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Performance analysis of fault-tolerant quantum error correction against non-Clifford errors[1] TAKANORI SUGIYAMA, Dep. of Systems Innovation, Osaka University, KEISUKE FUJII, Photon Science Center, The University of Tokyo, HARUHISA NAGATA, FUYUHIKO TANAKA, Dep. of Systems Innovation, Osaka University — As error rates of quantum gates implemented in recent experiments approach a fault-tolerant threshold of a 2D planer surface code against a depolarizing noise model, it becomes more important to investigate performance of quantum error correction codes against more general and realistic noise models. A brute-force simulation for the investigation on a classical computer requires an exponential amount of memory, and we need alternative methods for the purpose. The standard approach assuming depolarizing (or Clifford) error models, which is not realistic, can overestimate the performance, and it is not valid to apply the results to experiments. On the other hand, a rigorous approach with the diamond norm is applicable to realistic error models but greatly underestimates the performance and is not practical. Here we propose a new theoretical framework for evaluating performances of quantum error correction, which is practical and applicable to a wider class of error models. We apply the method to a quantum 1D repetition code, and numerically evaluate the performance.

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