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Adiabatic Surface Code Quantum Computing CHRIS CESARE, CQuIC, University of New Mexico, DAVE BACON, Department of Computer Science & Engineering, University of Washington, STEVE FLAMMIA, Perimeter Institute for Theoretical Physics, ANDREW LANDAHL, Sandia National Laboratories, ALICE NEELS, Department of Computer Science & Engineering, University of Washington — There are many approaches to constructing a quantum computer. In addition to the numerous different physical substrates available, there are a plethora of different underlying computational architectures from which to choose. Two major classes of architectures can be distinguished: those requiring a substantial external active control system to suppress errors, and those whose underlying physical construction eliminates much, if not all, of the need for such a control system. Here we focus on the latter class of architectures and address the question: "How does one fault-tolerantly quantum compute on a system protected from decoherence by a static Hamiltonian?" We present a solution that adiabatically interpolates between static Hamiltonians, each of which protects the quantum information stored in its ground space. Since each of these ground spaces can be described as a quantum error-correcting codespace, we call this process adiabatic code deformation. After describing a particular surface code (the toric code) and the way to encode information in code defects, we give explicit adiabatic interpolations that effect braids between defects, allowing for a CNOT gate between encoded qubits. We finish by describing how to extend our procedures to allow for universality.

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