

Abstract Submitted  
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**Optimization of topological quantum algorithms using Lattice Surgery is hard** DANIEL HERR, FRANCO NORI, SIMON DEVITT, RIKEN - Saitama — The traditional method for computation in the surface code or the Raussendorf model is the creation of holes or "defects" within the encoded lattice of qubits which are manipulated via topological braiding to enact logic gates. However, this is not the only way to achieve universal, fault-tolerant computation. In this work we turn attention to the Lattice Surgery representation, which realizes encoded logic operations without destroying the intrinsic 2D nearest-neighbor interactions sufficient for braided based logic and achieves universality without using defects for encoding information. In both braided and lattice surgery logic there are open questions regarding the compilation and resource optimization of quantum circuits. Optimization in braid-based logic is proving to be difficult to define and the classical complexity associated with this problem has yet to be determined. In the context of lattice surgery based logic, we can introduce an optimality condition, which corresponds to a circuit with lowest amount of physical qubit requirements, and prove that the complexity of optimizing the geometric (lattice surgery) representation of a quantum circuit is NP-hard.

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