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Optimal and near-optimal probe states for quantum metrology of number conserving two-mode bosonic Hamiltonians[1] TYLER VOLKOFF, KonKuk Univ — We derive families of optimal and near-optimal probe states for quantum estimation of the coupling constants of a general two-mode number-conserving bosonic Hamiltonian describing one-body and two-body dynamics. For $su(2)$ dynamics and for interactions diagonal in the basis of Dicke states, families of superpositions of antipodal $SU(2)$ coherent states maximize the quantum Fisher information appearing in the quantum Cramer-Rao bound. For nonlinear tunneling processes such as pair tunneling and density-dependent single particle tunneling, respectively, we present new classes of variational superposition probe states that provide near perfect saturation of the corresponding quantum Cramer-Rao bounds. We show that the ground state of a pair tunneling Hamiltonian exhibits high fidelity with an optimal state for estimation of a single particle tunneling amplitude, and thereby conclude that a high-performance probe state for tunneling amplitude estimation may be produced by tuning the two-mode system through a quantum phase transition.

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