Local Equivalence of Surface Code States

Pradeep Sarvepalli[1] and Robert Raussendorf[1]

[1]Department of Physics and Astronomy, University of British Columbia, Vancouver

The LU-LC conjecture states that two stabilizer states are local unitary equivalent if and only if they are local Clifford equivalent. In light of its recent refutation, one is prompted to ask if there exist counterexamples to the LU-LC conjecture among prominent classes of stabilizer states such as the surface code states. In this paper we show that under minimal restrictions surface code states do not contain any counterexamples to the LU-LC conjecture. In the process we show that surface codes do not have any encoded non-Clifford transversal gates. We then show that CSS surface code states can be associated to a class of minor closed binary matroids. This association is useful in that it provides us with an efficient test to rule out many CSS states as being counterexamples to the LU-LC conjecture.