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The surface code with a twist THEODORE YODER, MIT, ISAAC H. KIM, IBM — The surface code is one of the most successful approaches to topological quantum error-correction. It boasts the smallest known syndrome extraction circuits and correspondingly largest thresholds. Defect-based logical encodings of a new variety called twists have made it possible to implement the full Clifford group on surface codes without state distillation. Here we investigate a patch-based encoding involving a modified twist. The resulting codes, called triangle codes for the shape of their planar layout, have only weight-four checks and relatively simple syndrome extraction circuits, maintaining a high, near surface-code-level threshold. They also use 25% fewer physical qubits per logical qubit than the surface code. Moreover, benefiting from the twist, we can implement all Clifford gates by lattice surgery without the need for state distillation. By a surgical transformation to the surface code, we also develop a scheme of doing the same gates on surface code patches in an atypical planar layout, though with less qubit efficiency. Finally, we remark that logical qubits encoded in triangle codes are naturally amenable to logical tomography, and the smallest triangle code can demonstrate high-pseudothreshold fault-tolerance to depolarizing noise using just 13 physical qubits.

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