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Upper and Lower Concurrence Bounds of Entanglement Swapping of Two Bell-Diagonal States BRIAN KIRBY, SIDDHARTHA SANTRA, VLADIMIR MALINOVSKY, MICHAEL BRODSKY, U.S. Army Research Laboratory — Entanglement swapping is one of the basic operations of a quantum network. While the swapping is easily understood for fully entangled states, it is less well understood for partially mixed states. A particularly important class of mixed states which we will consider are the Bell-diagonal states, comprising a mixture of the pure Bell states. Bell-diagonal states are versatile as they can range from completely mixed to completely pure and from zero to perfect entanglement. Also Bell-diagonal states have well defined entanglement measures, such as concurrence. Therefore, an understanding of entanglement swapping with Bell-diagonal states is essential to quantum information processing and the realization of quantum networks. Here we rigorously treat the result of swapping of two, generally different, partially mixed, Bell-diagonal states and present numerical bounds on the its concurrence. In addition, we give an analytical solution for the concurrence of the state resulting from the swapping of two identical rank-two Bell-diagonal states in terms of the concurrence of the input states. Our results provide a simple method for analyzing the performance of quantum networks which utilize entanglement swapping of Bell-diagonal states.

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