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**Error correction with quantum low-density parity check codes**[1]

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We study quantum low-density parity check (LDPC) codes and their fault tolerance. We show that any family of quantum LDPC codes where each syndrome measurement involves a limited number of qubits, and each qubit is involved in a limited number of measurements (as well as any similarly-limited family of classical LDPC codes), where distance scales as a positive power of the number of physical qubits, has a finite error probability threshold. We conclude that for sufficiently large quantum computers, finite-rate quantum LDPC codes can offer an advantage over the toric codes. Error correction in the presence of errors in syndrome measurements is also addressed. We discuss possible realizations of decoders and their error thresholds, e.g. in relation to LDPC versions of the quantum hypergraph-product codes [1] and their generalizations [2].

[1] J.P. Tillich, G. Zemor, in Proc. IEEE Int. Symp. Inf. Theory (ISIT), 799 (2009).
[2] A. A. Kovalev and L. P. Pryadko, in Proc. IEEE Int. Symp. Inf. Theory (ISIT), 348 (2012).

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