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**Uncorrectable Errors in a Quantum Error Correction Code: The Limits of Resilient Quantum Computation in Correlated Environment** E. NOVAIS, UFABC (Brazil) and Duke University, E. R. MUCCIOLO, University of Central Florida, HAROLD U. BARANGER, Duke University — In general, Quantum Error Correction (QEC) cannot perfectly protect quantum information. Errors that keep the logical qubit inside the logical Hilbert space lead to "uncorrectable errors"; indeed, in most physical systems, this situation is the rule rather than the exception. We show that such uncorrectable errors change the conditions required for resilient quantum computation in correlated environments. Although QEC effectively reduces the coupling constant between the quantum computer and the environment, there are two distinct behaviors for the effect of noise in the long-time limit: (i) If the qubits are separated by a certain minimum distance, QEC changes the infrared behavior of the noise in favor of resilience [as derived in PRL 98, 040501 (2007) and PRA 78, 012314 (2008)]. (ii) If the qubits are not separated by that minimum distance, then the noise at low frequencies and long wave lengths reduces the time evolution of the computer to that of the bare system (i.e., without QEC). In this case, QEC provides no real advantage. We illustrate this point by calculating the entropy produced by uncorrectable errors, and then provide an upper bound on how long a quantum computation can be performed with a relatively high chance of success.

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