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Flux-controlled quantum computation with Majorana zero modes
TIMO HYART, BERNARD VAN HECK, ION COSMA FULGA, Instituut-Lorentz, Universiteit Leiden, MICHELE BURRELLO, Max Planck Institute of Quantum Optics, ANTON R. AKHMEROV, Delft University of Technology, CARLO W.J. BEENAKKER, Instituut-Lorentz, Universiteit Leiden — Majorana zero modes, exotic quasiparticles which are their own antiparticles, can be constructed out of electron and hole excitations in topological superconductors. Because widely separated Majorana zero modes can store quantum information nonlocally and their non-Abelian braiding statistics allows accurate quantum gates, Majorana zero modes offer a promise for topological quantum computation. The coupling of Majorana zero modes to superconducting transmon qubits permits braiding of Majoranas and readout operations by external variation of magnetic fluxes. We identify the minimal circuit for the demonstration of the non-Abelian Majorana statistics and discuss the possible limitations which might hinder the braiding operation. A key benefit of our approach is that the whole operation is performed at the electrical circuit level, without requiring local control of microscopic parameters. Finally, we take a longer term perspective and introduce the Random Access Majorana Memory, a scalable circuit that can perform a joint parity measurement on Majoranas belonging to a selection of topological qubits. Such multi-qubit measurements allow for the efficient creation of highly entangled states and simplify quantum error correction protocols by avoiding the need for ancilla qubits.

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