

An energetic constraint for qubit-qubit entanglement

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We analyze qubit-qubit entanglement from an energetic perspective and reveal an energetic trade-off between quantum coherence and entanglement. We decompose each qubit internal energy into a coherent and an incoherent component. The qubits' coherent energies are maximal if the qubit-qubit state is pure and separable. They decrease as qubit-qubit entanglement builds up under locally- energy-preserving processes. This yields a “coherent energy deficit” that we show is proportional to a well-known measure of entanglement, the square concurrence. In general, a qubit-qubit state can always be represented as a mixture of pure states. Then, the coherent energy deficit splits into a quantum component, corresponding to the average square concurrence of the pure states, and a classical one reflecting the mixedness of the joint state. Minimizing the quantum deficit over the possible pure state decompositions yields the square concurrence of the mixture. Our findings bring out new figures of merit to optimize and secure entanglement generation and distribution under energetic constraints.

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