive_summary.docx / PDF).
2. Then open the v0_6.1 experiment folder (code + outputs) to reproduce the result.
3. Optional background: "Need to know…" notes for deeper theory.

Suggested GitHub paths (adjust filenames as used in the repo):

• experiments/v0_6/

• experiments/v0_6_1/

• experiments/v0_6_1/v0_6_1_Final.py (or latest patched entry point)

• experiments/v0_6_1/*output*.txt

• need_to_know_about_the_qubit_experiments.pdf (background)

8. Next Steps (Minimal, Scientific)

- Add a lightweight negative control (e.g., label shuffling) to demonstrate enrichment collapses toward ~1× under a null.
- Repeat the evidence layer on 1–2 alternative Hamiltonian families to test generality.
- If/when convenient: cross-check a small subset on a backend to see whether family identity survives hardware noise.

End of Executive Summary.