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Useful Entanglement in Quantum Metrology

Entanglement is the key quantum resource for improving measurement sensitivity beyond classical limits. Yet, not all entangled states are equally useful for metrological purposes: the "useful" ones are those, and only those, which have a Fisher information larger than the number of particles (or qubits) [1,2]. It is thus clear that devising model-independent theoretical tools to guide the experimental extraction of the Fisher information is of crucial interest in quantum metrology. In this talk I will review the theory and discuss a recent experiment with Bose-Einstein condensates of a large number of atoms [3] where the Fisher information has been obtained via particle counting and without access to the full density matrix. I will finally illustrate the creation and detection of useful entanglement in Rydberg atoms systems [4].

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