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=== v0_7: Convergence + Baseline Calibration + Perturbation Robustness +
Gap/Isolation + Open-system (v23) ===
Qubits: 4 (d=16) | terms=5
Batches: 3 ├ù 5000 seeds (base_seed=0, stride=1000000)
Neighbor eps=0.050
Dominant set: keep_mass=0.90 (mass-based; guarantees non-empty mask)
Bins (SigAbs): ent_step=0.100 | leak_step=0.050
Bins (SigQ_GLOBAL fine): q_bins=10 (pooled REAL+NULL per batch)
Bins (SigQG_COARSE): q_bins_coarse=6 + dom_bin(dom/d) + leak_bin_coarse
(pooled REAL+NULL per batch)
Leakage proxy times=[0.5, 1.0, 1.5] (FAST analytic evolution in
eigenpair)
Stable selection: stable_frac=0.010 per model (optional leak constraint
max=None, q=None)
Perturbation robustness: eta=[] | reps=3 | seeds=0 | pairs/seed=5 |
dH_terms=None
Open-system (v23): enabled=True | include_baselines=True |
pairs_per_cat=400 | noise=both(phi=0.1,g1=0.02) | t=5.0/25 |
states=rand64 | basis=eigen | noise_qubits=subset:[3] | stable_pool=False
TopK=25 | min_overall=3 | min_stable=3 | alpha=0.5
Optional family filter: p_tail_max=None
Pauli ops: precomputed cache (excluding all-I)

Batch 1/3 generated: REAL=46747 NULL=46747 (elapsed 345.2s)
Batch 2/3 generated: REAL=46735 NULL=46735 (elapsed 326.9s)
Batch 3/3 generated: REAL=46879 NULL=46879 (elapsed 329.8s)

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Batch 1/3 (seed_offset=0)
Model: REAL | candidates=46747 | stable_rate=0.0100 (score-only
ref=0.0100)
  score(mean/median/max)=0.429/0.422/0.700
  leakage(mean/median/min)=0.076/0.080/0.000
  entropy(mean/median/max)=2.962/3.036/4.000
  dom_count(mean/median/max)=9.96/10.0/15
  gaps: ╬öE_in(mean/med/p90)=0.00146/5.551e-16/1.998e-15 |
╬öE_out(mean/med/p90)=0.1623/0.04393/0.4891 |
logR(mean/med/p90)=0.760/6.537/7.685
  gaps_cond(╬öE_in>iso_eps): n=2759 |
╬öE_in(mean/med/p90)=0.02321/0.02244/0.0437
  entropy effect (stable-overall)=-0.032 bits  CI95=(-
0.05551828082318287, -0.004830457738185095)

Top signature families (REAL, SigQ_GLOBAL (fine)):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (14, 2, 2, 1) |    1376 |     280 |     13.75 | 2.79e-265 |    264.55 |
1150.98x
  (14, 3, 3, 1) |     949 |      81 |      9.48 | 1.25e-47 |     46.90 |
484.81x
  (14, 7, 7, 1) |     264 |      35 |      2.64 | 5.40e-28 |     27.27 |
758.08x
  (14, 6, 6, 1) |     258 |      20 |      2.58 | 3.34e-12 |     11.48 |
447.92x
  (14, 5, 5, 1) |     245 |      17 |      2.45 | 7.51e-10 |      9.12 |
402.62x
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  (14, 4, 4, 1) |     405 |      20 |      4.05 | 9.04e-09 |      8.04 |
285.54x
  (14, 2, 3, 1) |      35 |       4 |      0.35 | 4.07e-04 |      3.39 |
715.97x
  (14, 8, 8, 1) |     182 |       5 |      1.82 | 3.69e-02 |      1.43 |
170.22x

Top signature families (REAL, SigQG_COARSE):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (3, 1, 1, 1) |    4545 |     320 |     45.40 | 3.88e-158 |    157.41 |
613.08x
  (3, 2, 2, 1) |    1781 |      64 |     17.79 | 1.15e-17 |     16.94 |
314.81x
  (3, 4, 4, 1) |     961 |      44 |      9.60 | 2.90e-16 |     15.54 |
402.42x
  (3, 3, 3, 1) |     925 |      32 |      9.24 | 3.09e-09 |      8.51 |
305.34x
  (3, 5, 5, 1) |     448 |       3 |      4.48 | 8.25e-01 |      0.08 |
67.85x

Model: NULL_HAAR_BASIS | candidates=46747 | stable_rate=0.0100 (score-
only ref=0.0100)
  score(mean/median/max)=0.421/0.421/0.467
  leakage(mean/median/min)=0.083/0.084/0.035
  entropy(mean/median/max)=3.414/3.433/3.946
  dom_count(mean/median/max)=10.06/10.0/14
  gaps: ╬öE_in(mean/med/p90)=0.001492/9.992e-16/3.109e-15 |
╬öE_out(mean/med/p90)=0.1549/0.02988/0.4777 |
logR(mean/med/p90)=0.455/6.327/7.675
  gaps_cond(╬öE_in>iso_eps): n=2956 |
╬öE_in(mean/med/p90)=0.02319/0.0223/0.04352
  entropy effect (stable-overall)=-0.002 bits  CI95=(-
0.014131806881240671, 0.01576770180457149)

Top signature families (NULL, SigQ_GLOBAL (fine)):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (12, 6, 9, 1) |     170 |      30 |      1.70 | 5.07e-28 |     27.30 |
1252.95x
  (12, 3, 9, 1) |     125 |      23 |      1.25 | 2.78e-22 |     21.56 |
1311.55x
  (12, 7, 9, 1) |     172 |      22 |      1.72 | 7.72e-18 |     17.11 |
913.59x
  (12, 5, 9, 1) |     159 |      21 |      1.59 | 2.18e-17 |     16.66 |
944.14x
  (12, 6, 8, 1) |     183 |      18 |      1.83 | 7.16e-13 |     12.15 |
706.15x
  (12, 8, 9, 1) |     138 |      16 |      1.38 | 1.04e-12 |     11.98 |
834.44x
  (12, 4, 8, 1) |     139 |      16 |      1.39 | 1.17e-12 |     11.93 |
828.46x
  (12, 5, 7, 1) |     156 |      16 |      1.56 | 6.98e-12 |     11.16 |
738.46x
  (12, 6, 7, 1) |     149 |      15 |      1.49 | 4.09e-11 |     10.39 |
726.19x
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  (12, 7, 8, 1) |     160 |      15 |      1.60 | 1.13e-10 |      9.95 |
676.42x
  ... (25 total, showing 10)

Top signature families (NULL, SigQG_COARSE):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (2, 2, 3, 2) |       7 |       4 |      0.07 | 3.40e-07 |      6.47 |
5499.58x
  (3, 3, 4, 1) |      27 |       5 |      0.27 | 6.69e-06 |      5.17 |
1833.19x
  (2, 3, 4, 2) |       7 |       3 |      0.07 | 3.39e-05 |      4.47 |
4277.45x
  (3, 2, 4, 1) |      27 |       4 |      0.27 | 1.45e-04 |      3.84 |
1499.89x
  (3, 4, 5, 1) |      51 |       5 |      0.51 | 1.59e-04 |      3.80 |
978.89x
  (3, 3, 3, 1) |      12 |       3 |      0.12 | 2.05e-04 |      3.69 |
2566.47x
  (3, 2, 3, 1) |      24 |       3 |      0.24 | 1.72e-03 |      2.76 |
1309.42x
  (2, 3, 5, 1) |    4705 |      64 |     47.00 | 1.02e-02 |      1.99 |
125.64x
  (2, 4, 5, 1) |    4585 |      56 |     45.80 | 7.82e-02 |      1.11 |
112.94x
  (2, 2, 5, 1) |    4036 |      49 |     40.32 | 1.00e-01 |      1.00 |
112.40x
  ... (21 total, showing 10)

Open-system logical retention (Lindblad; v23):
  settings: noise=both | gamma_phi=0.1 | gamma_1=0.02 | t_max=5.0 |
t_steps=25 | states=rand64 | stable_pool=False | pairs_per_cat=400
  REAL_Q4: n_pairs=400 | t_fid90_med=1.04 | t_leak10_med=1.04
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.129/0.216/0.226 |
t=5=0.221/0.354/0.382
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.774/0.782/0.825 | t=5=0.615/0.639/0.701
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.950/0.998/1.000 | t=5=0.910/0.994/1.000
    AUC medians: fid_uncond=3.974 | fid_cond=4.987 | leak=1.013
  REAL_Q1: n_pairs=400 | t_fid90_med=1.04 | t_leak10_med=1.04
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.125/0.216/0.225 |
t=5=0.224/0.351/0.380
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.774/0.783/0.822 | t=5=0.617/0.642/0.693
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.931/0.997/1.000 | t=5=0.878/0.994/1.000
    AUC medians: fid_uncond=3.980 | fid_cond=4.986 | leak=1.013
  NULL_Q4: n_pairs=400 | t_fid90_med=1.25 | t_leak10_med=1.25
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.177/0.204/0.218 |
t=5=0.312/0.354/0.376
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.775/0.783/0.796 | t=5=0.609/0.623/0.647
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.965/0.984/0.994 | t=5=0.931/0.965/0.984
    AUC medians: fid_uncond=3.960 | fid_cond=4.917 | leak=0.974
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Batch 1: Jaccard(Top-25) REAL vs NULL: fine=0.000 | coarse=0.040

Baseline scoreboard (REAL - NULL):
  delta median entropy (bits): -0.397
  delta median leakage       : -0.003
  delta median dom_count     : +0.000
  entropy Cohen's d          : -1.093

------------------------------------------------
Batch 2/3 (seed_offset=1000000)
Model: REAL | candidates=46735 | stable_rate=0.0100 (score-only
ref=0.0100)
  score(mean/median/max)=0.430/0.422/0.678
  leakage(mean/median/min)=0.076/0.080/0.000
  entropy(mean/median/max)=2.954/3.035/4.000
  dom_count(mean/median/max)=9.92/10.0/15
  gaps: ╬öE_in(mean/med/p90)=0.001474/5.551e-16/1.998e-15 |
╬öE_out(mean/med/p90)=0.1648/0.04704/0.5011 |
logR(mean/med/p90)=0.831/6.560/7.696
  gaps_cond(╬öE_in>iso_eps): n=2778 |
╬öE_in(mean/med/p90)=0.02325/0.02285/0.04482
  entropy effect (stable-overall)=+0.038 bits
CI95=(0.00020487540639864253, 0.07994945318162947)

Top signature families (REAL, SigQ_GLOBAL (fine)):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (14, 2, 2, 1) |    1302 |     282 |     13.01 | 2.43e-275 |    274.61 |
1230.20x
  (14, 3, 3, 1) |     942 |      71 |      9.41 | 1.94e-38 |     37.71 |
430.29x
  (14, 7, 7, 1) |     254 |      28 |      2.54 | 1.66e-20 |     19.78 |
635.17x
  (14, 2, 3, 1) |      60 |      15 |      0.60 | 3.45e-17 |     16.46 |
1453.16x
  (14, 4, 4, 1) |     384 |      28 |      3.84 | 8.60e-16 |     15.07 |
420.42x
  (14, 5, 5, 1) |     238 |      18 |      2.38 | 5.94e-11 |     10.23 |
439.97x
  (14, 6, 6, 1) |     188 |      12 |      1.88 | 5.56e-07 |      6.25 |
376.13x
  (14, 8, 8, 1) |     175 |       3 |      1.75 | 2.55e-01 |      0.59 |
113.12x

Top signature families (REAL, SigQG_COARSE):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (3, 1, 1, 1) |    4303 |     335 |     43.00 | 1.23e-178 |    177.91 |
676.89x
  (3, 2, 2, 1) |    1718 |      61 |     17.17 | 1.13e-16 |     15.95 |
310.72x
  (3, 4, 4, 1) |     935 |      33 |      9.34 | 1.09e-09 |      8.96 |
310.92x
  (3, 3, 3, 1) |     917 |      28 |      9.16 | 3.57e-07 |      6.45 |
269.70x
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  (3, 1, 2, 1) |      68 |       3 |      0.68 | 3.09e-02 |      1.51 |
443.64x

Model: NULL_HAAR_BASIS | candidates=46735 | stable_rate=0.0100 (score-
only ref=0.0100)
  score(mean/median/max)=0.421/0.421/0.463
  leakage(mean/median/min)=0.084/0.084/0.039
  entropy(mean/median/max)=3.414/3.434/3.915
  dom_count(mean/median/max)=10.05/10.0/14
  gaps: ╬öE_in(mean/med/p90)=0.001515/9.992e-16/3.109e-15 |
╬öE_out(mean/med/p90)=0.1572/0.03236/0.4879 |
logR(mean/med/p90)=0.515/6.336/7.683
  gaps_cond(╬öE_in>iso_eps): n=3006 |
╬öE_in(mean/med/p90)=0.02317/0.02258/0.04497
  entropy effect (stable-overall)=-0.006 bits  CI95=(-
0.018475240869027743, 0.004674808135118195)

Top signature families (NULL, SigQ_GLOBAL (fine)):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (12, 7, 9, 1) |     165 |      24 |      1.65 | 1.16e-20 |     19.93 |
1034.07x
  (12, 4, 7, 1) |     138 |      22 |      1.38 | 5.86e-20 |     19.23 |
1134.78x
  (12, 7, 8, 1) |     147 |      22 |      1.47 | 2.42e-19 |     18.62 |
1065.54x
  (12, 5, 9, 1) |     162 |      22 |      1.62 | 2.09e-18 |     17.68 |
967.19x
  (12, 8, 9, 1) |     181 |      22 |      1.81 | 2.35e-17 |     16.63 |
865.94x
  (12, 5, 6, 1) |     160 |      21 |      1.60 | 2.50e-17 |     16.60 |
935.72x
  (12, 4, 9, 1) |     155 |      20 |      1.55 | 1.99e-16 |     15.70 |
920.88x
  (12, 3, 8, 1) |     109 |      17 |      1.09 | 1.35e-15 |     14.87 |
1116.36x
  (12, 4, 6, 1) |     126 |      17 |      1.26 | 1.63e-14 |     13.79 |
966.34x
  (12, 3, 9, 1) |     111 |      16 |      1.11 | 3.29e-14 |     13.48 |
1033.69x
  ... (25 total, showing 10)

Top signature families (NULL, SigQG_COARSE):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (3, 2, 5, 1) |      38 |       9 |      0.38 | 1.25e-10 |      9.90 |
2264.96x
  (3, 4, 5, 1) |      42 |       8 |      0.42 | 8.67e-09 |      8.06 |
1835.81x
  (3, 4, 4, 1) |      24 |       5 |      0.24 | 3.61e-06 |      5.44 |
2060.60x
  (3, 3, 4, 1) |      32 |       5 |      0.32 | 1.60e-05 |      4.80 |
1553.37x
  (3, 3, 5, 1) |      49 |       5 |      0.49 | 1.32e-04 |      3.88 |
1019.89x
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  (3, 5, 5, 1) |      12 |       3 |      0.12 | 2.05e-04 |      3.69 |
2570.13x
  (2, 4, 5, 1) |    4550 |      67 |     45.47 | 1.56e-03 |      2.81 |
136.16x
  (2, 5, 5, 1) |    2176 |      31 |     21.74 | 3.50e-02 |      1.46 |
132.85x
  (2, 2, 5, 1) |    4152 |      49 |     41.49 | 1.38e-01 |      0.86 |
109.42x
  (2, 1, 5, 1) |    1607 |      20 |     16.06 | 1.91e-01 |      0.72 |
117.06x
  ... (20 total, showing 10)

Open-system logical retention (Lindblad; v23):
  settings: noise=both | gamma_phi=0.1 | gamma_1=0.02 | t_max=5.0 |
t_steps=25 | states=rand64 | stable_pool=False | pairs_per_cat=400
  REAL_Q4: n_pairs=400 | t_fid90_med=1.04 | t_leak10_med=1.04
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.113/0.216/0.225 |
t=5=0.207/0.352/0.382
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.774/0.783/0.831 | t=5=0.616/0.641/0.717
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.941/0.999/1.000 | t=5=0.892/0.996/1.000
    AUC medians: fid_uncond=3.977 | fid_cond=4.993 | leak=1.013
  REAL_Q1: n_pairs=400 | t_fid90_med=1.04 | t_leak10_med=1.04
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.125/0.216/0.225 |
t=5=0.227/0.352/0.381
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.774/0.783/0.821 | t=5=0.615/0.641/0.698
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.936/0.997/1.000 | t=5=0.882/0.993/1.000
    AUC medians: fid_uncond=3.980 | fid_cond=4.984 | leak=1.012
  NULL_Q4: n_pairs=400 | t_fid90_med=1.25 | t_leak10_med=1.25
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.180/0.204/0.218 |
t=5=0.318/0.355/0.377
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.775/0.782/0.796 | t=5=0.608/0.621/0.644
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.968/0.984/0.994 | t=5=0.936/0.966/0.985
    AUC medians: fid_uncond=3.957 | fid_cond=4.920 | leak=0.979

Batch 2: Jaccard(Top-25) REAL vs NULL: fine=0.000 | coarse=0.042

Baseline scoreboard (REAL - NULL):
  delta median entropy (bits): -0.399
  delta median leakage       : -0.004
  delta median dom_count     : +0.000
  entropy Cohen's d          : -1.093

------------------------------------------------
Batch 3/3 (seed_offset=2000000)
Model: REAL | candidates=46879 | stable_rate=0.0100 (score-only
ref=0.0100)
  score(mean/median/max)=0.429/0.422/0.600
  leakage(mean/median/min)=0.076/0.080/0.000
  entropy(mean/median/max)=2.955/3.036/4.000
  dom_count(mean/median/max)=9.93/10.0/15
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  gaps: ╬öE_in(mean/med/p90)=0.001513/5.551e-16/2.109e-15 |
╬öE_out(mean/med/p90)=0.1598/0.03551/0.4934 |
logR(mean/med/p90)=0.584/6.397/7.689
  gaps_cond(╬öE_in>iso_eps): n=2884 |
╬öE_in(mean/med/p90)=0.0231/0.02188/0.04488
  entropy effect (stable-overall)=+0.005 bits  CI95=(-
0.033251884171931444, 0.04972155688816217)

Top signature families (REAL, SigQ_GLOBAL (fine)):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (14, 2, 2, 1) |    1382 |     279 |     13.83 | 3.80e-263 |    262.42 |
1151.51x
  (14, 3, 3, 1) |     983 |      74 |      9.83 | 6.41e-40 |     39.19 |
431.45x
  (14, 7, 7, 1) |     296 |      27 |      2.96 | 1.08e-17 |     16.97 |
528.27x
  (14, 6, 6, 1) |     241 |      24 |      2.41 | 9.08e-17 |     16.04 |
577.83x
  (14, 4, 4, 1) |     354 |      26 |      3.54 | 7.75e-15 |     14.11 |
425.78x
  (14, 5, 5, 1) |     245 |      18 |      2.45 | 9.74e-11 |     10.01 |
429.21x
  (14, 2, 3, 1) |      54 |       9 |      0.54 | 3.56e-09 |      8.45 |
992.84x
  (14, 8, 8, 1) |     178 |      10 |      1.78 | 1.49e-05 |      4.83 |
335.04x

Top signature families (REAL, SigQG_COARSE):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (3, 1, 1, 1) |    4330 |     330 |     43.32 | 4.52e-173 |    172.34 |
662.04x
  (3, 2, 2, 1) |    1679 |      56 |     16.80 | 2.62e-14 |     13.58 |
291.82x
  (3, 4, 4, 1) |     999 |      40 |      9.99 | 4.61e-13 |     12.34 |
351.50x
  (3, 3, 3, 1) |     942 |      33 |      9.42 | 1.35e-09 |      8.87 |
308.33x
  (3, 5, 5, 1) |     442 |       7 |      4.42 | 1.58e-01 |      0.80 |
147.03x

Model: NULL_HAAR_BASIS | candidates=46879 | stable_rate=0.0100 (score-
only ref=0.0100)
  score(mean/median/max)=0.421/0.421/0.465
  leakage(mean/median/min)=0.084/0.084/0.039
  entropy(mean/median/max)=3.414/3.435/3.907
  dom_count(mean/median/max)=10.06/10.0/14
  gaps: ╬öE_in(mean/med/p90)=0.001543/9.992e-16/3.109e-15 |
╬öE_out(mean/med/p90)=0.1527/0.02167/0.4839 |
logR(mean/med/p90)=0.305/6.123/7.681
  gaps_cond(╬öE_in>iso_eps): n=3073 |
╬öE_in(mean/med/p90)=0.02313/0.02197/0.04488
  entropy effect (stable-overall)=+0.004 bits  CI95=(-
0.010766970625623883, 0.017046250245701815)
```

```
Top signature families (NULL, SigQ_GLOBAL (fine)):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (12, 6, 9, 1) |     180 |      29 |      1.80 | 6.16e-26 |     25.21 |
1140.37x
  (12, 6, 8, 1) |     181 |      27 |      1.81 | 2.46e-23 |     22.61 |
1057.20x
  (12, 5, 9, 1) |     161 |      25 |      1.61 | 3.64e-22 |     21.44 |
1101.71x
  (12, 4, 9, 1) |     148 |      24 |      1.48 | 8.37e-22 |     21.08 |
1151.17x
  (12, 8, 9, 1) |     158 |      21 |      1.58 | 1.97e-17 |     16.71 |
946.48x
  (12, 4, 6, 1) |     137 |      19 |      1.37 | 2.88e-16 |     15.54 |
989.54x
  (12, 3, 6, 1) |      84 |      16 |      0.84 | 3.38e-16 |     15.47 |
1362.48x
  (12, 7, 9, 1) |     173 |      20 |      1.73 | 1.77e-15 |     14.75 |
824.43x
  (12, 5, 6, 1) |     155 |      19 |      1.55 | 2.97e-15 |     14.53 |
875.00x
  (12, 6, 7, 1) |     180 |      20 |      1.80 | 3.83e-15 |     14.42 |
792.46x
  ... (25 total, showing 10)

Top signature families (NULL, SigQG_COARSE):
Format: sig=(a,b,c,d) | overall | stable | expected | p_tail | -log10(p)
| enrichment
  (3, 4, 4, 1) |      14 |       5 |      0.14 | 1.86e-07 |      6.73 |
3471.26x
  (3, 4, 5, 1) |      42 |       6 |      0.42 | 3.86e-06 |      5.41 |
1399.64x
  (3, 3, 3, 1) |      14 |       3 |      0.14 | 3.36e-04 |      3.47 |
2208.99x
  (3, 3, 4, 1) |      35 |       4 |      0.35 | 4.09e-04 |      3.39 |
1160.05x
  (3, 2, 5, 1) |      30 |       3 |      0.30 | 3.32e-03 |      2.48 |
1050.17x
  (2, 3, 5, 1) |    4734 |      65 |     47.36 | 8.31e-03 |      2.08 |
126.61x
  (2, 4, 5, 1) |    4517 |      59 |     45.19 | 2.70e-02 |      1.57 |
120.53x
  (2, 5, 5, 1) |    2188 |      29 |     21.89 | 8.22e-02 |      1.09 |
123.36x
  (2, 2, 5, 1) |    3983 |      46 |     39.85 | 1.83e-01 |      0.74 |
106.83x
  (2, 3, 4, 1) |    4968 |      56 |     49.70 | 2.02e-01 |      0.69 |
104.07x
  ... (19 total, showing 10)

Open-system logical retention (Lindblad; v23):
  settings: noise=both | gamma_phi=0.1 | gamma_1=0.02 | t_max=5.0 |
t_steps=25 | states=rand64 | stable_pool=False | pairs_per_cat=400
  REAL_Q4: n_pairs=400 | t_fid90_med=1.04 | t_leak10_med=1.04
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.084/0.214/0.225 |
t=5=0.150/0.349/0.380
```

```
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.774/0.784/0.841 | t=5=0.616/0.645/0.733
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.916/0.997/1.000 | t=5=0.853/0.992/1.000
    AUC medians: fid_uncond=3.986 | fid_cond=4.982 | leak=1.008
  REAL_Q1: n_pairs=400 | t_fid90_med=1.04 | t_leak10_med=1.04
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.120/0.216/0.226 |
t=5=0.213/0.352/0.383
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.773/0.783/0.836 | t=5=0.615/0.641/0.725
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.934/0.997/1.000 | t=5=0.881/0.993/1.000
    AUC medians: fid_uncond=3.977 | fid_cond=4.985 | leak=1.013
  NULL_Q4: n_pairs=400 | t_fid90_med=1.25 | t_leak10_med=1.25
    leak(q10/q50/q90): t=0=0.000/0.000/0.000 | t=2.5=0.183/0.204/0.218 |
t=5=0.320/0.354/0.375
    fid_uncond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.775/0.783/0.796 | t=5=0.609/0.623/0.644
    fid_cond(q10/q50/q90): t=0=1.000/1.000/1.000 |
t=2.5=0.969/0.985/0.994 | t=5=0.937/0.967/0.984
    AUC medians: fid_uncond=3.959 | fid_cond=4.923 | leak=0.974

Batch 3: Jaccard(Top-25) REAL vs NULL: fine=0.000 | coarse=0.091

Baseline scoreboard (REAL - NULL):
  delta median entropy (bits): -0.399
  delta median leakage       : -0.004
  delta median dom_count     : +0.000
  entropy Cohen's d          : -1.087

------------------------------------------------
=== Convergence diagnostics (REAL) ===
REAL overlap fine:   Jaccard(Top-25) batch1 vs batch2 = 1.000
REAL overlap coarse: Jaccard(Top-25) batch1 vs batch2 = 0.667
REAL overlap fine:   Jaccard(Top-25) batch1 vs batch3 = 1.000
REAL overlap coarse: Jaccard(Top-25) batch1 vs batch3 = 1.000
REAL overlap fine:   Jaccard(Top-25) batch2 vs batch3 = 1.000
REAL overlap coarse: Jaccard(Top-25) batch2 vs batch3 = 0.667

=== Notes (scientific reading) ===
1) Compare REAL vs NULL primarily via deltas/effect sizes and batch
stability, not raw entropy levels (d differs with n_qubits).
2) Use fine families for within-model discovery; use coarse families for
cross-model interpretability.
3) If results at n=4 resemble n=3 (stable deltas + stable overlaps), that
is strong qualitative evidence the effect is not a 3-qubit artifact.

=== End of v22 ===
```