

README file

Dataset Title: “**QUANTHEM. Data for the basis-minimized stabilizer asymmetry in qubit systems. Version 1.**”

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Dataset Content

The dataset contains data generated in the framework of Horizon Europe ERC QUANTHEM project. The data were the result of numerical computations of nonstabilizerness for several classes of quantum states in qubit systems. Specifically, the data contains the value of the so-called basis-minimized stabilizer asymmetry and other nonstabilizerness measures, such as the stabilizer Rényi entropies.

The data are presented in the pre-print:

P. S. Tarabunga, M. Frau, T. Haug, E. Tirrito, and L. Piroli, *A Nonstabilizerness Monotone from Stabilizerness Asymmetry*, arXiv:2411.05766v1 (2025)

Dataset Documentation

The dataset consists of a .zip archive, named **QUANTHEM_BMSAsymmetry.zip**, containing 20 tabular quantitative data files saved in .txt format and a README file saved in .pdf format (**README_QUANTHEM.pdf**).

The data correspond to the numerical evaluation of analytic formulas describing the nonstabilizerness of quantum states. We have produced data for different families of quantum states and studied their behavior with the number of qubits.

The family of quantum states considered include: (A) product states of the form

$$|\psi\rangle = (|0\rangle + e^{i\theta}|1\rangle)^{\otimes N}$$

where N is the number of qubits and θ (theta) a rotation angle; (B) ground states of the one-dimensional quantum Ising model with both open and periodic boundary conditions [in the following, we denote by h the value of the transverse magnetic field in this model]; (C) states obtained by evolving a trivial product state via a random-Hamiltonian dynamics; (D) states obtained as the output of doped Clifford circuits, with a tunable density q of T-gates.

In the data files, we denote by α (alpha) the index of the basis-minimized stabilizer asymmetry, and by n the index of the stabilizer-Rényi entropy.

The 2 data files named:

QUANTHEM_A_versus_N_theta_pi_X.txt

(with $X=4,8$)

contain the basis-minimized stabilizer asymmetry for product states of N qubits and different angles theta. These data are obtained via an exact branch-and-bound numerical method.

The 4 data files named:

QUANTHEM_A_exact_versus_N_h_X.txt

(with $X=0.5, 0.8, 1.0, 1.5$)

contain the basis-minimized stabilizer asymmetry for the ground state of the quantum Ising chain with open boundary conditions, for the specified values of the field h . These data are obtained via an exact diagonalization numerical method.

The 4 data files named:

QUANTHEM_A_versus_N_h_X.txt

(with $X=0.5, 0.8, 1.0, 1.5$)

contain the basis-minimized stabilizer asymmetry for the ground state of the quantum Ising chain with open boundary conditions, for the specified values of the field h . These data are obtained via minimization of participation entropy. The third column in each file corresponds to the statistical error associated with the method used to compute the basis-minimized asymmetry.

The 2 data files named:

QUANTHEM_A_periodic_versus_h_N_X.txt

(with $X=8,9$)

contain the basis-minimized stabilizer asymmetry for the ground state of the quantum Ising chain with periodic boundary conditions vs the field h , for $N = 8, 9$. These data are obtained via an exact diagonalization numerical method.

The 4 data files named:

QUANTHEM_A_periodic_versus_h_N_X.txt

(with $X=8,9,12,14$)

contain the basis-minimized stabilizer asymmetry for the ground state of the quantum Ising chain with periodic boundary conditions vs the field h , for $N = 8,9,12,14$. These data are obtained via minimization of participation entropy. The third column in each file corresponds to the statistical error associated with the method used to compute the basis-minimized asymmetry.

The data file named:

QUANTHEM_GUEAsymmetryVSRobustness.txt

contains different measures of nonstabilizerness for states obtained by evolving a trivial product state via a random- Hamiltonian dynamics up to time t . The first column is the values of time t , while the other columns contain, respectively:

(A) the basis-minimized stabilizer asymmetry for $\alpha=1/2$; (B) the basis-minimized stabilizer asymmetry for $\alpha= 1$; (C) the basis-minimized stabilizer asymmetry for $\alpha=2$; (D) the log-robustness of nonstabilizerness; (E) the relative entropy of nonstabilizerness; (F) the min-relative entropy of nonstabilizerness. The number of qubits is $N = 3$, while the number of random samples is $M = 100$

The data file named:

QUANTHEM_CliffordTAsymmetryVSRobustness.txt

contains different measures of nonstabilizerness for states obtained by evolving a trivial product state via doped Clifford circuit with q T -gates per qubit. The first column is the values of time q , while the other columns contain:

(A) the basis-minimized stabilizer asymmetry for $\alpha=1/2$; (B) the basis-minimized stabilizer asymmetry for $\alpha= 1$; (C) the basis-minimized stabilizer asymmetry for $\alpha=2$; (D) the log-robustness of nonstabilizerness; (E) the relative entropy of nonstabilizerness; (F) the min-relative entropy of nonstabilizerness. The number of qubits is $N = 3$, while the number of random samples is $M = 100$

QUANTHEM_GUEAsymmetryVSSRE.txt

contains different measures of nonstabilizerness for staes obtained by evolving a trivial product state via a random-Hamiltonian dynamics up to time t . The first column is the value of time t , while the other columns contain:

(A) the basis-minimized stabilizer asymmetry for $\alpha=1/2$; (B) the basis-minimized stabilizer asymmetry for $\alpha= 1$; (C) the basis-minimized stabilizer asymmetry for $\alpha=2$; (D) the stabilizer Rényi entropy for $\alpha=1/2$; (E) the stabilizer Rényi entropy for $\alpha=1$; (F) the stabilizer Rényi entropy for $\alpha=2$. The number of qubits is $N = 3$, while the number of random samples is $M = 100$

QUANTHEM_CliffordTAsymmetryVSSRE.txt

contains different measures of nonstabilizerness for states obtained by evolving a trivial

product state via doped Clifford circuit with q T-gates per qubit. The first column is the values of q , while the other columns contain:

(A) the basis-minimized stabilizer asymmetry for $\alpha=1/2$; (B) the basis-minimized stabilizer asymmetry for $\alpha=1$; (C) the basis-minimized stabilizer asymmetry for $\alpha=2$; (D) the stabilizer Rényi entropy for $\alpha=1/2$; (E) the stabilizer Rényi entropy for $\alpha=1$; (F) the stabilizer Rényi entropy for $\alpha=2$. The number of qubits is $N = 3$, while the number of random samples is $M = 100$

Methodology

All the data were obtained by numerical computations.

The data contained in

QUANTHEM_A_versus_N_theta_pi_X.txt (with $X=4,8$)

were obtained using an exact branch-and-bound numerical method.

The data contained in

QUANTHEM_A_exact_versus_N_h_X.txt (with $X=0.5, 0.8, 1.0, 1.5$)

QUANTHEM_A_periodic_versus_h_N_X.txt (with $X=8,9$)

QUANTHEM_GUEAsymmetryVSRobustness.txt

QUANTHEM_CliffordTAsymmetryVSRobustness.txt

QUANTHEM_GUEAsymmetryVSSRE.txt

QUANTHEM_CliffordTAsymmetryVSSRE.txt

were produced using an exact "brute-force" method, based on a state-vector representation the qubit Hilbert space.

The data contained in

QUANTHEM_A_versus_N_h_X.txt (with $X=0.5, 0.8, 1.0, 1.5$)

QUANTHEM_A_periodic_versus_h_N_X.txt (with $X=8,9$)

were produced using an estimation via minimization of the participation entropy, which comes with a statistical error (reported in the data set). The method was introduced and fully explained in the pre-print

P. S. Tarabunga, M. Frau, T. Haug, E. Tirrito, and L. Piroli, *A Nonstabilizerness Monotone from Stabilizerness Asymmetry*, arXiv:2411.05766v1 (2025)

Notes

The data are further explained and presented in the pre-print:

P. S. Tarabunga, M. Frau, T. Haug, E. Tirrito, and L. Piroli, *A Nonstabilizerness Monotone from Stabilizerness Asymmetry*, arXiv:2411.05766 v1 (2025)