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Resilient Quantum Computation in Correlated Environments: A Quantum Phase Transition Perspective EDUARDO NOVAIS, Duke University, EDUARDO R. MUCCIOLO, University of Central Florida, HAROLD U. BARANGER, Duke University — The 'threshold theorem' is a central result in the theory of quantum error correction. It was derived initially for a stochastic error model, but relentless effort has been dedicated to including correlated errors. Here, we demonstrate that a large class of correlated error models is reduced to the simple stochastic model in the asymptotic limit of large number of qubits or long time. Thus, in order to prove the resilience of the quantum information for these models, we can fall back on the traditional derivation of the threshold theorem. Because the conditions for this fall back have clear parallels with the theory of quantum phase transitions, we rephrase the threshold theorem as a dimensional criterion: (1) For systems above their "critical dimension", the traditional proof of resilience is valid, and there are two regimes, or phases, as a function of the coupling with the environment. (2) However, when the system is below its "critical dimension", correlations produce large corrections, and it is not possible to prove resilience by our arguments.

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