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Persistent Tensors: Multiqudit Version of Multiqubit W State and Multiqudit Entanglement Transformation

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We construct a lower bound of the tensor rank for a class of tensors that we call them persistent tensors. In this class, there is a specific subclass of tensors that the lower bound is tight. Indeed, this subclass is n-qudit version of n-qubit W states (we call them n-qudit M states denoted by $|\mathrm{M}(d,n)\rangle$ and we have $\mathcal{M}(2,n) = \mathcal{W}_n$). Consequently, we show that one can obtain n-qudit M states from a generalized n-qudit GHZ state via asymptotic Stochastic Local Operations and Classical Communication (SLOCC) with a rate approaching unity. We also show that the tensor rank of Kronecker product, and hence, tensor product of m-qudit GHZ and n-qudit M states is equal to the product of their tensor ranks, i.e., $R\big(\mathcal{G}(d_1,m)\otimes\mathcal{M}(d_2,n)\big) = d_1\big((n-1)d_2 - n + 2\big)$.

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