Creating NOON states in a free oscillation atom interferometer

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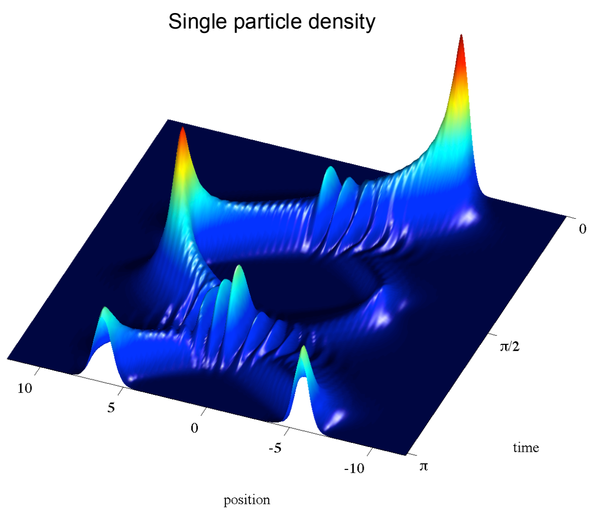
Mesoscopic superposition states utilising ultracold atoms have recently become an exciting field when discussing atomic interferometry schemes. Unlike photons the finite mass of ultracold atoms can increase the sensitivity of the measurements of an unknown phase. Quantum correlations also play a key role in these measurements, and due to advances in manipulating single atoms and tuning interactions via feshbach resonances the creation of entanglement in ultracold gases is an achievable resource. The quantum fisher information (QFI) is a metric that allows us to estimate how accurately a given state can measure an unknown parameter. We assess the value of the states generated via the atomic interferometer in quantum metrology by calculating the QFI [1].

In this work I will present a simple model which incorporates the interferometry process in the dynamics of the harmonic oscillator. Based on the free oscillation atom interferometer [2], two interacting bosons in one dimension scatter off a delta function barrier acting as a beamsplitter. After one oscillation the scattered bosons scatter off the barrier again to complete the interferometry procedure. Through the one-dimensional scattering length the initial correlations of the atoms can be varied and the tunneling probabilities can be tuned by adjusting the delta barrier height. By varying these parameters a wide range of interesting and useful states can be easily generated, including the NOON state, which maximizes the QFI and is the foremost state in quantum metrology.



References:
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