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Majorana Fermion Surface Code for Universal Quantum Computation SAGAR VIJAY, TIM HSIEH, LIANG FU, MIT — We introduce an exactly solvable model of interacting Majorana fermions realizing Z_2 topological order with a Z_2 fermion parity grading and lattice symmetries permuting the three fundamental anyon types. We propose a concrete physical realization by utilizing quantum phase slips in an array of Josephson-coupled mesoscopic topological superconductors, which can be implemented in a wide range of solid state systems, including topological insulators, nanowires or two-dimensional electron gases, proximitized by s-wave superconductors. Our model finds a natural application as a Majorana fermion surface code for universal quantum computation, with a single-step stabilizer measurement requiring no physical ancilla qubits, increased error tolerance, and simpler logical gates than a surface code with bosonic physical qubits. We thoroughly discuss protocols for stabilizer measurements, encoding and manipulating logical qubits, and gate implementations.

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