ICMAT
INSTITUTO DE CIENCIAS MATEMÁTICAS

SPECIAL COLLOQUIUM

Quantum Circuits, Cellular Automata and Tensor Networks

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Quantum computers employ quantum circuits to implement algorithms. They are composed of quantum gates that act on near neighbors according to some spatial geometry. They are particular instances of quantum cellular automata (QCA), the set of operators whose action respects both locality and causality. I will show that QCAs can be effectively represented in terms of tensor networks in any spatial dimension. As a result, they obey an area law for the entanglement entropy they can create. Then, I will generalize these notions in two different ways: (i) by replacing unitary operators by quantum channels, i.e., operations that do not preserve the purity of states; (ii) by including local measurements assisted by classical communication. In the first case, the resulting operations still comply with an area law for the mutual information they can create but, in general, cannot be efficiently expressed as tensor networks. In the second, they can still give rise to unitary dynamics but cannot be described in terms of QCA in general.

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