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Quantum Metrology with Product States[1] ANIMESH DATTA, SERGIO BOIXO, University of New Mexico, STEVEN FLAMMIA, Perimeter Institute, Waterloo, ANIL SHAJI, CARLTON CAVES, University of New Mexico, EMILIO BAGAN, Universitat Autònoma de Barcelona — We study the performance of initial product states of n-body systems in generalized quantum metrology protocols that involve estimating an unknown coupling constant in a nonlinear k-body ($k \ll n$) Hamiltonian. We obtain the theoretical lower bound on the uncertainty in the estimate of the parameter. For arbitrary initial states, the lower bound scales as $1/n^k$, and for initial product states, it scales as $1/n^{k-1/2}$. We show that the latter scaling can be achieved using simple, separable measurements. We formulate a simple model, based on the evolution of angular-momentum coherent states, which explains the $O(n^{-3/2})$ scaling for $k = 2$, implementable with Bose-Einstein condensates; the model shows that the entanglement generated by the quadratic Hamiltonian does not play a role in the enhanced sensitivity scaling. We show that phase decoherence does not affect the $O(n^{-3/2})$ sensitivity scaling for initial product states.

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