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Metrological usefulness of entanglement and nonlinear Hamiltonians

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A central task in quantum metrology is to exploit quantum correlations to outperform classical sensitivity limits. Metrologically useful entanglement is identified when the quantum Fisher information (QFI) exceeds a separability bound for a given parameter-encoding Hamiltonian. However, so far, only results for linear Hamiltonians are well-established. Here, we characterize metrologically useful entanglement for nonlinear Hamiltonians, presenting separability bounds for collective angular momenta. Also, we provide a general expression for entangled states maximizing the QFI, showing that these are not always GHZ-like states. Finally, we compare the metrological usefulness of linear and nonlinear cases, in terms of entanglement detection and random symmetric states.

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