Floquet spin-chain results

Computed and descriptive analysis of retained results; no automatic experimental validation

Report status: complete

Audience: technical

Status dimensions: {"coverage":"complete","delivery":"complete","execution":"completed","literature":"not_assessed","numerical":"passed","statistical":"not_assessed"}

Result SHA256: 4e3e07d545383be97a0bac74de8a4103272de2c08b6e6c459f861bc5b2c17109

Presentation SHA256: e5da1b729243b9a7234d35fe1cd50ae798138e39c907d3e6cb1253b46b61023a

final_density_matrix

The saved state passes the declared numerical state checks. Purity is 0.12517588; entropy is 4.4881159 bits.

Claim scope: numerical_consistency_only

Method: matrix

trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"trace_one","passed":true,"tolerance":1e-08,"value":4.441671893457538e-15}

hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"hermiticity","passed":true,"tolerance":1e-08,"value":2.6725583551767684e-17}

positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.0017597830734751502}

Method metadata: {"basis":"Computational basis; little-endian integer indexing, q0 least significant","kind":"density_matrix","name":"final_density_matrix","seed":0,"source":"artifact:final_states_json#/final_density_matrix","tolerance":1e-08}

Evidence: ["artifact:final_states_json#/final_density_matrix"]

Retained values: {"eigenvalues_hermitian_part":[0.0017597830734751502,0.0018051912018288993,0.00200773614747285,0.0023263851376208898,0.0023263851376208997,0.0023826390360256085,0.0025331400228729203,0.002533140022872933,0.0029303221768851484,0.002930322176885164,0.002950236130655672,0.0029969841110372417,0.0031013635647879883,0.003101363564787993,0.0031842125459905514,0.0031842125459905653,0.0034022465679858747,0.0034754123268813940,0.0036278643268255655,0.0036278643268255824,0.0040101214891659350,0.004158701648702552 5,0.0041587016487025594,0.0045259111352984865,0.0047663912702650440,0.0049046423059930 3,0.00490464230599305 3,0.004990562071698784 5,0.00499056207169879 7,0.005147820198937891,0.005498721478930437,0.005498721478930447,0.006531017225272484,0.0065310172252725,0.006536585606091658,0.007266894797001269,0.007266894797001277,0.007285905032931032 5,0.007990841001970256,0.007990841001970273,0.008444637251143972,0.009567657767202213,0.009567657767202230,0.010508773292995734,0.0105087732929957 5,0.011355402453182405,0.012174953116315680,0.014376637969970140,0.016177108973273974,0.016177108973274010,0.016968826227300260,0.016968826227300290,0.018963092174556550,0.019407341923833850,0.021157928733984283,0.021157928733984307,0.023882953349032970,0.023882953349032995,0.030705515235352040,0.030705515235352077,0.034700958515832370,0.05639798670317471,0.06494939112933491,0.330149771667211],"entropy_bits":4.4881159024954265,"entropy_convention":"Eigenvalues within tolerance below zero clipped for entropy only; stored state unchanged.","maximum_absolute_entry":0.0912799269670486,"purity_imag":1.0440104591382879e-17,"purity_real":0.125

1758776755814,"shape":[64,64],"trace_imag":8.322606926541853e-17,"trace_real":0.9999999999999956}

Calculated reduced q0 state checkpoints

The explorer contains only saved calculated checkpoints; joining plotted points does not create intermediate evidence.

Claim scope: numerical_consistency_only

Method: quantum_checkpoints

0.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"0.0:trace_one","passed":true,"tolerance":1e-08,"value":0.0}

0.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"0.0:hermiticity","passed":true,"tolerance":1e-08,"value":0.0}

0.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"0.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.0}

1.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"1.0:trace_one","passed":true,"tolerance":1e-08,"value":4.440892098500626e-16}

1.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"1.0:hermiticity","passed":true,"tolerance":1e-08,"value":0.0}

1.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"1.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.024421313042864212}

2.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"2.0:trace_one","passed":true,"tolerance":1e-08,"value":6.673276261750871e-16}

2.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"2.0:hermiticity","passed":true,"tolerance":1e-08,"value":6.982261990806649e-17}

2.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"2.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.2052531972381049}

3.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"3.0:trace_one","passed":true,"tolerance":1e-08,"value":1.4461874211828443e-15}

3.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"3.0:hermiticity","passed":true,"tolerance":1e-08,"value":1.1222847737940578e-16}

3.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"3.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.2408496972853006}

4.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"4.0:trace_one","passed":true,"tolerance":1e-08,"value":2.00217665195862e-15}

4.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"4.0:hermiticity","passed":true,"tolerance":1e-08,"value":1.8583225236401546e-16}

4.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"4.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.37885562351155605}

5.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"5.0:trace_one","passed":true,"tolerance":1e-08,"value":2.6672132715768856e-15}

5.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"5.0:hermiticity","passed":true,"tolerance":1e-08,"value":1.4490362035268767e-16}

5.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"5.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.41810025173453785}

6.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"6.0:trace_one","passed":true,"tolerance":1e-08,"value":3.3320783604193874e-15}

6.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"6.0:hermiticity","passed":true,"tolerance":1e-08,"value":1.3921155894713877e-16}

6.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"6.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.45212861494303663}

7.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"7.0:trace_one","passed":true,"tolerance":1e-08,"value":3.775518913232322e-15}

7.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"7.0:hermiticity","passed":true,"tolerance":1e-08,"value":1.5677563414140394e-16}

7.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"7.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.47588123015749995}

8.0:trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"8.0:trace_one","passed":true,"tolerance":1e-08,"value":4.441671893457538e-15}

8.0:hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"8.0:hermiticity","passed":true,"tolerance":1e-08,"value":1.4360257774570506e-16}

8.0:positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"8.0:positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.45952340007728876}

Method metadata: {"basis":"computational","kind":"quantum_checkpoints","label":"Calculated reduced q0 state checkpoints","link_group":"floquet-cycles","name":"reduced_q0_checkpoints","observables":["Z"],"origin":"numerical_state","qubit_order":"little_endian","seed":0,"source":"/data/reduced_q0_checkpoints","tolerance":1e-08,"units":"dimensionless"}

Evidence: ["/data/reduced_q0_checkpoints"]

Retained values: {"checkpoint_count":9,"coordinate":"cycle","dynamics":{"interpretation":"Calculated one-qubit reduced states at retained cycles; other intermediate full-state information is not retained.","model":"Floquet Ising phase-flip evolution","settings":{"J":0.34,"boundary":"ring","cycles":8,"h":0.71,"initial_state":"neel","n":6,"p":0.025},"subsystem":[0],"traced_out_qubits":[1,2,3,4,5]},"interpolation":"none; only retained calculated checkpoints","link_group":"floquet-cycles","observation_ids":["floquet-cycle:0","floquet-cycle:1","floquet-cycle:2","floquet-cycle:3","floquet-cycle:4","floquet-cycle:5","floquet-cycle:6","floquet-cycle:7","floquet-cycle:8"],"observations":[{"at":0.0,"observables":{"Z":1.0},"observation_id":"floquet-cycle:0","purity":1.0},{"at":1.0,"observables":{"Z":0.15022546991168584},"observation_id":"floquet-cycle:1","purity":0.9523501749757458},{"at":2.0,"observables":{"Z":-0.5305726665416548},"observation_id":"floquet-cycle:2","purity":0.6737513554767178},{"at":3.0,"observables":{"Z":-0.18592332459685934},"observation_id":"floquet-cycle:3","purity":0.6343177587942386},{"at":4.0,"observables":{"Z":0.1374399275734947},"observation_id":"floquet-cycle:4","purity":0.5293519199095453},{"at":5.0,"observables":{"Z":0.08327088786477171},"observation_id":"floquet-cycle:5","purity":0.5134151375318889},{"at":6.0,"observables":{"Z":0.0020129326408164228},"observation_id":"floquet-cycle:6","purity":0.5045833390145404},{"at":7.0,"observables":{"Z":0.03699676837767779},"observation_id":"floquet-cycle:7","purity":0.50

11634301174269},{"at":8.0,"observables":{"Z":-0.012959091092591024},"observation_id":"floquet-cycle:8","purity":0.5032767102826016}],"units":null}

Final state: local and joint evidence

State checks passed. Local states, declared observables and qualified bipartition evidence are retained separately.

Claim scope: numerical_consistency_only

Method: quantum_state

trace_one: PASS; tolerance: 1e-08; retained check:
{"name":"trace_one","passed":true,"tolerance":1e-08,"value":4.441671893457538e-15}

hermiticity: PASS; tolerance: 1e-08; retained check:
{"name":"hermiticity","passed":true,"tolerance":1e-08,"value":2.6725583551767684e-17}

positive_semidefinite: PASS; tolerance: 1e-08; retained check:
{"name":"positive_semidefinite","passed":true,"tolerance":1e-08,"value":0.0017597830734751502}

Method metadata: {"basis":"computational","kind":"quantum_state","label":"Final state: local and joint evidence","name":"quantum_state_evidence","origin":"numerical_state","qubit_order":"little_endian","seed":0,"source":"artifact:final_states_json#/final_density_matrix","tolerance":1e-08,"units":"dimensionless"}

Evidence: ["artifact:final_states_json#/final_density_matrix"]

Retained values: {"eigenvalues_hermitian_part":[0.0017597830734751502,0.0018051912018288993,0.0020077361474728 5,0.0023263851376208898,0.0023263851376208997,0.0023826390360256085,0.0025331400228729203,0.00253314002287 2933,0.0029303221768851484,0.0029303221768851 64,0.0029502361306556 72,0.0029969841110372417,0.0031013635647879883,0.0031013635647879 93,0.0031842125459905514,0.0031842125459905653,0.0034022465679858747,0.0034754123268813 94,0.0036278643268255655,0.0036278643268255824,0.0040101214891659 35,0.0041587016487025525,0.0041587016487025594,0.0045259111352984865,0.0047663912702650 44,0.0049046423059930 53,0.0049905620716987845,0.0049905620716987 97,0.0051478201989378 91,0.0054987214789304 47,0.0054987214789304 47,0.0065310172252724 84,0.0065310172252725,0.0065365856060916 58,0.0072668947970012 69,0.0072668947970012 77,0.0072859050329310325,0.0079908410019702 56,0.0079908410019702 73,0.0084446372511439 72,0.0095676577672022 13,0.0095676577672022 3,0.0105087732929957 34,0.0105087732929957 5,0.0113554024531824 05,0.0121749531163156 8,0.0143766379699701 4,0.0161771089732739 74,0.0161771089732740 1,0.0169688262273002 6,0.0169688262273002 9,0.0189630921745565 5,0.0194073419238338 5,0.0211579287339842 83,0.0211579287339843 07,0.0238829533490329 7,0.0238829533490329 95,0.0307055152353520 4,0.0307055152353520 77,0.0347009585158323 7,0.0563979867031747 1,0.0649493911293349 1,0.330149771667211],"entanglement":{"conclusion":"entanglement_detected","negativity":0.14290060933153992,"partition":[0],"scope":"Declared bipartition of the supplied complete state"},"entropy_bits":4.4881159024954265,"entropy_convention":"Negative eigenvalues within tolerance omitted only in entropy; retained state unchanged.","local_bloch_vectors":[{"qubit":0,"x":-0.07060558306000426,"y":-0.03742103905589744,"z":-0.012959091092590747},{"qubit":1,"x":-0.0706055830600043,"y":0.037421039055897456,"z":0.012959091092590858},{"qubit":2,"x":-0.07060558306000426,"y":-0.037421039055897456,"z":-0.012959091092590858},{"qubit":3,"x":-0.07060558306000425,"y":0.037421039055897366,"z":0.012959091092590802},{"qubit":4,"x":-0.07060558306000425,"y":-0.037421039055897436,"z":-0.012959091092590747},{"qubit":5,"x":-0.07060558306000425,"y":0.037421039055897 43,"z":0.012959091092590691}],"num_qubits":6,"observables":{},"pauli_string_order":"qubit_index","purity":0.12517587767558147,"qubit_order":"little_endian","reduced_basis_order":"Listed qubits from most significant to least significant tensor factor","reduced_states":[{"matrix":{"imag":[[7.180128887285253e-17,0.018710519527948714],[-0.01871051952794873,1.1424780392566003e-17]],"real":[[0.4935204544537023,-0.03530279153000216],[-0.035302791530002105,0.506479545546293]]},"purity":0.5032767102826015,"qubits":[0]},{"matrix":{"imag":[[8.117963766485214e-17,-0.018710519527948 74],[0.018710519

527948714,2.0464316005663896e-18]],"real":[[0.5064795455462932,-0.035302791530002146],[-0.03530279153000215,0.4935204544537023]]},"purity":0.5032767102826016,"qubits":[1]},{"matrix":{"imag":[[4.388308293135079e-17,0.01871051952794873],[-0.018710519527948725,3.934298633406774e-17]],"real":[[0.4935204544537023,-0.03530279153000217],[-0.0353027915300021,0.5064795455462932]]},"purity":0.5032767102826016,"qubits":[2]},{"matrix":{"imag":[[1.7428549922704484e-17,-0.018710519527948697],[0.01871051952794867,6.579751934271405e-17]],"real":[[0.5064795455462932,-0.03530279153000212],[-0.03530279153000213,0.49352045445370235]]},"purity":0.5032767102826016,"qubits":[3]},{"matrix":{"imag":[[3.2824220771998647e-17,0.01871051952794867 3],[-0.018710519527948763,5.040184849341989e-17]],"real":[[0.4935204544537024,-0.03530279153000213],[-0.035302791530002126,0.5064795455462932]]},"purity":0.5032767102826017,"qubits":[4]},{"matrix":{"imag":[[4.389663545850686e-17,-0.01871051952794871],[0.018710519527948718,3.9329433806911673e-17]],"real":[[0.5064795455462932,-0.03530279153000214],[-0.03530279153000212,0.49352045445370235]]},"purity":0.5032767102826015,"qubits":[5]}],"representation":"density_matrix","trace":{"imag":8.322606926541853e-17,"real":0.9999999999999956}}

Ideal-state overlap fidelity versus cycle

Ideal-state overlap fidelity versus cycle decreased from 1 to 0.32874773 over 9 recorded samples. The largest absolute step was 0.13794474 between x=0 and x=1.

Claim scope: descriptive

Method: floquet_cycle_series

Method metadata: {"kind":"floquet_cycle_series","label":"Ideal-state overlap fidelity versus cycle","name":"fidelity_series","seed":0,"source":"/series/0","units":"dimensionless","x_label":"Completed cycle"}

Evidence: ["/series/0"]

Retained values: {"change":-0.6712522652665734,"count":9,"final":0.32874773473342656,"initial":1.0,"largest_step":{"change":-0.137944736401303,"from_x":0.0,"to_x":1.0},"linear_fit":{"intercept":0.9488826644602968,"interpretation":"Descriptive least squares; no independence, causality or forecast claim","r_squared":0.9825566637362871,"rmse":0.028562218739781296,"slope":-0.08302360680298758},"maximum":1.0,"mean":0.6167882372483464,"minimum":0.32874773473342656,"population_std":0.21626048086320 89,"x_strictly_increasing":true}

Half-system entropy (bits) versus cycle

Half-system entropy (bits) versus cycle increased from -0 to 2.7172784 over 9 recorded samples. The largest absolute step was 0.95079117 between x=1 and x=2.

Claim scope: descriptive

Method: floquet_cycle_series

Method metadata: {"kind":"floquet_cycle_series","label":"Half-system entropy (bits) versus cycle","name":"half_entropy_bits_series","seed":0,"source":"/series/4","units":"bits","x_label":"Completed cycle"}

Evidence: ["/series/4"]

Retained values: {"change":2.717278417041989,"count":9,"final":2.717278417041989,"initial":-0.0,"largest_step":{"change":0.9507911728658407,"from_x":1.0,"to_x":2.0},"linear_fit":{"intercept":0.4771428758 15447,"interpretation":"Descriptive least squares; no independence, causality or forecast claim","r_squared":0.8653327843500797,"rmse":0.34336879585870905,"slope":0.33710647436085966},"maximum":2.7172 78417041989,"mean":1.8255687732588857,"minimum":-0.0,"population_std":0.935685469059726,"x_stri

ctly_increasing":true}

Mean Z magnetization versus cycle

Mean Z magnetization versus cycle decreased from 0 to -3.2959746e-17 over 9 recorded samples. The largest absolute step was 6.0715322e-17 between x=7 and x=8.

Claim scope: descriptive

Method: floquet_cycle_series

Method metadata: {"kind":"floquet_cycle_series","label":"Mean Z magnetization versus cycle","name":"magnetization_series","seed":0,"source":"/series/2","units":"dimensionless","x_label":"Completed cycle"}

Evidence: ["/series/2"]

Retained values: {"change":-3.2959746043559335e-17,"count":9,"final":-3.2959746043559335e-17,"initial":0.0,"largest_step":{"change":-6.071532165918825e-17,"from_x":7.0,"to_x":8.0},"linear_fit":{"intercept":-3.8067542945046596e-18,"interpretation":"Descriptive least squares; no independence, causality or forecast claim","r_squared":0.0006753782117986384,"rmse":2.153646453830085e-17,"slope":2.168404344971009e-19},"maximum":3.23815048849004e-17,"mean":-2.939392556516256e-18,"minimum":-3.2959746043559335e-17,"population_std":2.1543740853661175e-17,"x_strictly_increasing":true}

Mutual information (bits) versus cycle

Mutual information (bits) versus cycle increased from 0 to 0.94644093 over 9 recorded samples. The largest absolute step was 1.2691126 between x=1 and x=2.

Claim scope: descriptive

Method: floquet_cycle_series

Method metadata: {"kind":"floquet_cycle_series","label":"Mutual information (bits) versus cycle","name":"mutual_information_bits_series","seed":0,"source":"/series/5","units":"bits","x_label":"Completed cycle"}

Evidence: ["/series/5"]

Retained values: {"change":0.9464409315885511,"count":9,"final":0.9464409315885511,"initial":0.0,"largest_step":{"change":1.2691125614981213,"from_x":1.0,"to_x":2.0},"linear_fit":{"intercept":0.527353935997108,"interpretation":"Descriptive least squares; no independence, causality or forecast claim","r_squared":0.3010907245300495,"rmse":0.4869532585920153,"slope":0.1237859038745936},"maximum":1.6888479237804663,"mean":1.0224975514954824,"minimum":0.0,"population_std":0.5824744423924392,"x_strictly_increasing":true}

Purity versus cycle

Purity versus cycle decreased from 1 to 0.12517588 over 9 recorded samples. The largest absolute step was 0.25392928 between x=0 and x=1.

Claim scope: descriptive

Method: floquet_cycle_series

Method metadata: {"kind":"floquet_cycle_series","label":"Purity versus cycle","name":"purity_series","seed":0,"source":"/series/1","units":"dimensionless","x_label":"Completed cycle"}

Evidence: ["/series/1"]

Retained values: {"change":-0.8748241223244186,"count":9,"final":0.1251758776755814,"initial":1.0,"largest_step":{"change":-0.2539292810882079,"from_x":0.0,"to_x":1.0},"linear_fit":{"intercept":0.8550136827501774,"interpretation":"Descriptive least squares; no independence, causality or forecast claim","r_squared":0.9265995371482,"rmse":0.07574534117002014,"slope":-0.10423130992806258},"maximum":1.0,"mean":0.4380884430379271,"minimum":0.1251758776755814,"population_std":0.2795802744074797,"x_strictly_increasing":true}

Mean nearest-neighbor ZZ correlation versus cycle

Mean nearest-neighbor ZZ correlation versus cycle increased from -1 to -0.27101651 over 9 recorded samples. The largest absolute step was 0.97743231 between x=0 and x=1.

Claim scope: descriptive

Method: floquet_cycle_series

Method metadata: {"kind":"floquet_cycle_series","label":"Mean nearest-neighbor ZZ correlation versus cycle","name":"zz_correlation_series","seed":0,"source":"/series/3","units":"dimensionless","x_label":"Completed cycle"}

Evidence: ["/series/3"]

Retained values: {"change":0.728983490608371,"count":9,"final":-0.271016509391629,"initial":-1.0,"largest_step":{"change":0.9774323081898132,"from_x":0.0,"to_x":1.0},"linear_fit":{"intercept":-0.5540076221093605,"interpretation":"Descriptive least squares; no independence, causality or forecast claim","r_squared":0.19696717898869265,"rmse":0.22360472816112847,"slope":0.04289008397984963},"maximum":-0.02256769181018684,"mean":-0.382447286189962,"minimum":-1.0,"population_std":0.2495251553411049,"x_strictly_increasing":true}

Executed interaction edges

Diagram derived from the supplied structure; execution correspondence depends on the workflow metadata.

Claim scope: descriptive

Method: floquet_topology

Method metadata: {"kind":"network","label":"Executed interaction edges","name":"interaction_topology","seed":0,"source":"/data/edges"}

Evidence: ["/data/edges"]

Retained values: {"edges":6,"nodes":6}

fidelity

fidelity: 0.32874773473342656. This is the value retained by the scientific run.

Claim scope: descriptive

Method: scalar

Method metadata: {"kind":"scalar","name":"fidelity","seed":0,"source":"/metrics/fidelity"}

Evidence: ["/metrics/fidelity"]

Retained values: {"value":0.32874773473342656}

half_entropy_bits

half_entropy_bits: 2.717278417041989. This is the value retained by the scientific run.

Claim scope: descriptive

Method: scalar

Method metadata:
{"kind":"scalar","name":"half_entropy_bits","seed":0,"source":"/metrics/half_entropy_bits"}

Evidence: ["/metrics/half_entropy_bits"]

Retained values: {"value":2.717278417041989}

magnetization

magnetization: -3.2959746043559335e-17. This is the value retained by the scientific run.

Claim scope: descriptive

Method: scalar

Method metadata: {"kind":"scalar","name":"magnetization","seed":0,"source":"/metrics/magnetization"}

Evidence: ["/metrics/magnetization"]

Retained values: {"value":-3.2959746043559335e-17}

mutual_information_bits

mutual_information_bits: 0.9464409315885511. This is the value retained by the scientific run.

Claim scope: descriptive

Method: scalar

Method metadata:
{"kind":"scalar","name":"mutual_information_bits","seed":0,"source":"/metrics/mutual_information_bits"}

Evidence: ["/metrics/mutual_information_bits"]

Retained values: {"value":0.9464409315885511}

purity

purity: 0.1251758776755814. This is the value retained by the scientific run.

Claim scope: descriptive

Method: scalar

Method metadata: {"kind":"scalar","name":"purity","seed":0,"source":"/metrics/purity"}

Evidence: ["/metrics/purity"]

Retained values: {"value":0.1251758776755814}

zz_correlation

zz_correlation: -0.271016509391629. This is the value retained by the scientific run.

Claim scope: descriptive

Method: scalar

Method metadata: {"kind":"scalar","name":"zz_correlation","seed":0,"source":"/metrics/zz_correlation"}

Evidence: ["/metrics/zz_correlation"]

Retained values: {"value":-0.271016509391629}

observables

Standardized PCA has numerical rank 7. 2 occupied descriptive groups were fitted to 9 distinct rows; they are not established physical phases.

Claim scope: exploratory

Method: multivariate

Method metadata: {"kind":"table","name":"observables","seed":0,"source":"/tables/0"}

Evidence: ["/tables/0"]

Retained values: {"cluster_centers_standardized":[[-1.161895003862225,1.2168710526900037,1.2431780264353949,-0.507729615093254,-0.518696700642306,-1.258386195237559,-1.0291610882254365],[0.5809475019311126,-0.6084355263450029,-0.6215890132176972,0.25386480754662694,0.2593483503211534,0.6291930976187794,0.5145805441127181]],"cluster_labels":[0,0,0,1,1,1,1,1,1],"clustering_parallelism":"One numeric thread during fit and assignment to control reduction-order variability","constant_or_numerically_constant_features":[],"degenerate_component_axes":false,"distinct_rows":9,"excluded_nonnumeric_columns":[],"explained_variance_ratio":[0.675484190209187,0.16992407458337686],"feature_selection":"legacy numeric-column inference","features":["cycle","fidelity","purity","magnetization","zz_correlation","half_entropy_bits","mutual_information_bits"],"fitted_clusters":2,"inertia":29.0438516003919,"iterations":3,"means":[4.0,0.6167882372483464,0.43808844303792704,-2.9393925565162564e-18,-0.3824472861899621,1.8255687732588857,1.0224975514954824],"occupied_clusters":2,"principal_loadings":[[-0.43425184138515743,0.4499237088289271,0.45879766691951934,-0.048278110740013,-0.2592242990165585,-0.456250549248651,-0.34757174575831384],[-0.07042571465632938,0.04694866448450779,0.022947229238742584,0.8190479421950594,-0.4621383054269723,0.06739337536215163,0.32149067527527314]],"rank":7,"requested_clusters":2,"restart_adjusted_rand_indices":[0.5555555555555556,1.0,0.5555555555555556],"sample_count":9,"scales":[2.581988897471611,0.2162604808632089,0.2795802744074797,2.1543740853661175e-17,0.24952515534110487,0.9356854690597259,0.5824744423924393],"seed":0,"silhouette":0.3915902164683831,"stability_scope":"Optimization restart sensitivity only; not resampling or external replication.","validation":"Exploratory fit to these rows; no held-out prediction claim or inferred physical regimes"}

Scientific figure evidence

figure-001: Ideal-state overlap fidelity versus cycle; origin: unverified_import; finding: floquet_cycle_series:fidelity_series; source: /series/0; data SHA256: b8eb195668d9944fd890b34843e23606f13a8689a1ff1db1851a5cd2e9813733; selection: Connects

explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

figure-002: Purity versus cycle; origin: unverified_import; finding: floquet_cycle_series:purity_series; source: /series/1; data SHA256: a202b3389b52d93e8ede18fbdfa4a3e1efdecbc9f39b0fde9f631d83705ea5a3; selection: Connects explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

figure-003: Mean Z magnetization versus cycle; origin: unverified_import; finding: floquet_cycle_series:magnetization_series; source: /series/2; data SHA256: 030a179588751cf122b73a9ff3152d3d549b219e0e806cf480e64f3d248ad813; selection: Connects explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

figure-004: Mean nearest-neighbor ZZ correlation versus cycle; origin: unverified_import; finding: floquet_cycle_series:zz_correlation_series; source: /series/3; data SHA256: ca07030802089e2e174fe0c6bad0f6f17ab792d4cd9dca43d2e43fa1af18524e; selection: Connects explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

figure-005: Half-system entropy (bits) versus cycle; origin: unverified_import; finding: floquet_cycle_series:half_entropy_bits_series; source: /series/4; data SHA256: d295e5194cc4bd5783cbeff5a75092f807f4f8ff6b9bf4f02b7d7ba338fe73b0; selection: Connects explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

figure-006: Mutual information (bits) versus cycle; origin: unverified_import; finding: floquet_cycle_series:mutual_information_bits_series; source: /series/5; data SHA256: 3174eb5732f97301d4125b46cbb22423a3a3ea874f8fac585dd4e40715481860; selection: Connects explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

figure-007: Principal-component exploration; origin: unverified_import; finding: multivariate:observables; source: /tables/0; data SHA256: e787752994e62e9a65921608d3bad9899b3fe338d86959c2ea6d2252b928869c; selection: Shows observations without implying an ordered trajectory or interpolation.; selected display: {}

figure-008: final_density_matrix - real entries; origin: unverified_import; finding: matrix:final_density_matrix; source: artifact:final_states_json#/final_density_matrix; data SHA256: fd761f7e088cb99157b94adf8413da86ae724b573d0ceb77789d2ae2a881b3ef; selection: Shows each retained matrix entry on its declared row and column basis.; selected display: {}

figure-009: final_density_matrix - imaginary entries; origin: unverified_import; finding: matrix:final_density_matrix; source: artifact:final_states_json#/final_density_matrix; data SHA256: 98664fd3b5288cb7e21d1bc1446431e83d76561a70911bb6fb774cd780a10c4f; selection: Shows each retained matrix entry on its declared row and column basis.; selected display: {}

figure-010: Populations in the declared basis; origin: unverified_import; finding: matrix:final_density_matrix; source: artifact:final_states_json#/final_density_matrix; data SHA256: 512a7311bb6ead254f5c5ca99bcee0e89e7c98ddd54a59c4bd57139e690dde26; selection: Compares discrete declared categories without connecting independent observations.; selected display: {}

figure-011: interaction_topology; origin: unverified_import; finding: floquet_topology:interaction_topology; source: /data/edges; data SHA256: 4699f401c0e863036e4b591699c646aae45517414a9a55037c63fbc969dc8825; selection: Shows only explicitly declared nodes and edges; no inferred connections.; selected display: {}

figure-012: Retained state: real entries; origin: numerical_state; finding: quantum_state:quantum_state_evidence; source: artifact:final_states_json#/final_density_matrix; data SHA256: fe4e8b3d824cb5814c18931a94703bce9a4b4ee5bbeb3ef2e38bd6da8a4b51ed; selection: Shows each retained matrix entry on its declared row and column basis.; selected display: {}

figure-013: Retained state: imaginary entries; origin: numerical_state; finding: quantum_state:quantum_state_evidence; source: artifact:final_states_json#/final_density_matrix; data SHA256: f0dd58b1c7758cce4f579dbe3bae4653be1797b636f552abe2a6251abcec3fe6; selection: Shows each retained matrix entry on its declared row and column basis.; selected display: {}

figure-014: Local Bloch vectors (not an entanglement map); origin: numerical_state; finding: quantum_state:quantum_state_evidence; source: artifact:final_states_json#/final_density_matrix; data SHA256: ca0310adcbb2a3f7c0ae91f5a7cdd4a3cf9fe4106ab377a79d95b18ef5b38bfc; selection: Preserves three declared coordinates; no missing dimension is inferred.; selected display: {}

figure-015: Retained state checkpoints: real entries; origin: numerical_state; finding: quantum_checkpoints:reduced_q0_checkpoints; source: /data/reduced_q0_checkpoints; data SHA256: 4a059eeabda0725e23ae755bd86009746a02f9a4f52f07cb4229dd27511e2d97; selection: Shows each retained matrix entry on its declared row and column basis.; selected display: {}

figure-016: Saved checkpoint expectation Z; origin: numerical_state; finding: quantum_checkpoints:reduced_q0_checkpoints; source: /data/reduced_q0_checkpoints; data SHA256: eb269453bb488e6149f76e699cec132afc9351044755f20719220106153b4077; selection: Connects explicitly ordered retained coordinates; exact calculated observations remain available in the source data.; selected display: {}

Reporting issues and supplementary literature

None recorded.

Methods and execution provenance

Provenance: {"execution_origin":"fresh local r34 Python workflow/API run","run_config_sha256":"94885974030d094329aceeae55890eb8c8c548ac2e29b0a07dea8105b8196767","workflow_sha256":"61bc7f80e0f9201ee782a7c1ee52811955b1fe36842e85f500ea2978da1a47e4"}

Reporting requirements: {"analysis":{"mode":"exploratory","question":"How do the retained Floquet dynamics and final quantum state compare with the declared ideal evolution?"},"datasets":[{"basis":"Computational basis; little-endian integer indexing, q0 least significant","kind":"density_matrix","name":"final_density_matrix","source":"artifact:final_states_json#/final_density_matrix","tolerance":1e-08},{"kind":"floquet_cycle_series","label":"Ideal-state overlap fidelity versus cycle","name":"fidelity_series","source":"/series/0","units":"dimensionless","x_label":"Completed cycle"},{"kind":"floquet_cycle_series","label":"Purity versus cycle","name":"purity_series","source":"/series/1","units":"dimensionless","x_label":"Completed cycle"},{"kind":"floquet_cycle_series","label":"Mean Z magnetization versus cycle","name":"magnetization_series","source":"/series/2","units":"dimensionless","x_label":"Completed cycle"},{"kind":"floquet_cycle_series","label":"Mean nearest-neighbor ZZ correlation versus cycle","name":"zz_correlation_series","source":"/series/3","units":"dimensionless","x_label":"Completed cycle"},{"kind":"floquet_cycle_series","label":"Half-system entropy (bits) versus cycle","name":"half_entropy_bits_series","source":"/series/4","units":"bits","x_label":"Completed cycle"},{"kind":"floquet_cycle_series","label":"Mutual information (bits) versus cycle","name":"mutual_information_bits_series","source":"/series/5","units":"bits","x_label":"Completed cycle"},{"kind":"floquet_topology","label":"Executed interaction edges","name":"interaction_topology","source":"/data/edges"},{"basis":"computational","kind":"quantum_state","label":"Final state: local and joint evidence","name":"quantum_state_evidence","origin":"numerical_state","qubit_order":"little_endian","source":"artifact:final_states_json#/final_density_matrix","tolerance":1e-08,"units":"dimensionless"},{"basis":"computational","kind":"quantum_checkpoints","label":"Calculated reduced q0 state checkpoints","link_group"

:"floquet-cycles","name":"reduced_q0_checkpoints","observables":["Z"],"origin":"numerical_state","qubit_order":"little_endian","source":"/data/reduced_q0_checkpoints","tolerance":1e-08,"units":"dimensionless"}],"extensions":["reporting.py:configure"],"intent":"Floquet spin-chain results","presentation":{"audience":"technical"},"require":["matrix:final_density_matrix","quantum_state:quantum_state_evidence","quantum_checkpoints:reduced_q0_checkpoints"],"schema_version":2}

Analysis decisions: [{"analysis":"floquet_cycle_series:fidelity_series","reason":"Bound scientific inputs and registered capability checks
completed","status":"applied"},{"analysis":"floquet_cycle_series:purity_series","reason":"Bound scientific inputs and registered capability checks
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completed","status":"applied"},{"analysis":"floquet_cycle_series:half_entropy_bits_series","reason":"Bound scientific inputs and registered capability checks completed","status":"applied"},{"analysis":"floquet_cycle_series:mutual_information_bits_series","reason":"Bound scientific inputs and registered capability checks
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completed","status":"applied"},{"analysis":"floquet_topology:interaction_topology","reason":"Bound scientific inputs and registered capability checks
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completed","status":"applied"}]

Display policy: Exact retained JSON values; axis ticks and optional scientific notation are display formatting only

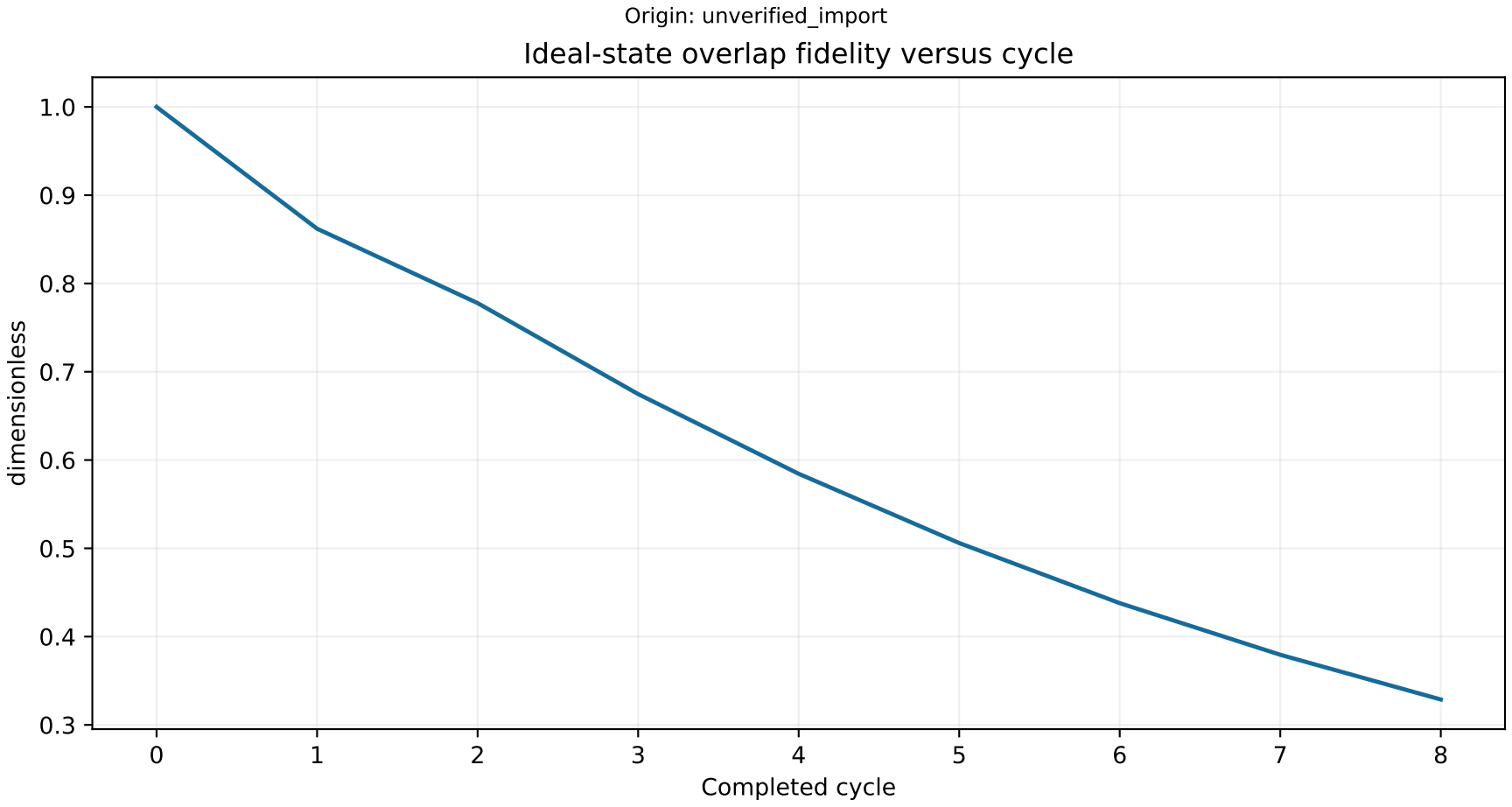
observables

cycle	fidelity	purity	magnetization	zz_correlation
0	1.0	1.0	0.0	-1.0
1	0.862055263598697	0.7460707189117921	-2.312964634635743e-17	-0.02256769181018684
2	0.7777928051561205	0.6108987715064593	-1.850371707708594e-17	-0.5130577911677695
3	0.6747344414251097	0.4653656214521953	3.2381504884900 4e-17	-0.3826952268641661
4	0.5844466561480225	0.3546780218044926	4.6259292692714 85e-18	-0.3261665842210726

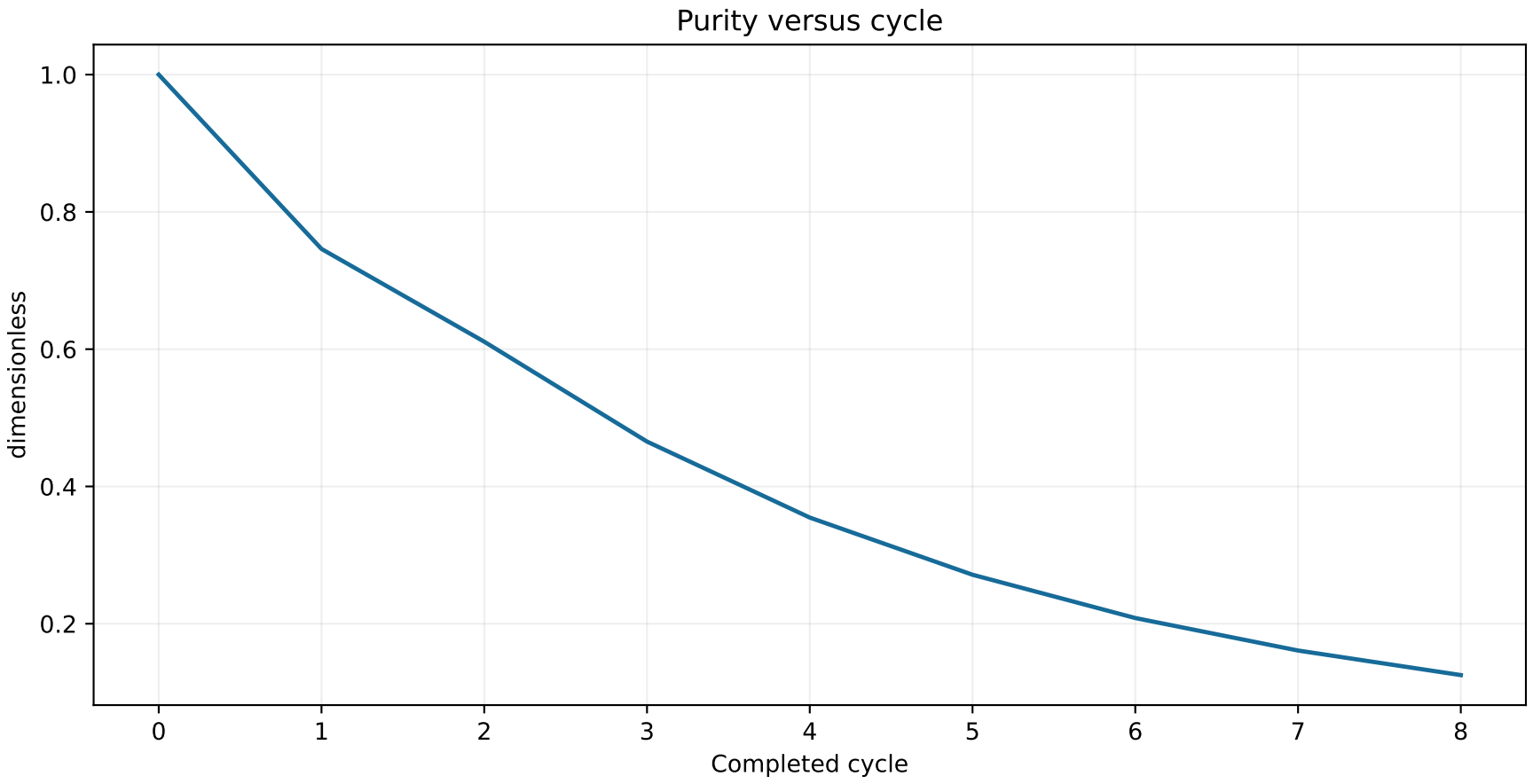
cycle	fidelity	purity	magnetization	zz_correlation
5	0.5059872076240339	0.2713675379816044	-2.0816681711721685e-17	-0.32677090128889047
6	0.4378987918526 7094	0.2082926371948 5033	4.1922484002772836e-18	-0.306980705913 9505
7	0.3794312346970351	0.1609468008143 6832	2.7755575615628914e-17	-0.292770165051 9934
8	0.3287477347334 2656	0.1251758776755814	-3.2959746043559335e-17	-0.271016509391629

half_entropy_bits	mutual_information_bits
-0.0	0.0
0.49677705743169903	1.9984014443252818e-15
1.4475682302975397	1.2691125614981233
1.8082787365517565	1.3348050056612513
2.2820236357972328	1.6888479237804663
2.4646807689554606	1.5450762769037576
2.5541959457927805	1.2852414342064105
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2.717278417041989	0.9464409315885511

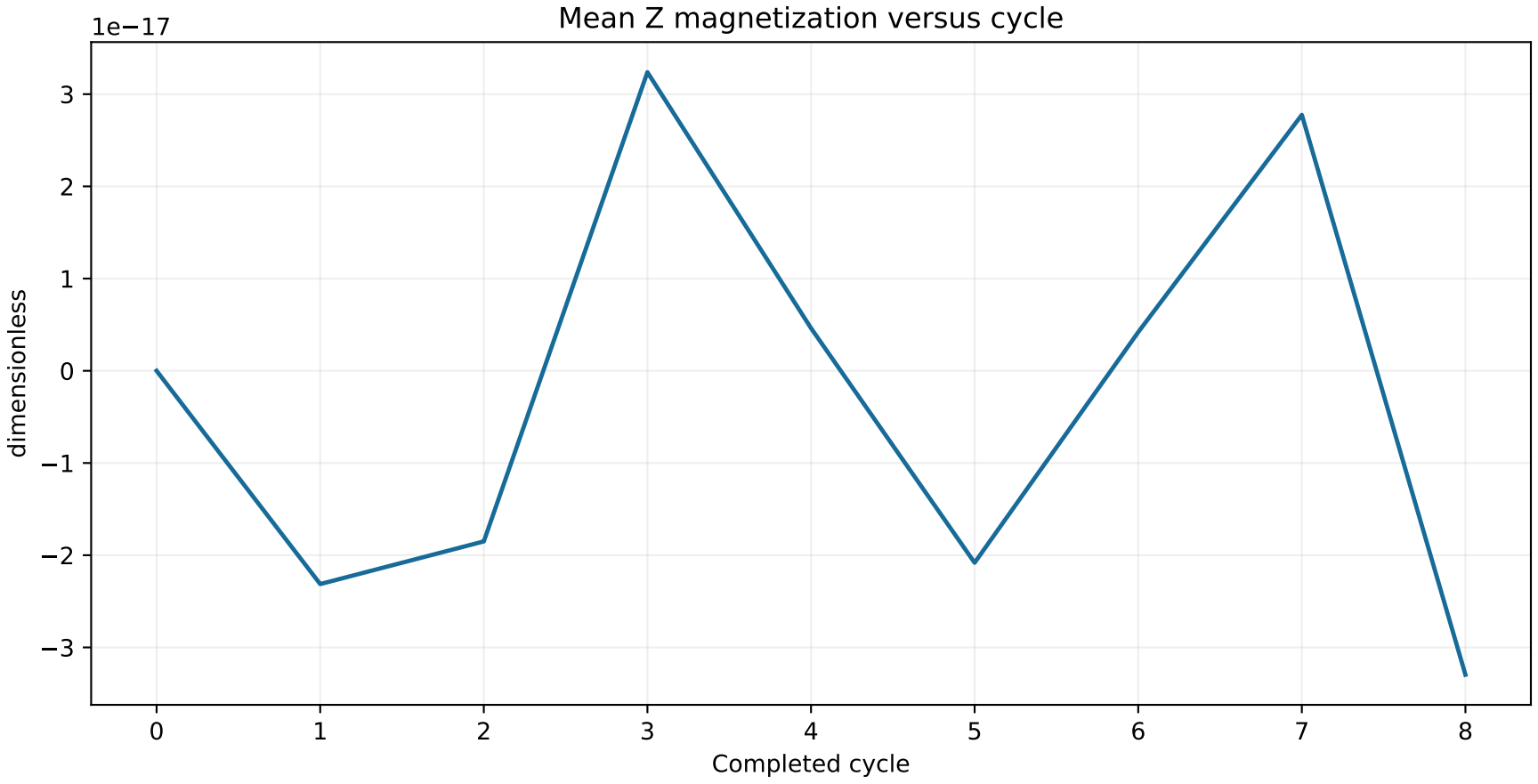
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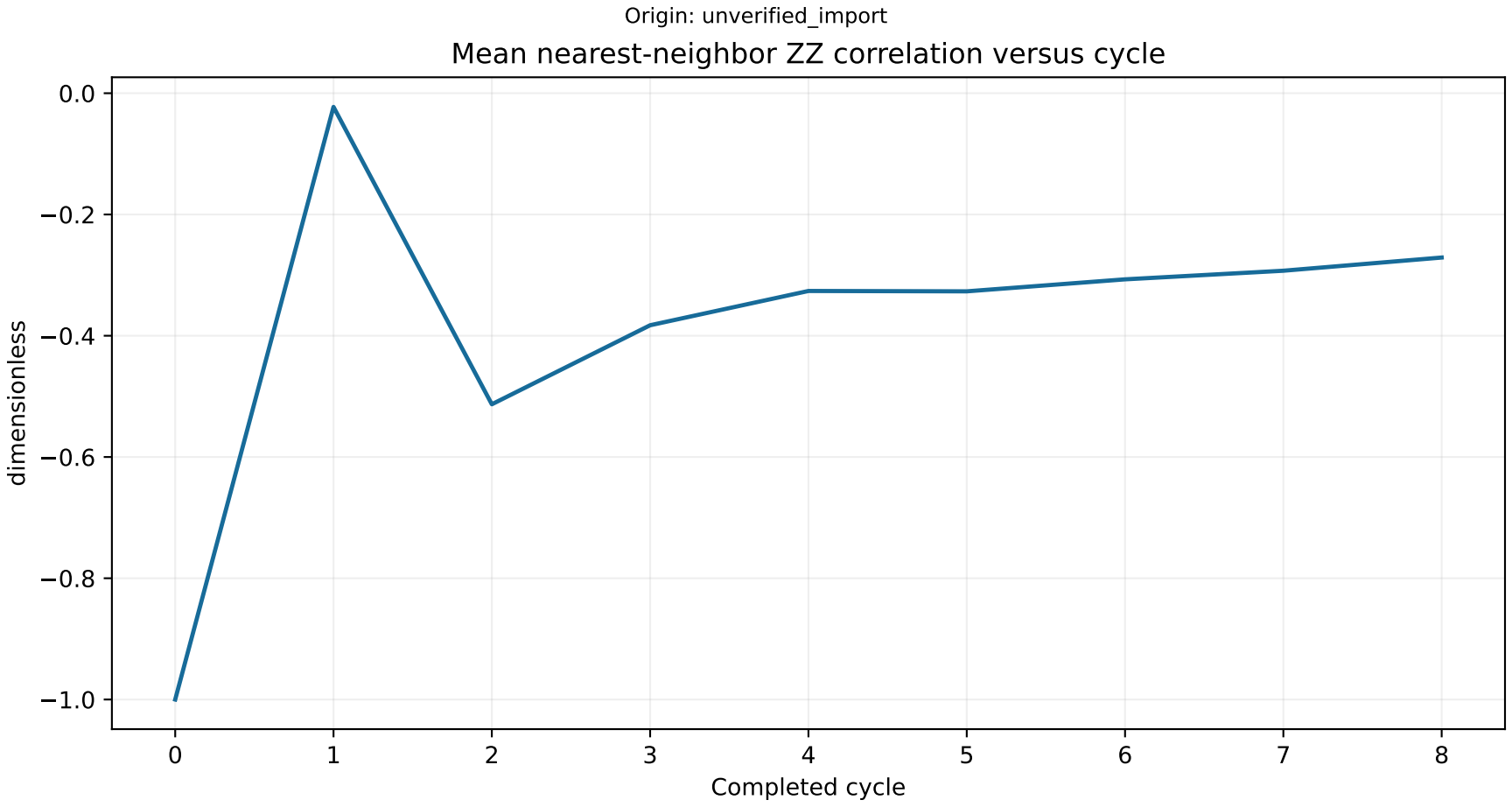
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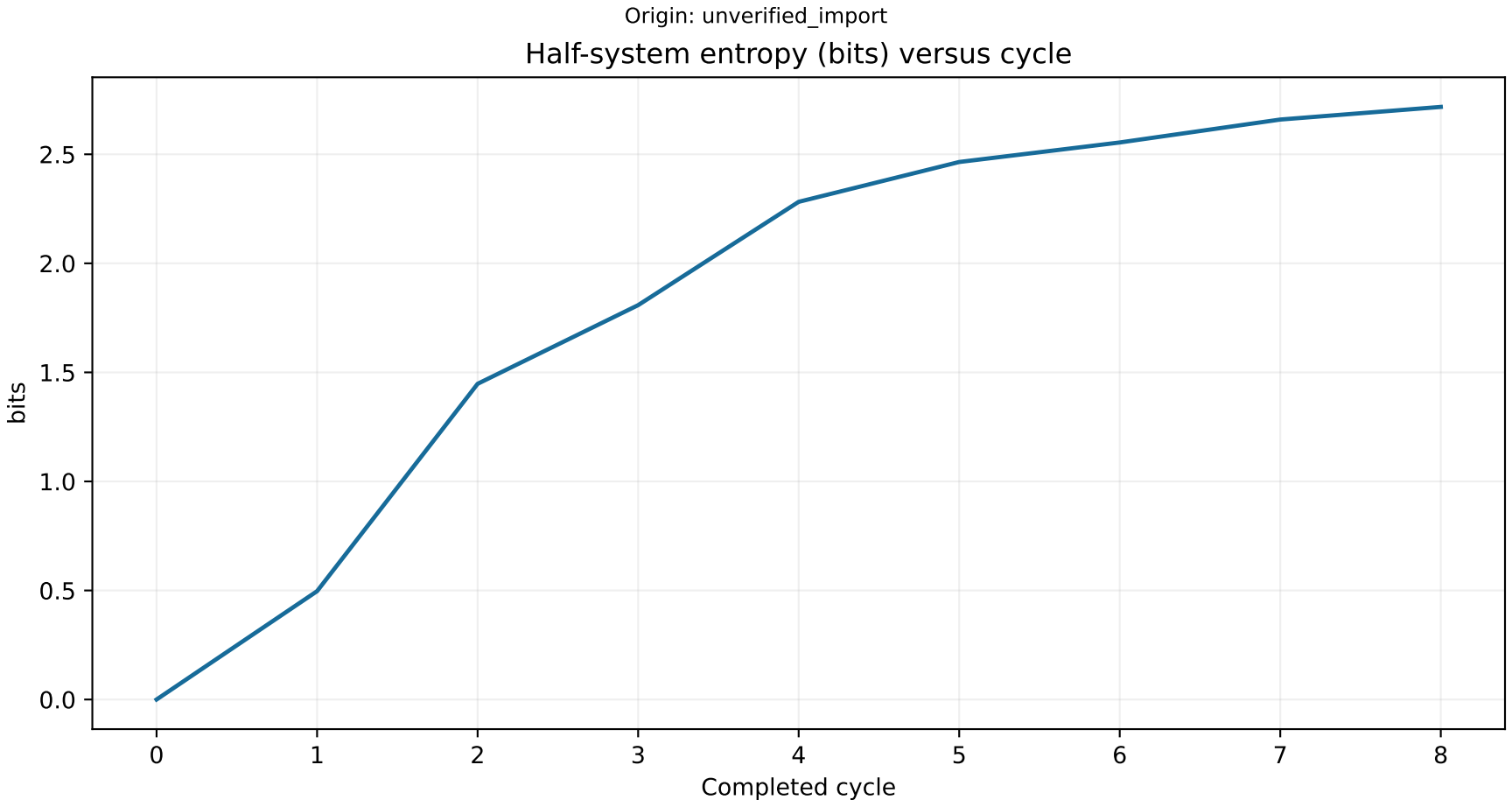
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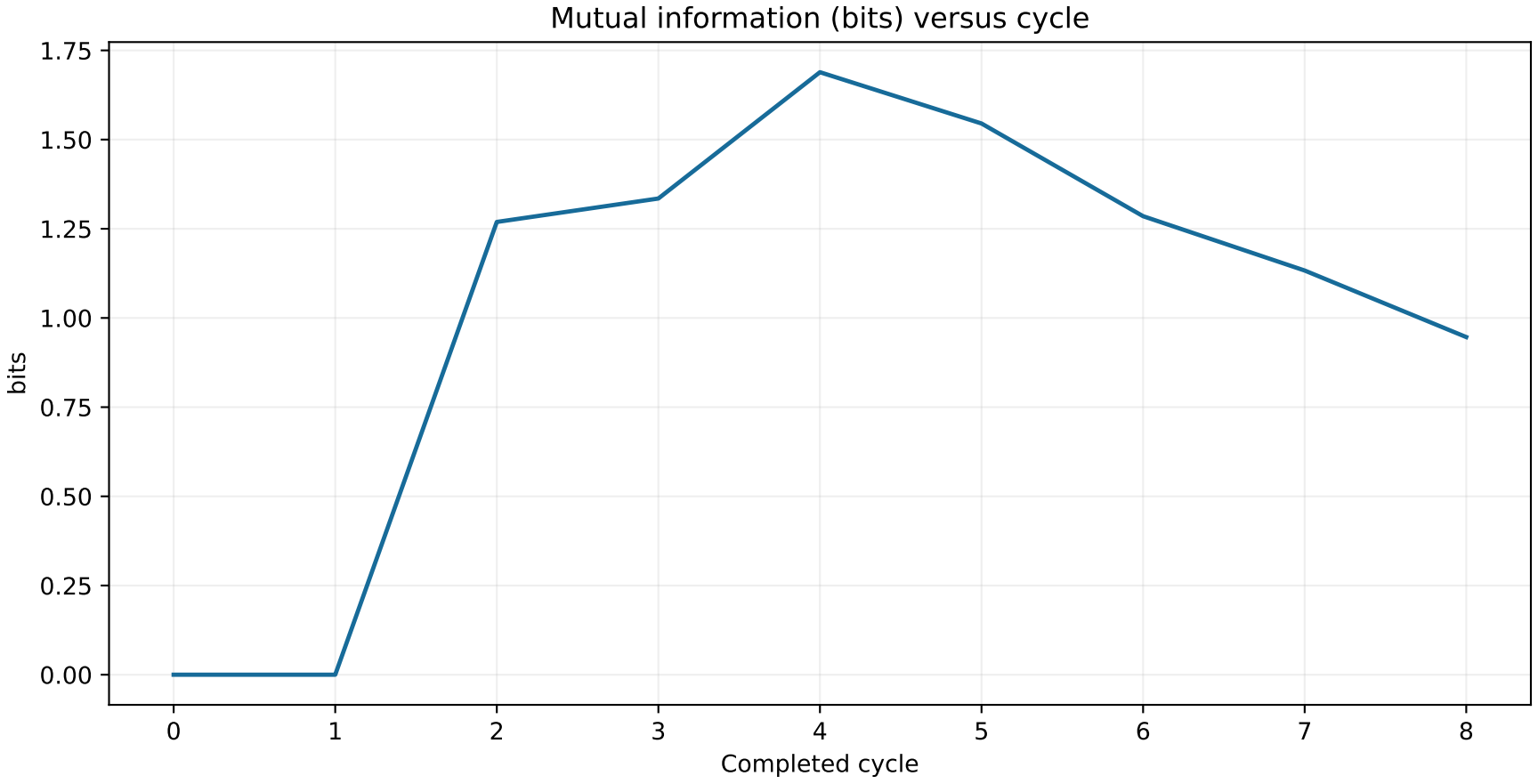
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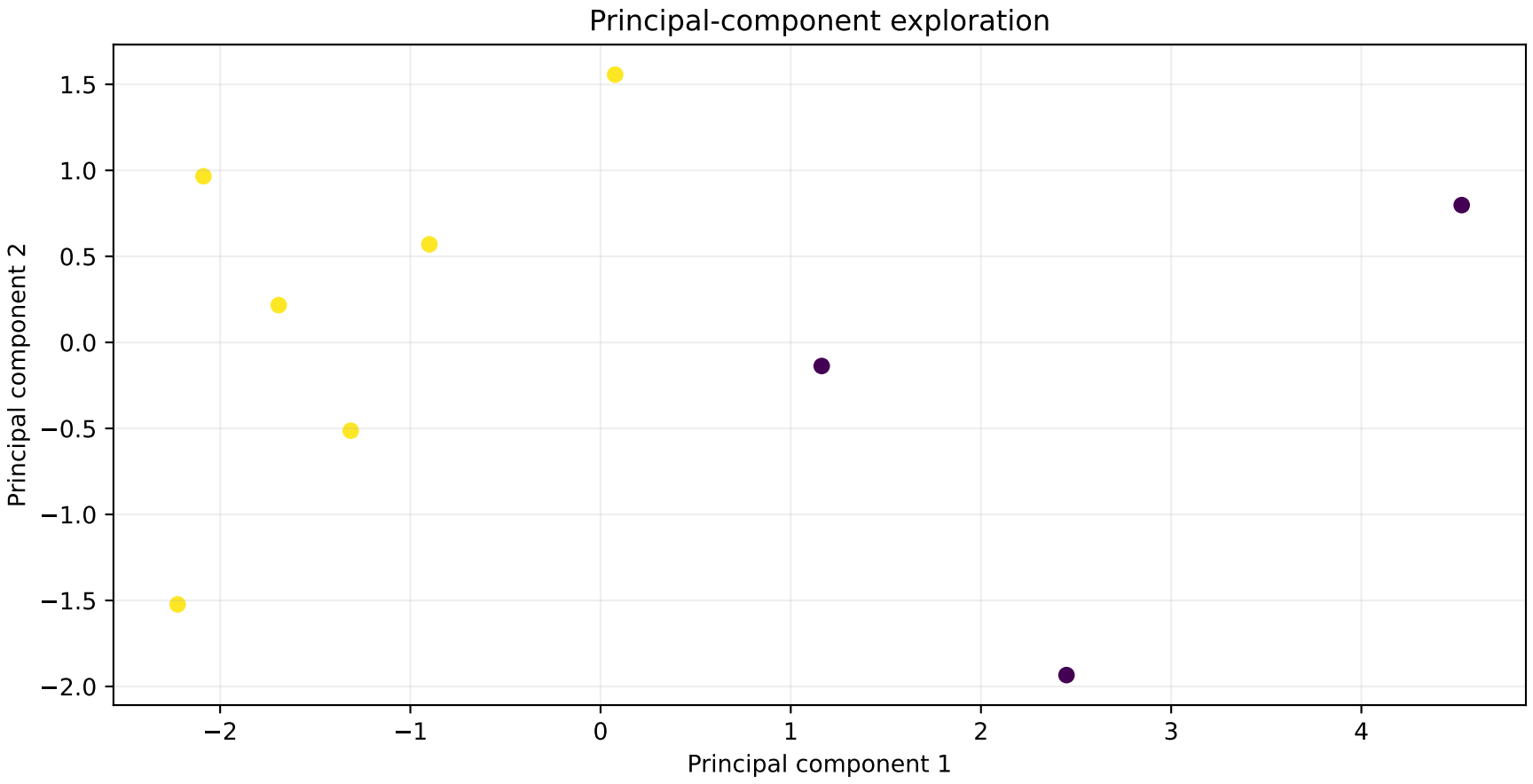
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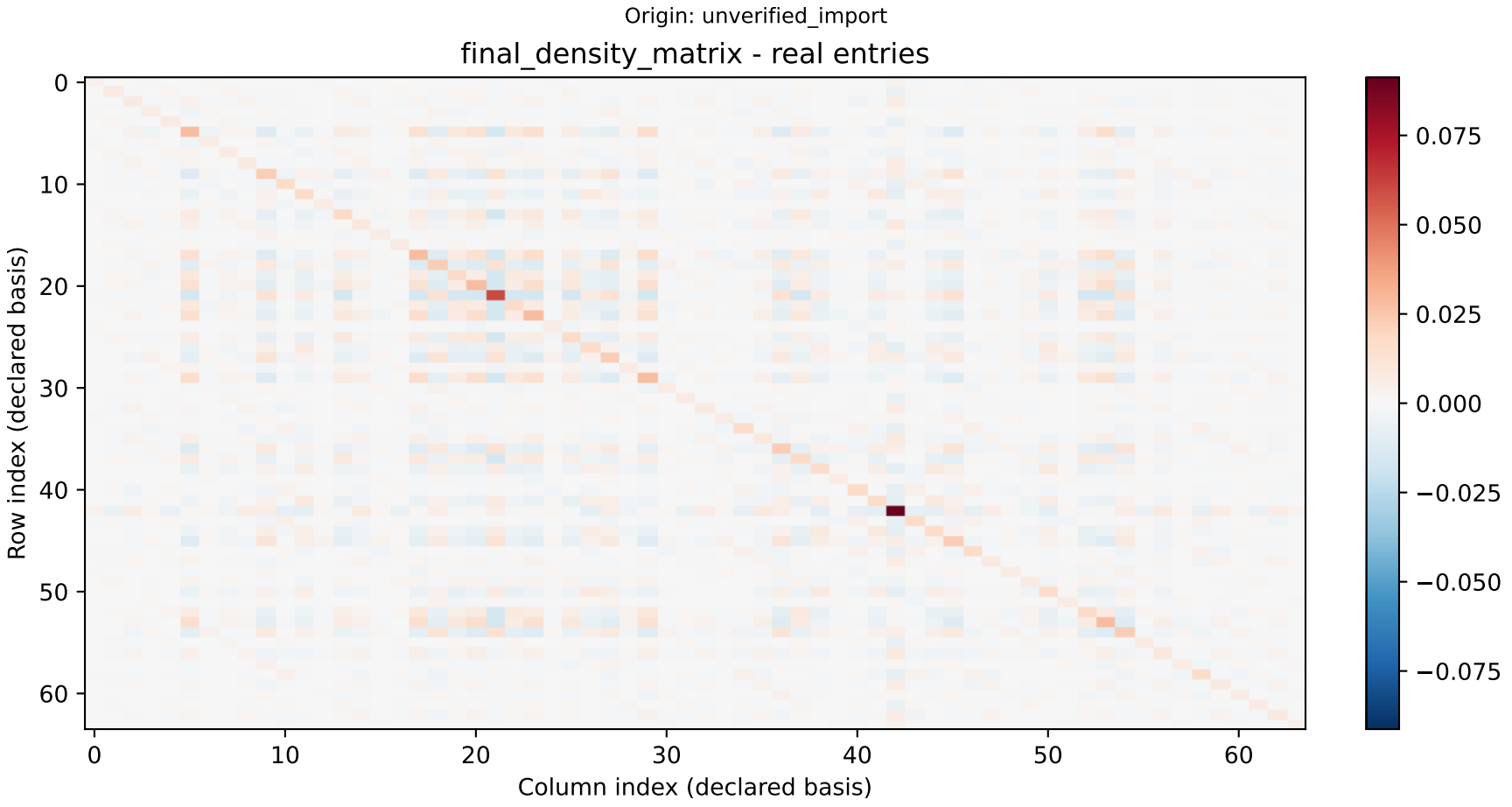


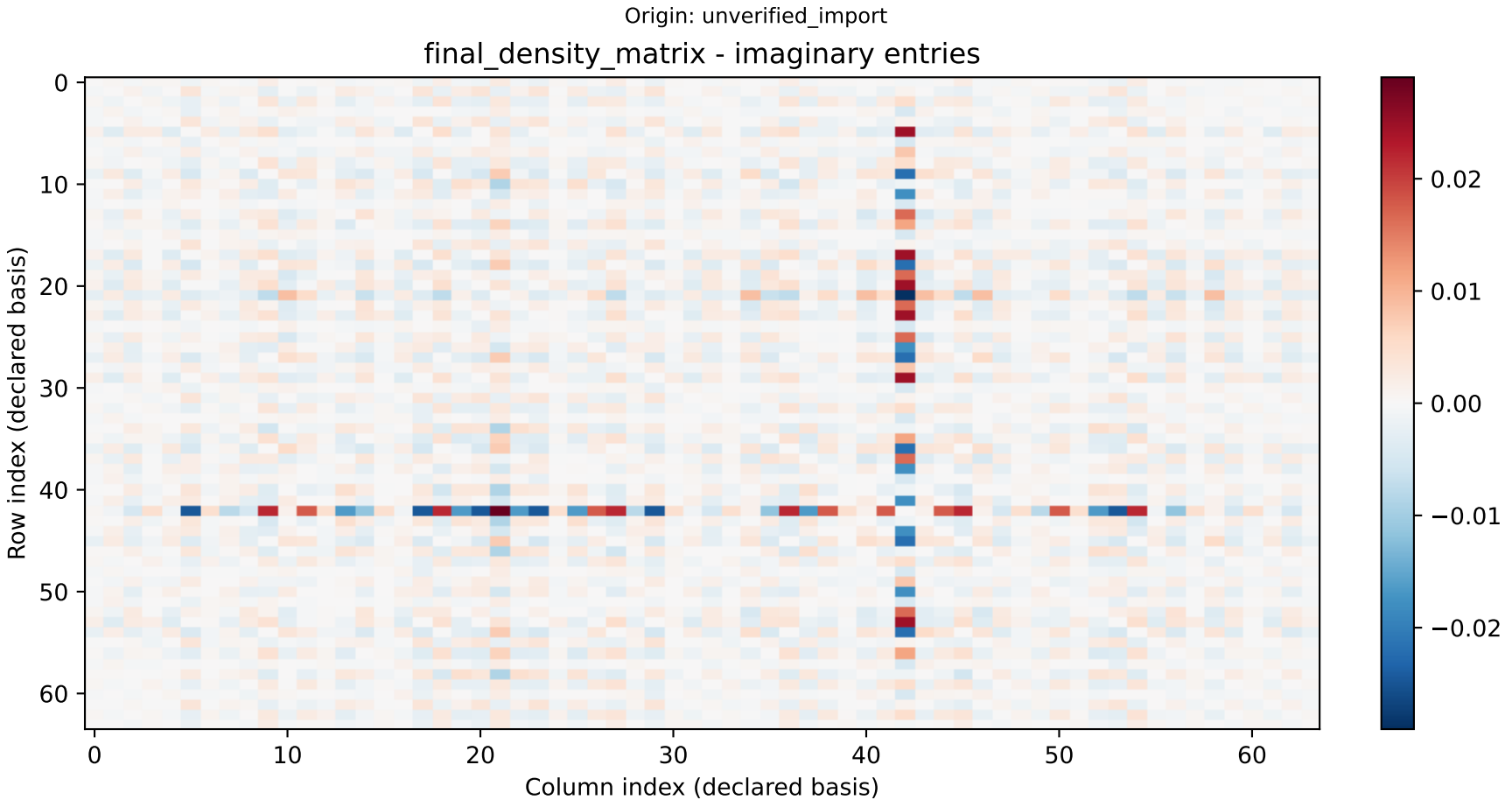
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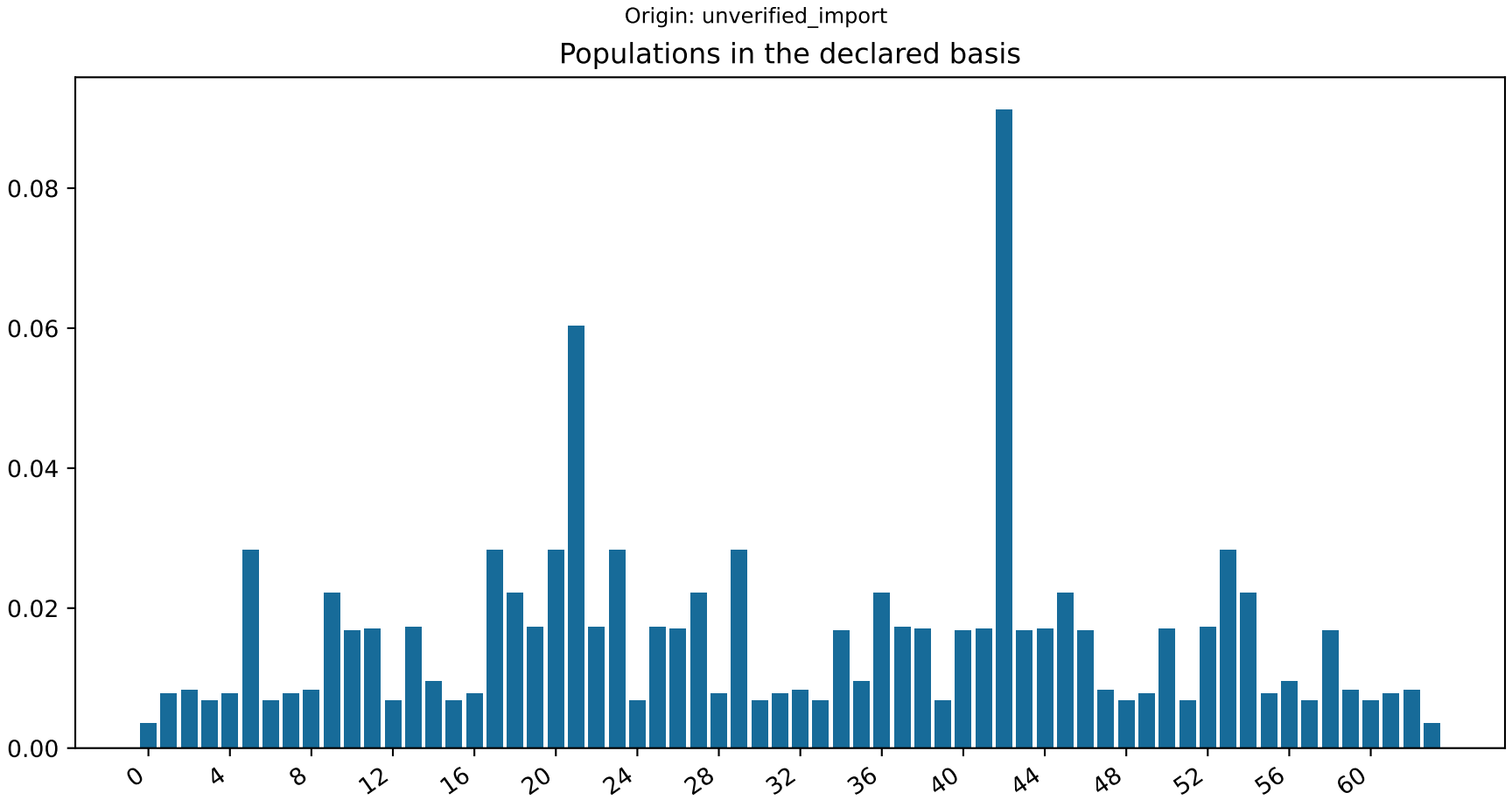
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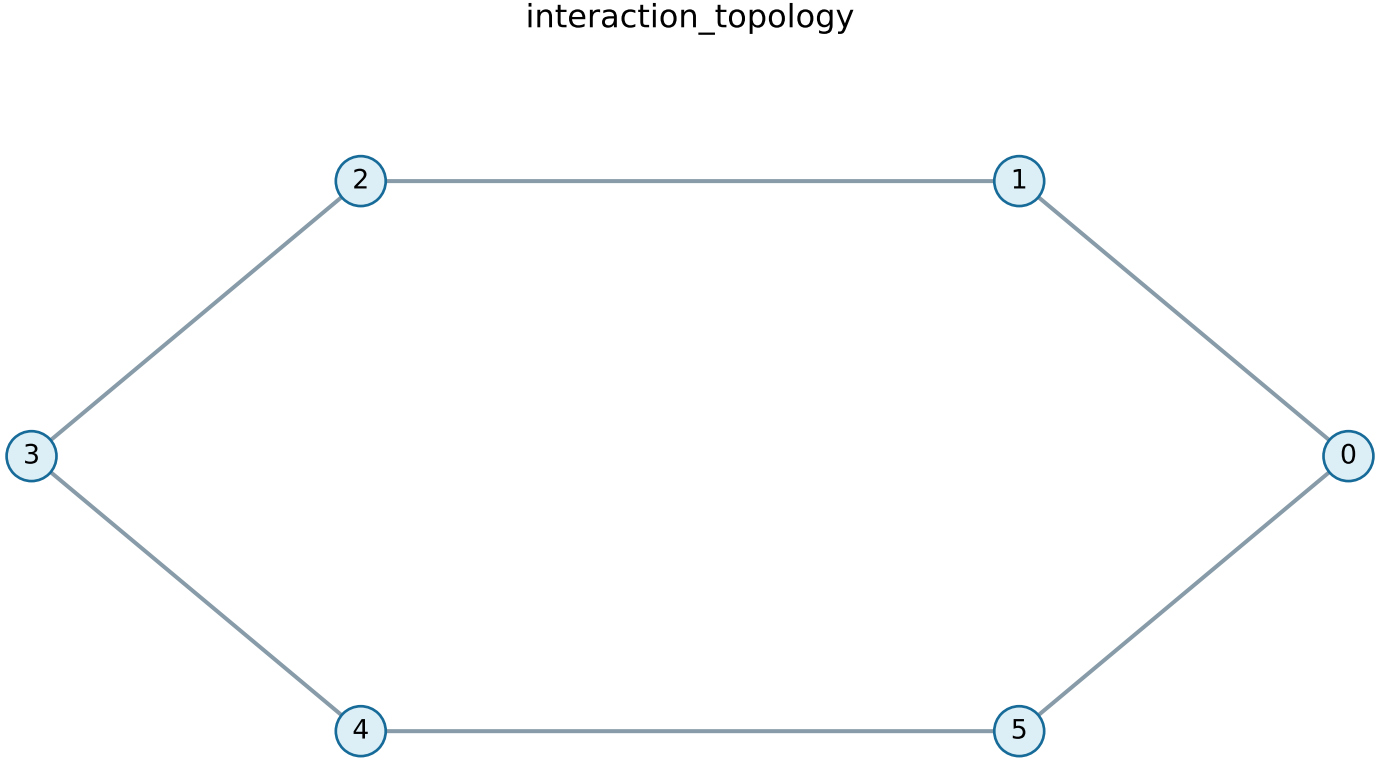

Origin: unverified_import
final_density_matrix - real entries
Row index (declared basis)
Column index (declared basis)
0
10
20
30
40
50
60
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075

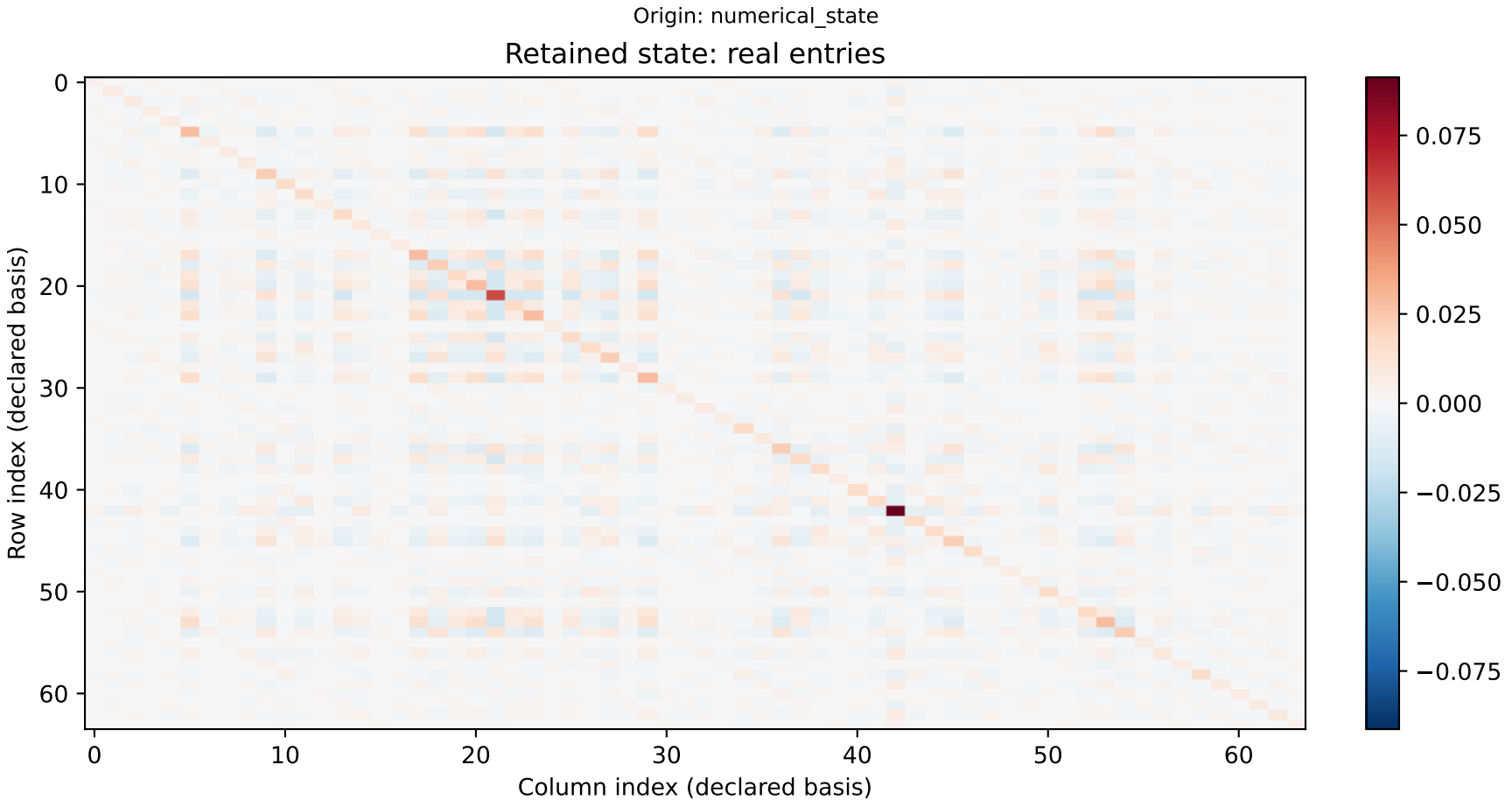

Origin: unverified_import
final_density_matrix - imaginary entries
Row index (declared basis)
Column index (declared basis)
0
10
20
30
40
50
60
0.02
0.01
0.00
−0.01
−0.02

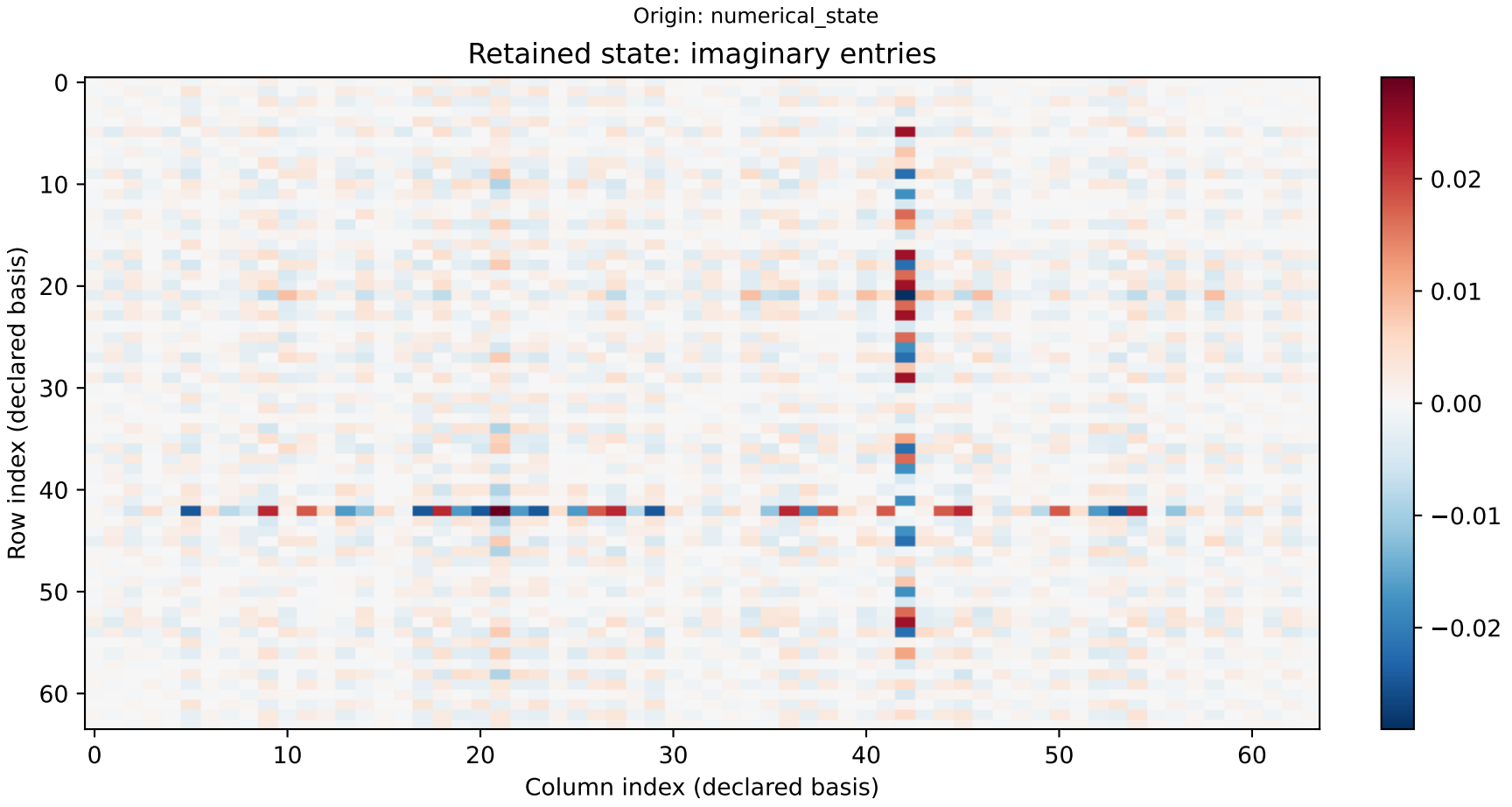
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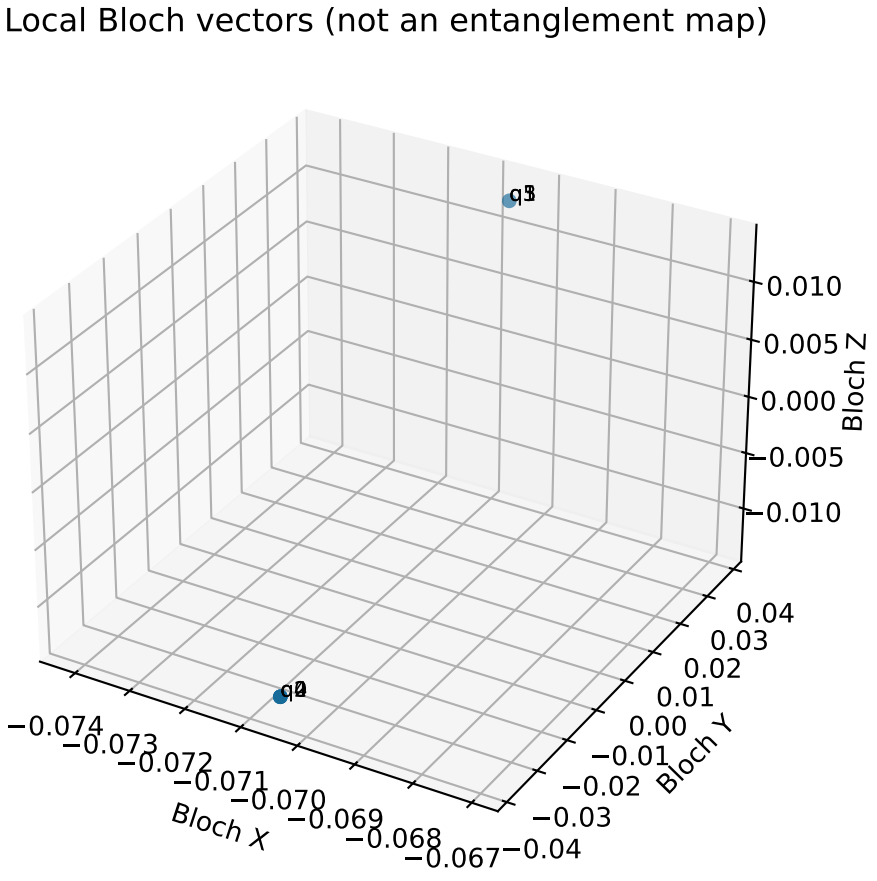
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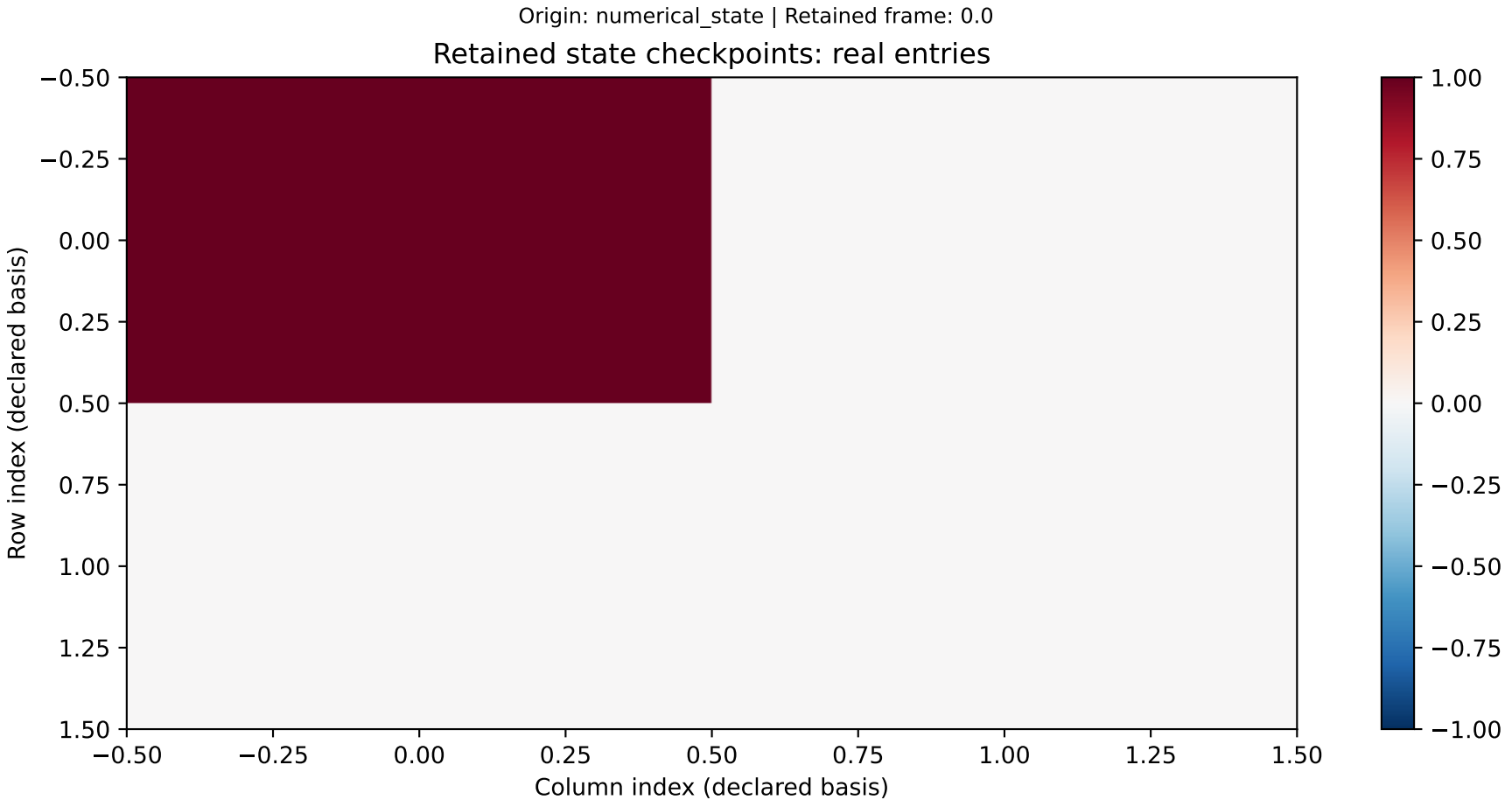


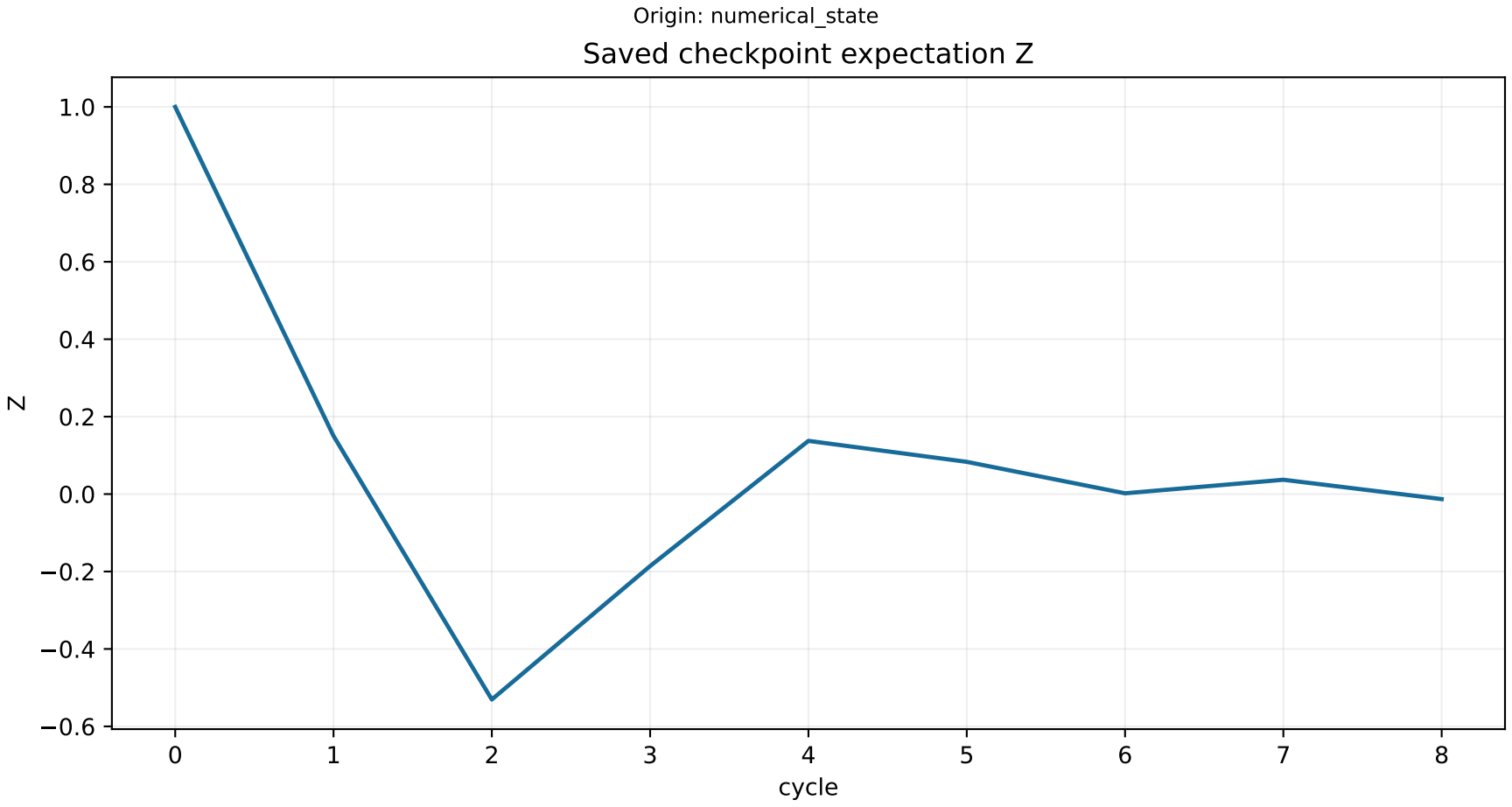

Origin: numerical_state
Retained state: real entries
Row index (declared basis)
Column index (declared basis)
0
10
20
30
40
50
60
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075


Origin: numerical_state
Retained state: imaginary entries
Row index (declared basis)
Column index (declared basis)
0
10
20
30
40
50
60
0.02
0.01
0.00
−0.01
−0.02

Origin: numerical_state




Origin: numerical_state | Retained frame: 0.0
Retained state checkpoints: real entries
Row index (declared basis)
Column index (declared basis)
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


Origin: numerical_state
Saved checkpoint expectation Z
Z
cycle
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
1
2
3
4
5
6
7
8