Executed Command
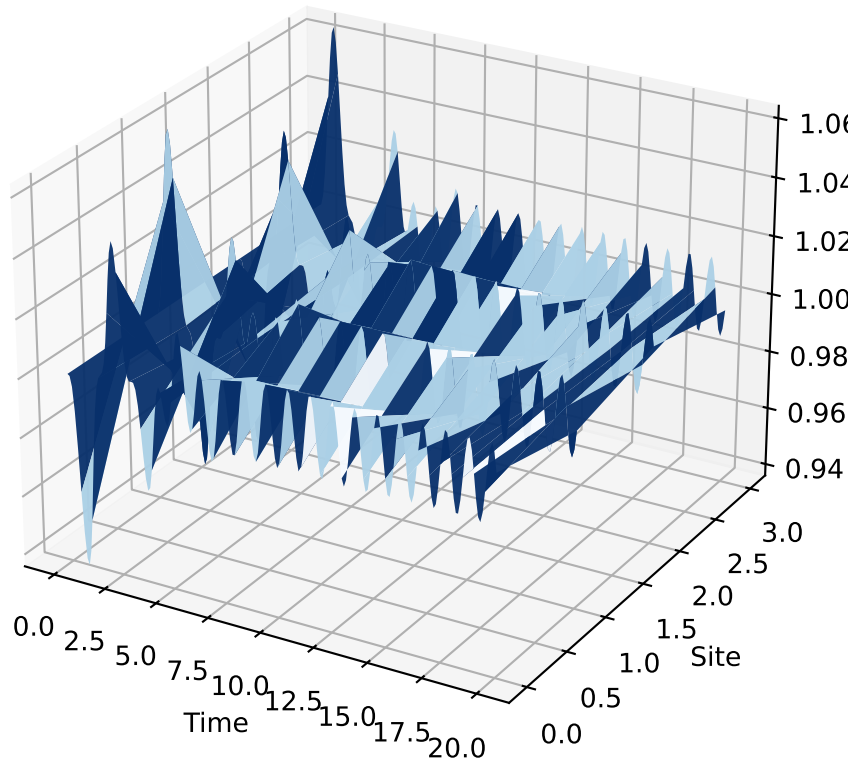
Reference: pipelines/PIPELINE_RUN_GUIDE.md
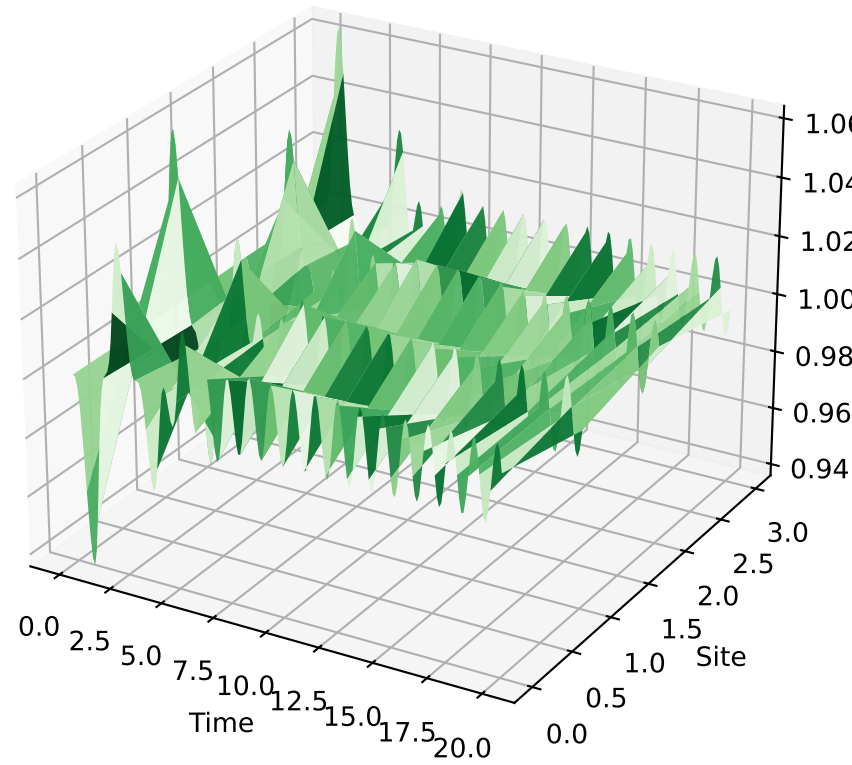Script: pipelines/hardcoded_hubbard_pipeline.py

```
/opt/anaconda3/bin/python pipelines/hardcoded_hubbard_pipeline.py --L 4 --t 1.0 --u 4.0 --dv 0.0 --boundary
  periodic --ordering blocked --enable-drive --drive-A 0.5 --drive-omega 2.0 --drive-tbar 3.0 --drive-phi 0.0
  --drive-pattern staggered --drive-time-sampling midpoint --drive-t0 0.0 --fidelity-subspace-energy-tol 1e-8
  --vqe-reps 4 --vqe-restarts 4 --vqe-maxiter 4000 --vqe-method COBYLA --vqe-seed 7 --t-final 20.0 --num-times
  201 --trotter-steps 256 --exact-steps-multiplier 3 --suzuki-order 2 --term-order sorted --skip-qpe --initial-
  state-source vqe --output-json artifacts/json/H_L4_vt_t1.0_U4.0_S256_dyn.json --output-pdf
  artifacts/pdf/H_L4_vt_t1.0_U4.0_S256_dyn.pdf
```
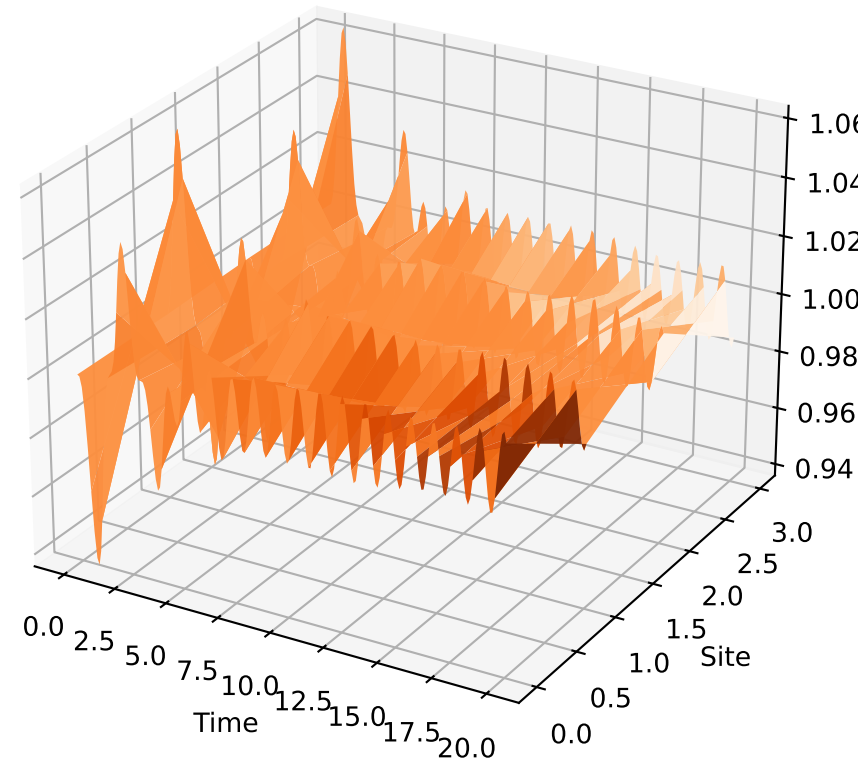
L=4 3D Densities (Total n)
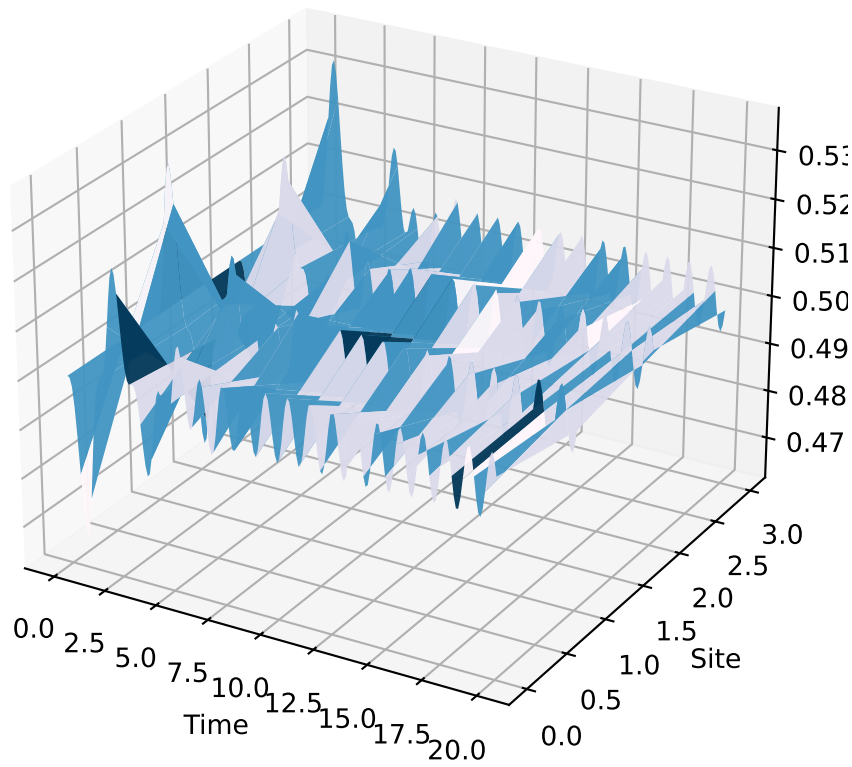
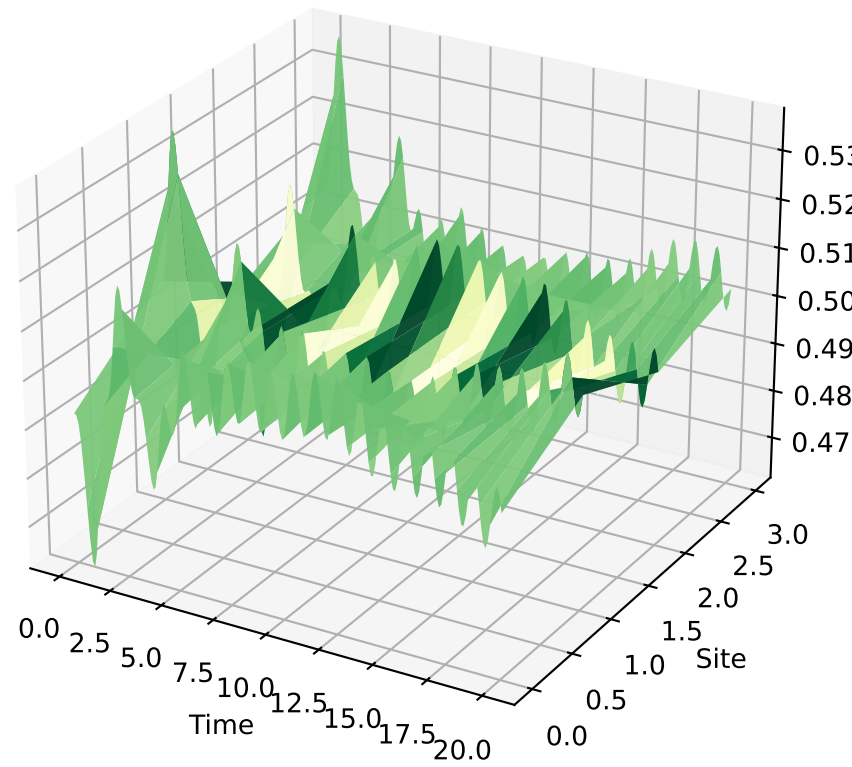Exact GS Filtered: n(site,t)　　　Exact Ansatz: n(site,t)　　　Trotter Ansatz: n(site,t)

L=4 3D Densities (Spin-Up)

Exact GS Filtered: n_up(site,t)

Exact Ansatz: n_up(site,t)

Trotter Ansatz: n_up(site,t)
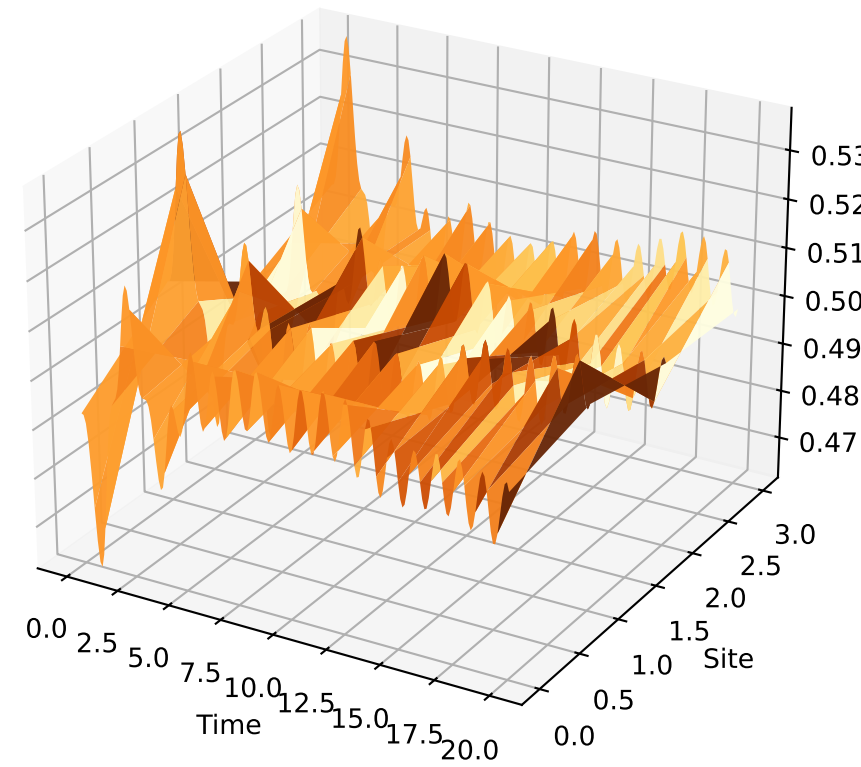
L=4 3D Densities (Spin-Down)

Exact GS Filtered: n_dn(site,t)
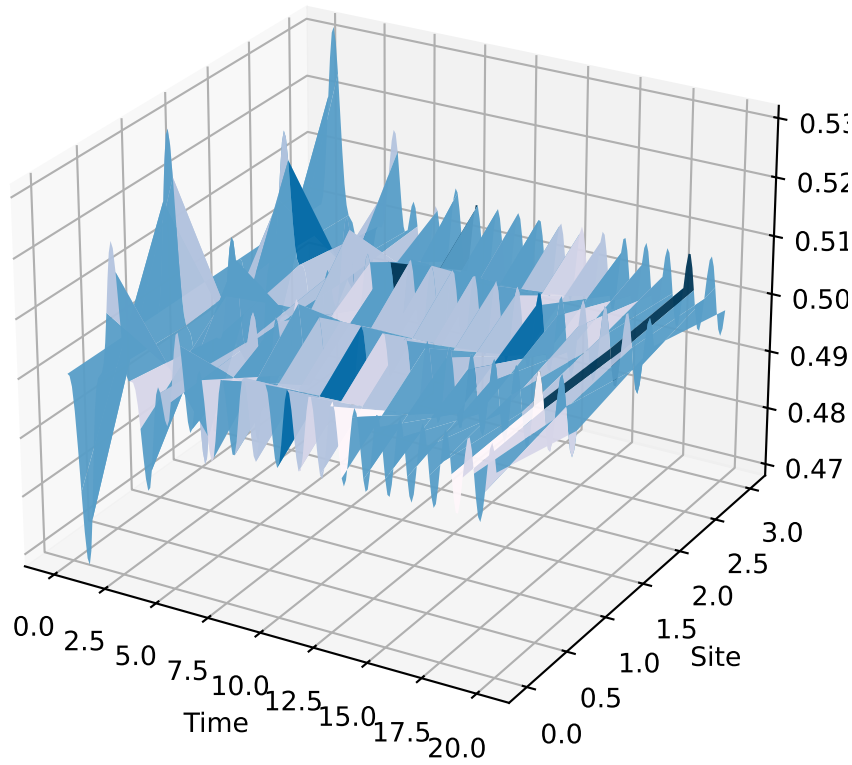
Exact Ansatz: n_dn(site,t)
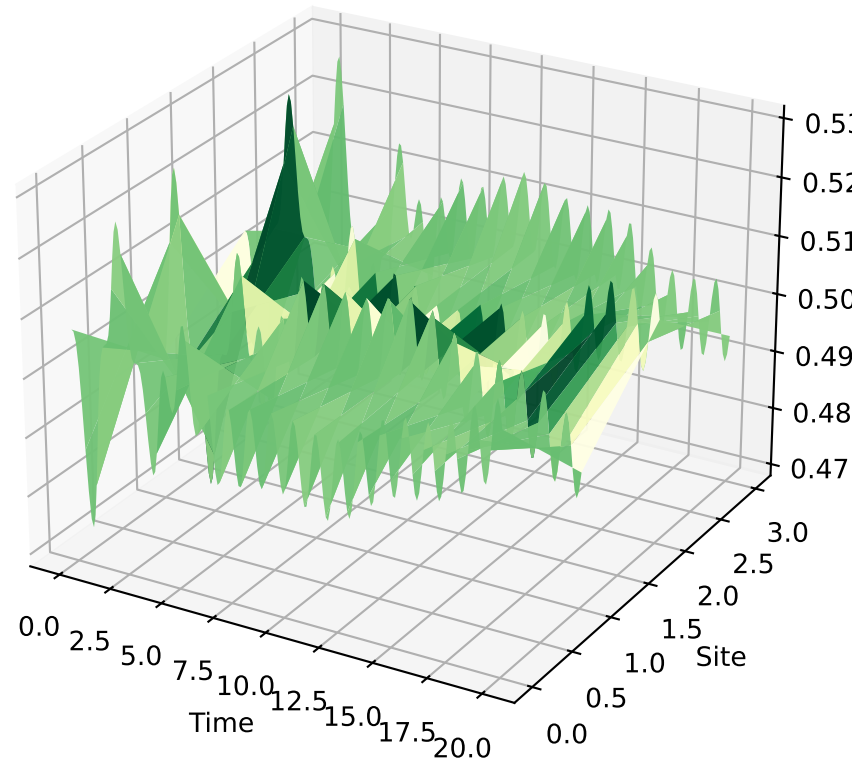
Trotter Ansatz: n_dn(site,t)
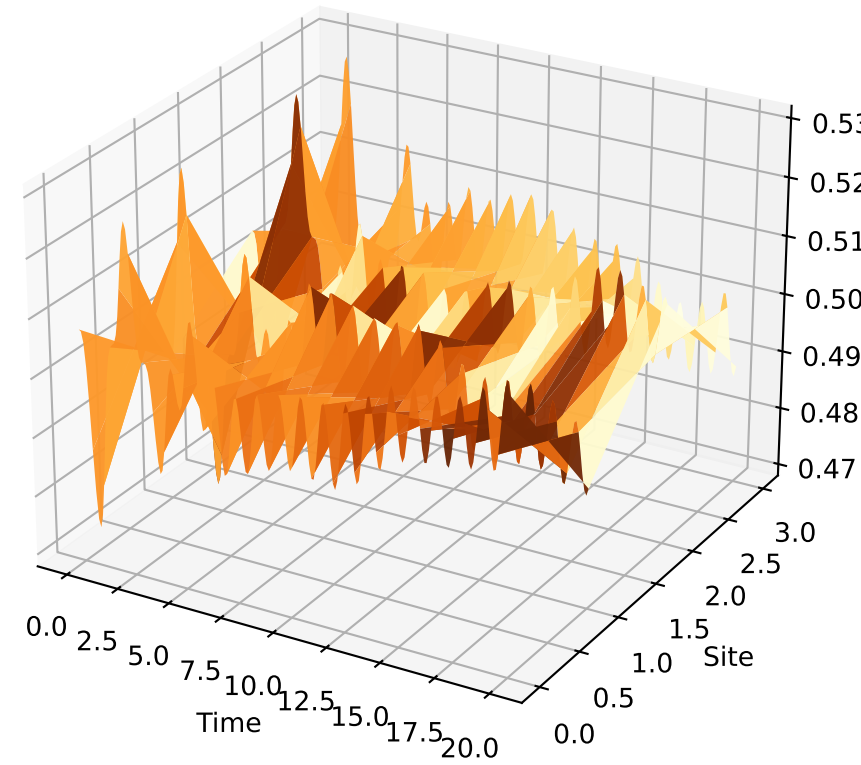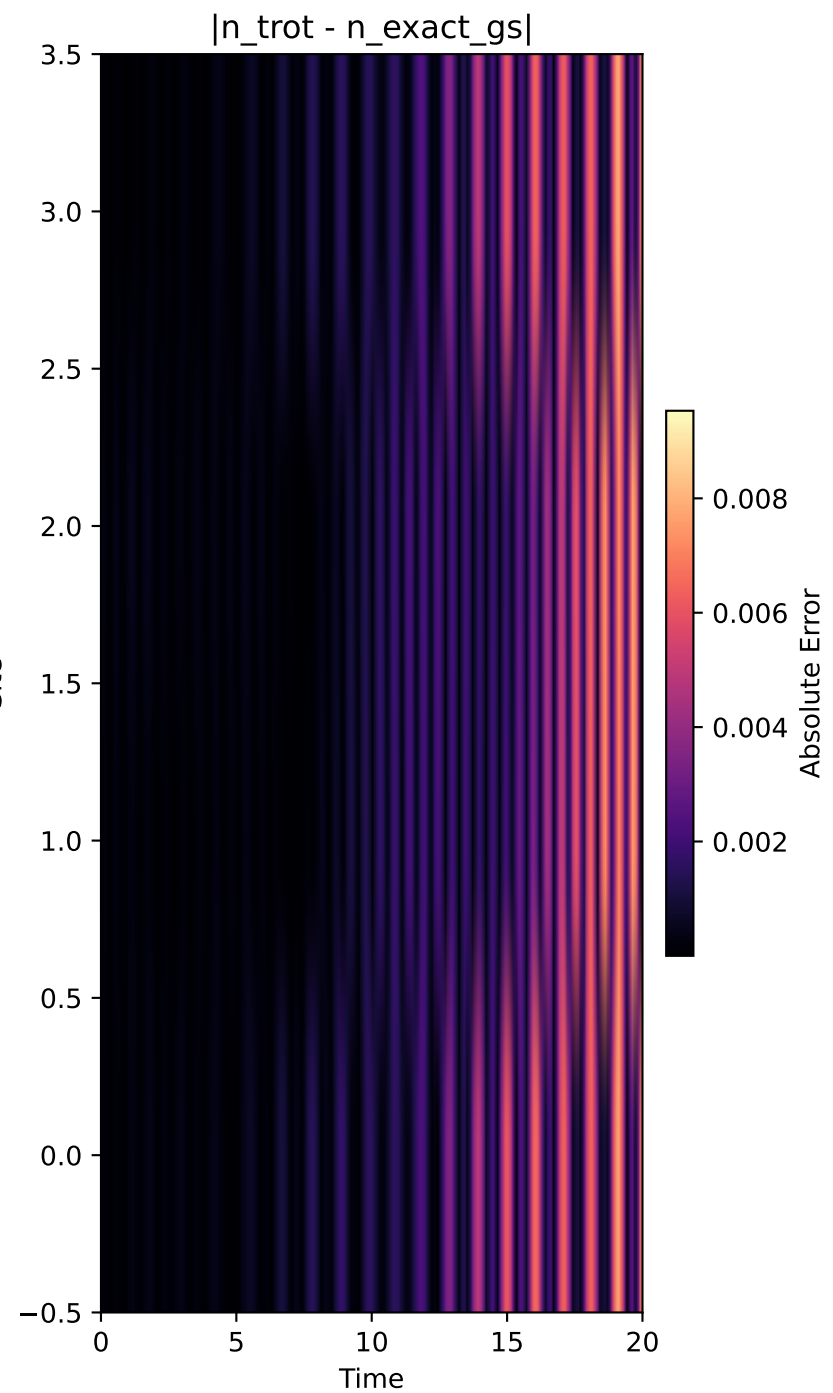
L=4 3D Scalar Observables (Three Evolutions)

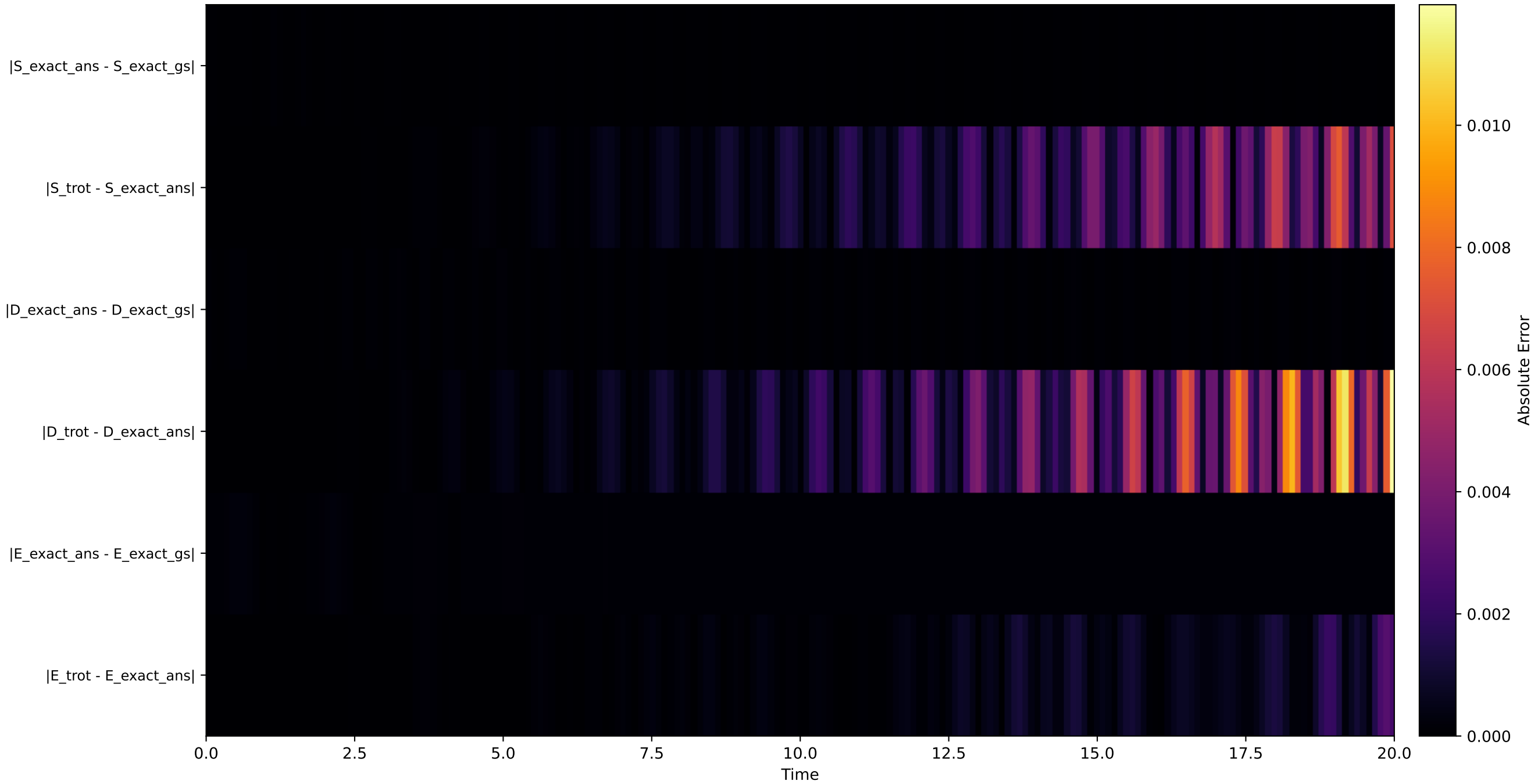3D Lanes: Total Energy

3D Lanes: Static Energy

3D Lanes: Doublon

3D Lanes: Staggered Order
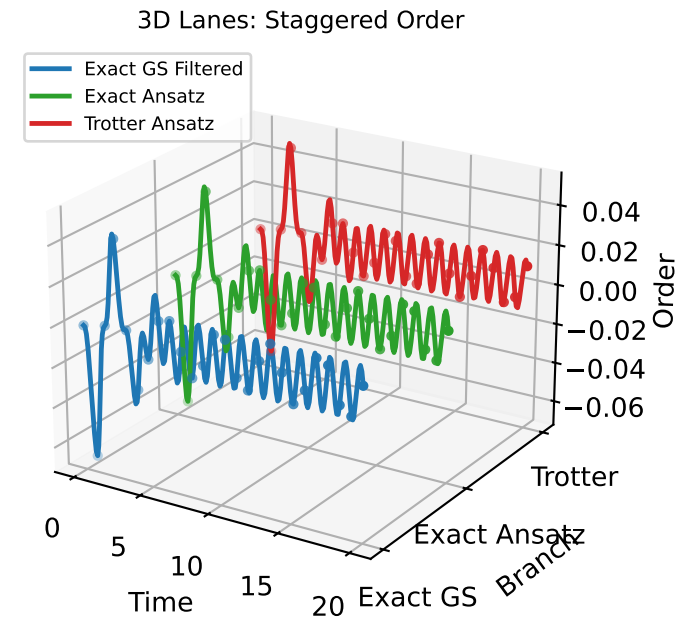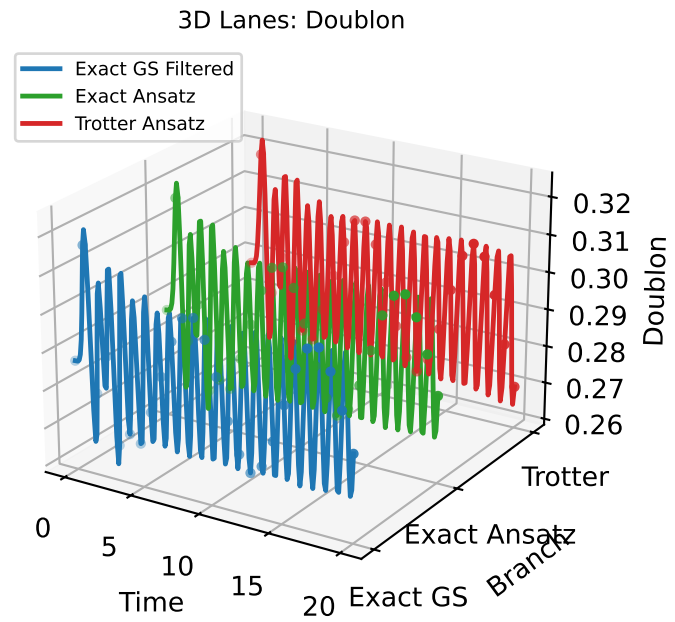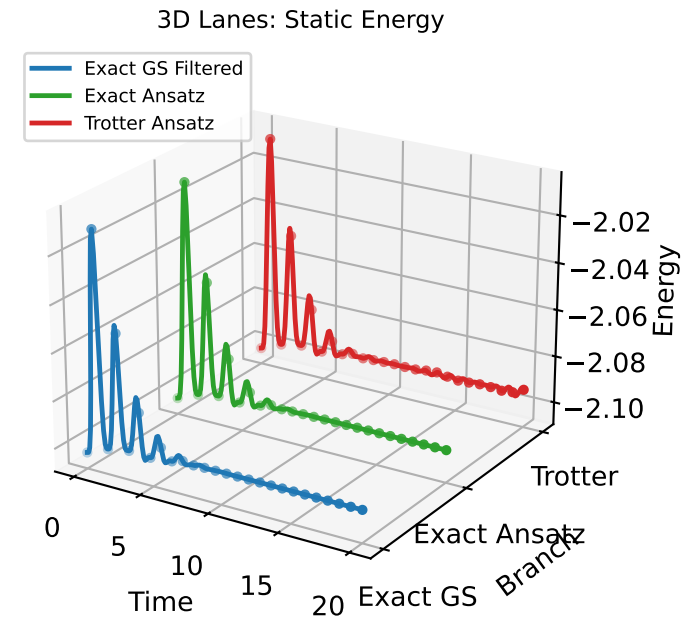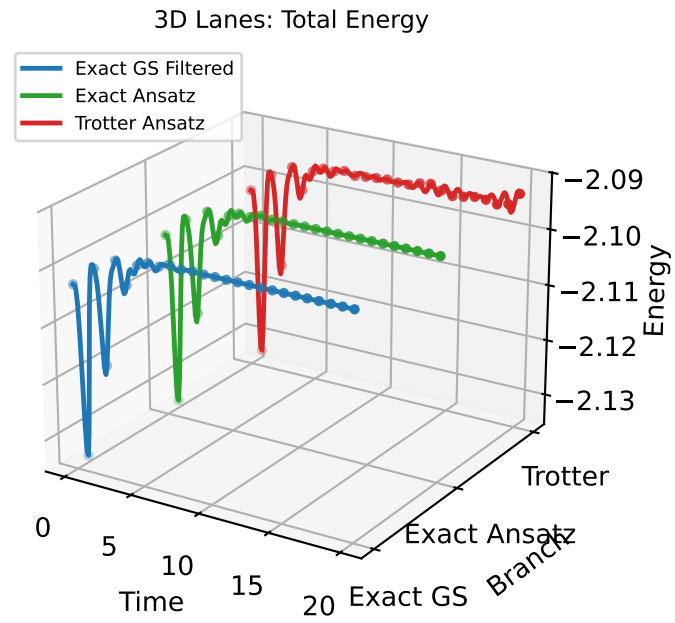
L=4 Error Heatmaps (Absolute Errors)
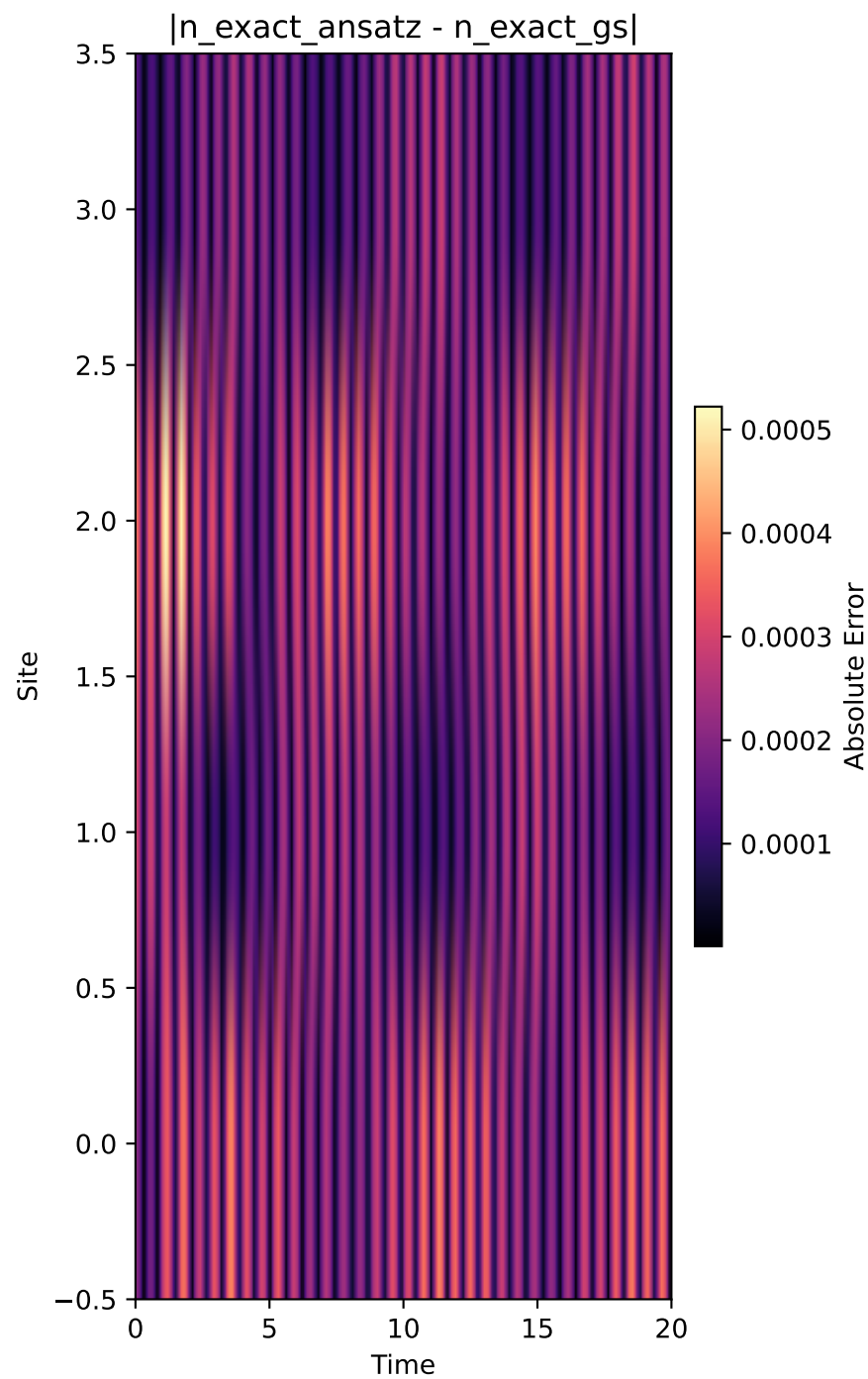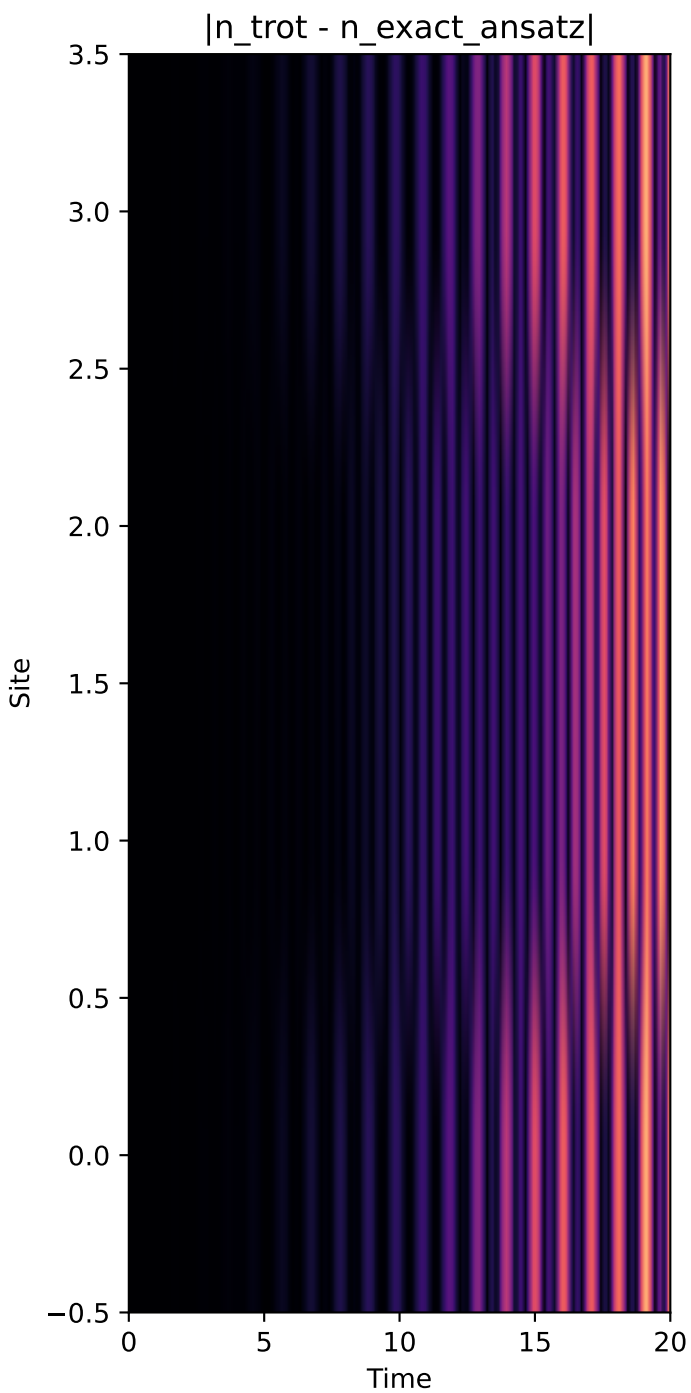
L=4 Scalar Error Heatmap

Absolute Error Heatmap (Scalar Observables)

Drive Diagnostics: A=0.5, omega=2.0, tbar=3.0, phi=0.0, t0=0.0
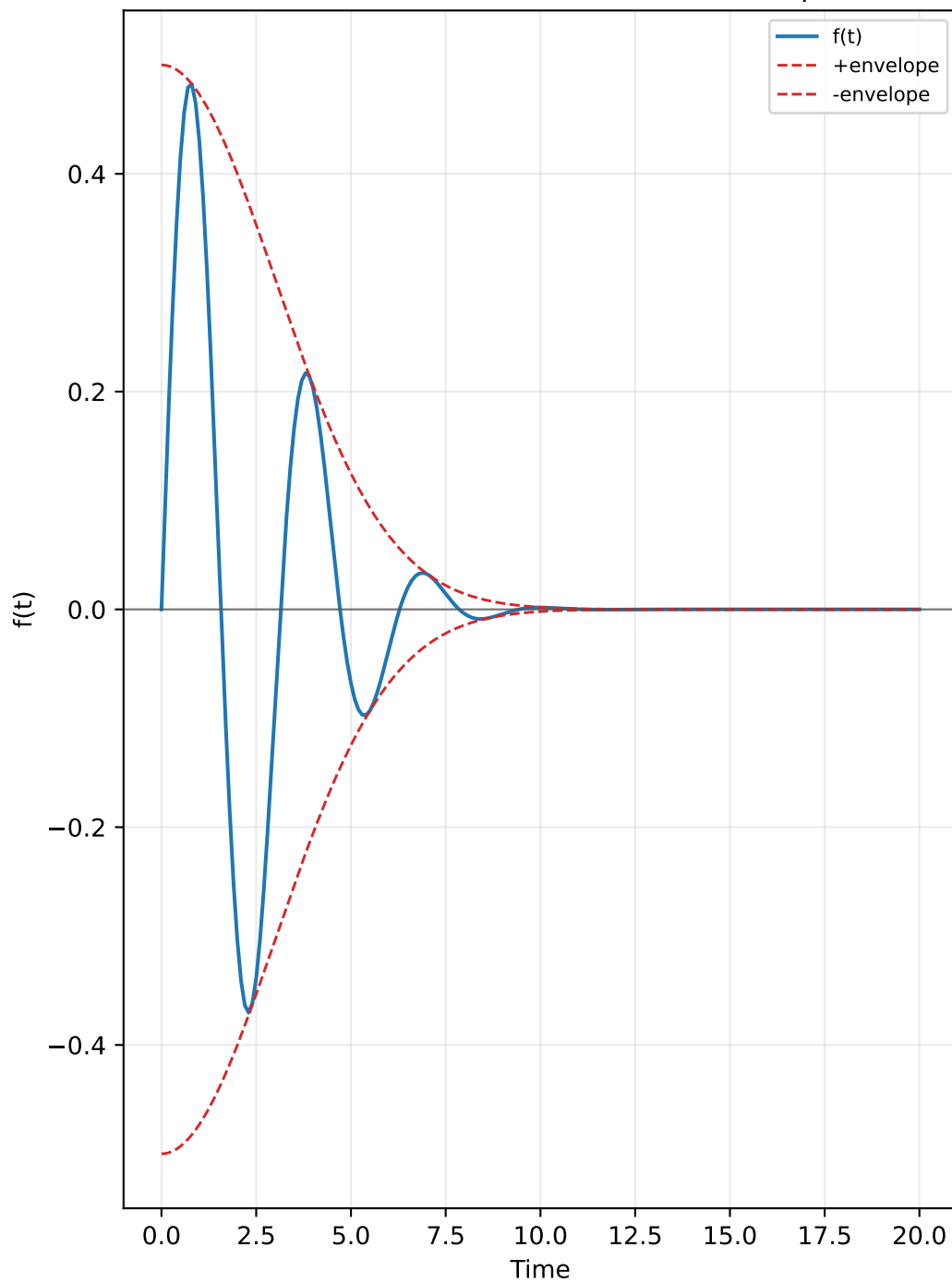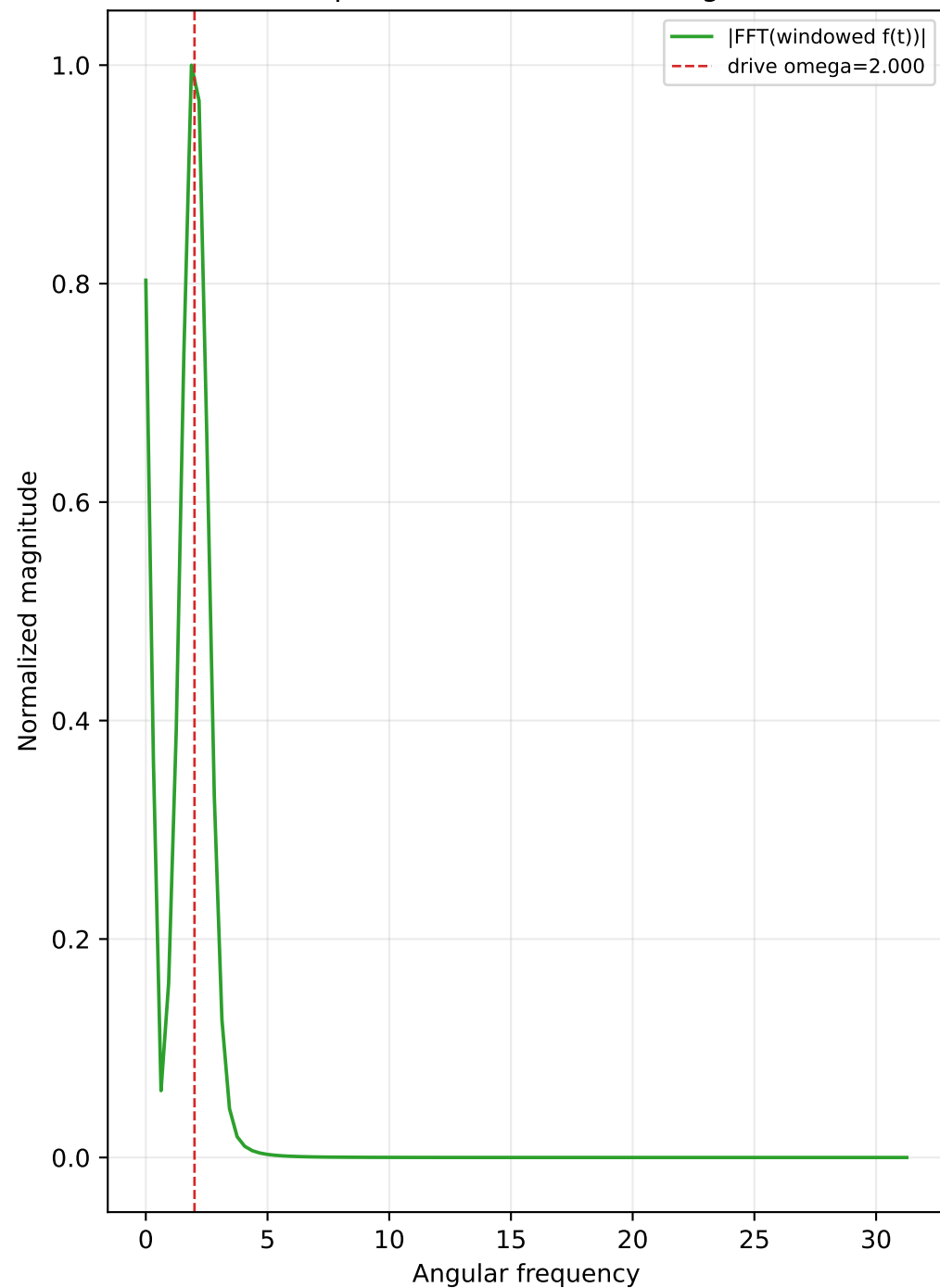
Hardcoded Hubbard Pipeline: L=4
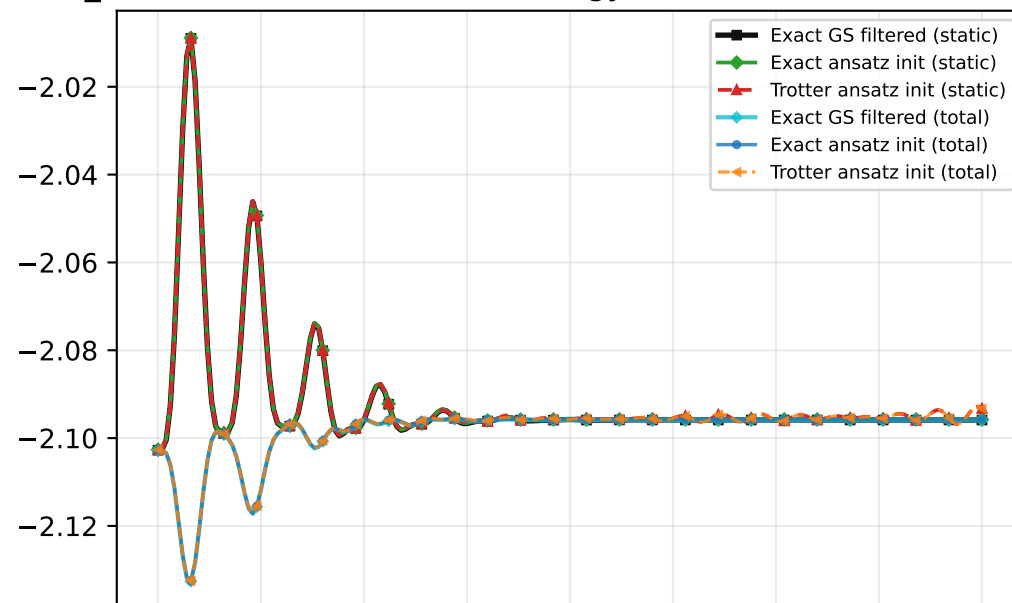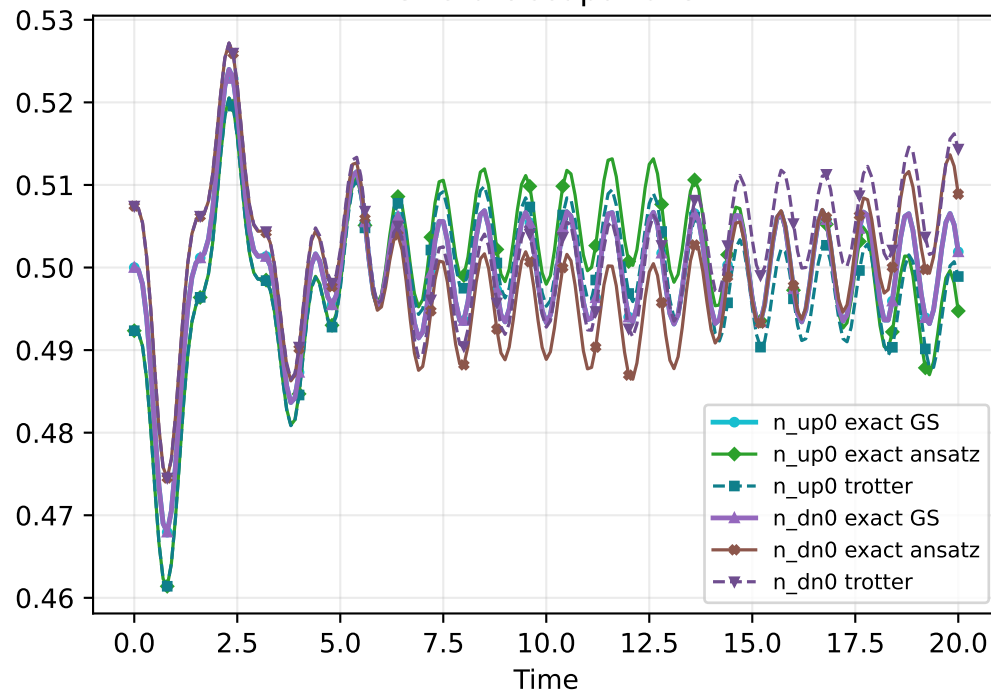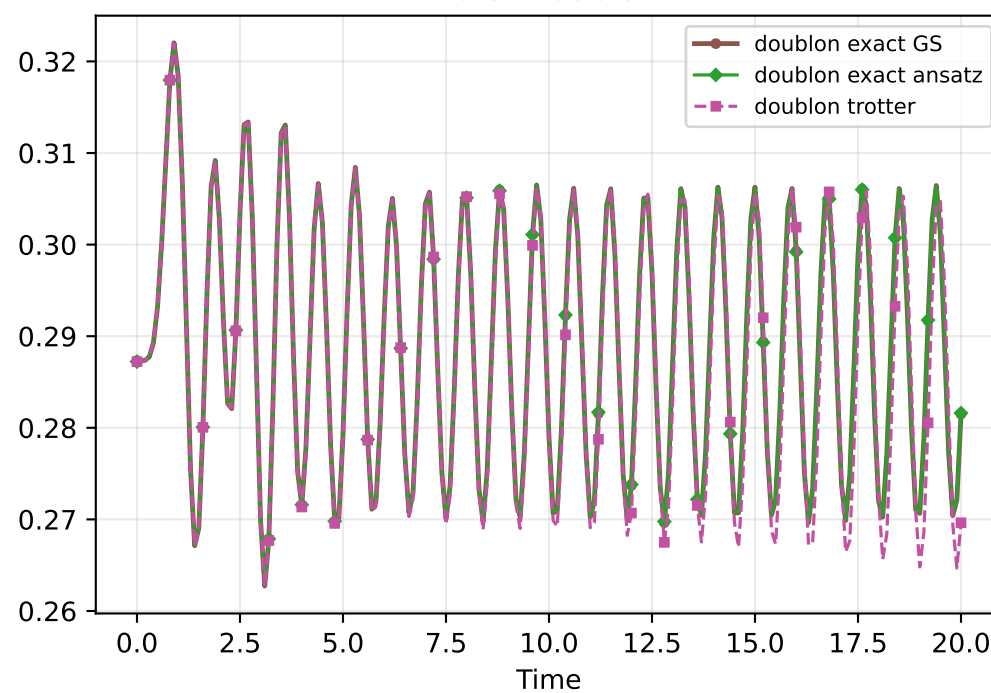
Appendix — L=4

This section contains supporting/redundant views and metadata.
Core non-redundant analysis appears earlier in the PDF.

VQE optimises within the half-filled sector; exact (filtered) is the true sector ground state.
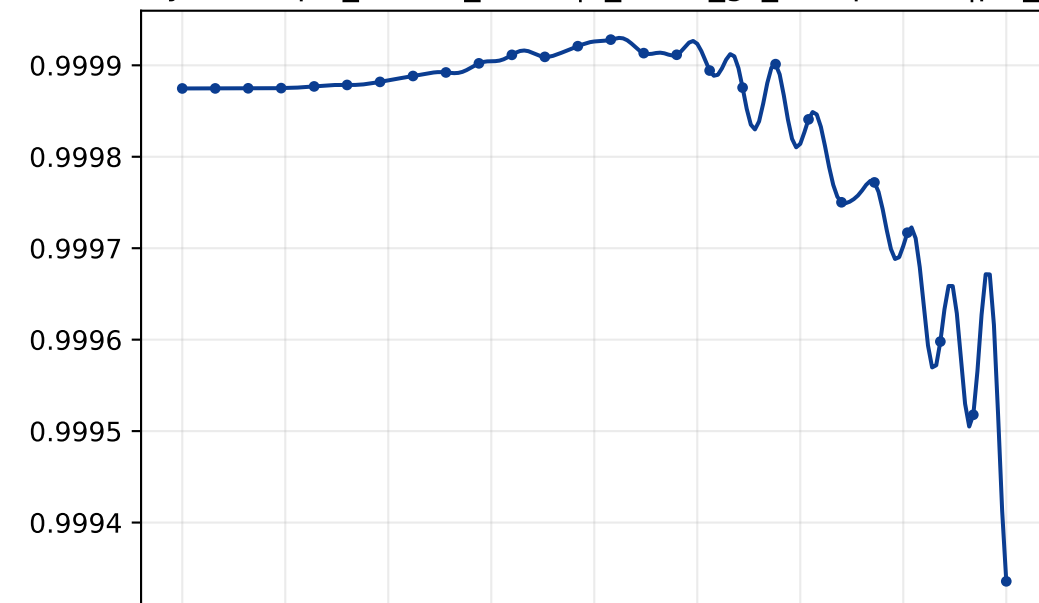Full-Hilbert exact energy is in the JSON text summary only.

VQE Energy vs Exact (filtered sector)
|VQE - Exact(filtered)| = 1.035e-04

Hardcoded Hubbard pipeline summary

settings: {"L": 4, "t": 1.0, "u": 4.0, "dv": 0.0, "boundary": "periodic", "ordering": "blocked", "t_final": 20.0, "num_times":
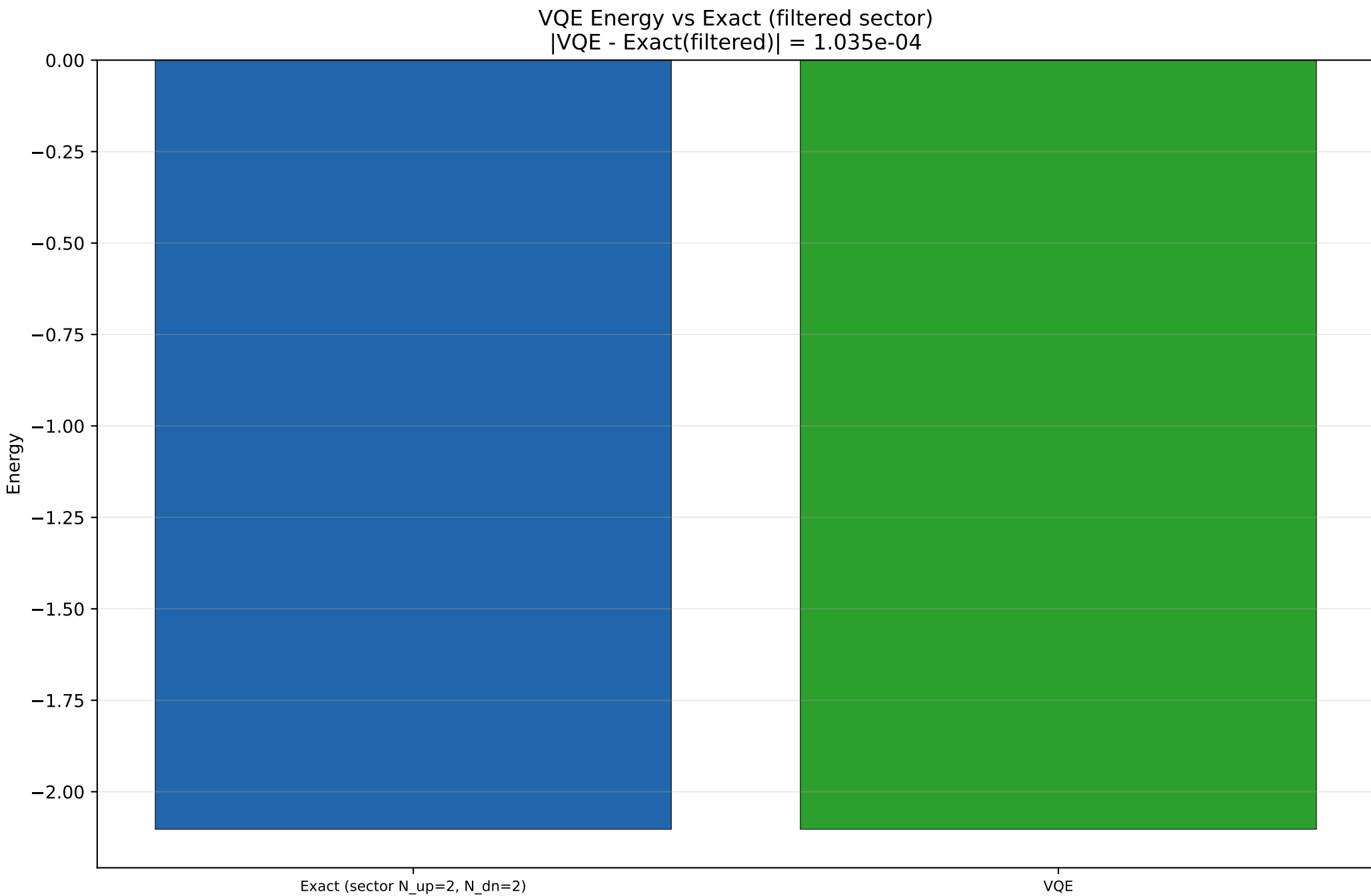exact_trajectory_label: Exact_Hardcode
exact_trajectory_method: python_matrix_eigendecomposition
fidelity_definition: fidelity(t) = <psi_ansatz_trot(t)|P_exact_gs_subspace(t)|psi_ansatz_trot(t)>, where P_exact_gs_subspace(t
subspace_fidelity_at_t0: 0.9998746882400258
energy_t0_exact_gs: -2.102748483462075
energy_t0_exact_ansatz: -2.1026450003175245
energy_t0_trotter: -2.1026450003175245
ground_state_exact_energy (full Hilbert): -3.418550718874
ground_state_exact_energy_filtered: -2.1027484834620753
filtered_sector: {'n_up': 2, 'n_dn': 2}
vqe_energy: -2.1026450003175046
qpe_energy_estimate: None
initial_state_source: vqe
hamiltonian_terms: 29
reference_sanity: {'checked': False, 'reason': 'no matching bundled reference for these settings'}