Numerical study of hypergraph product codes

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Résumé

Hypergraph product codes introduced by Tillich and Zémor are a class of quantum LDPC codes with constant rate and distance scaling with the square-root of the block size. Quantum expander codes, a subclass of these codes, can be decoded using the linear time small-set-flip algorithm of Leverrier, Tillich and Zémor. In this work, we estimate numerically the performance for the hypergraph product codes under independent bit and phase flip noise. We focus on a family of hypergraph product codes with rate 1/61∼1.6% and report that the threshold is at least 4.5% for the small-set-flip decoder. We also show that for similar rate, the performance of the hypergraph product is better than the performance of the toric code as soon as we deal with more than 1600 logical qubits and that for 14400 logical qubits, the logical error rate for the hypergraph product code is several orders of magnitude smaller.

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