Disproving the Peres conjecture by showing Bell nonlocality from bound entanglement

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Quantum entanglement and quantum nonlocality are among the most central phenomena in the field of quantum information theory, being responsible for the advantage of quantum protocols over classical ones for information processing. Although related, the exact connection between these two concepts is still not completely understood. In 1999, Peres conjectured that nonlocal correlations could only be observed on quantum states with distillable entanglement. Since there exist undistillable states, called bound entangled states, if Peres conjecture was true it would mean that this class of states would be useless for any quantum information protocols that require nonlocality.

In their work, Vertesi and Brunner disprove the Peres conjecture by showing that bipartite bound entangled state can violate a Bell inequality, that is, it shows nonlocal correlations although it is not possible to distill its entanglement. This work also solves a long-standing conjecture in the field.

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