Quantum Physics

Classical Interaction Cannot Replace Quantum Nonlocality

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We present a two-player communication task that can be solved by a protocol of polylogarithmic cost in the simultaneous message passing model with classical communication and shared entanglement, but requires exponentially more communication in the classical interactive model.

Our second result is a two-player nonlocality game with input length n and output of polylogarithmic length, that can be won with probability 1-o(1) by players sharing polylogarithmic amount of entanglement. On the other hand, the game is lost with probability $\Omega(1)$ by players without entanglement, even if they are allowed to exchange up to k bits in interactive communication for certain $k \in \Omega(n^{1/4})$.

These two results give almost the strongest possible (and the strongest known) indication of nonlocal properties of two-party entanglement.

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