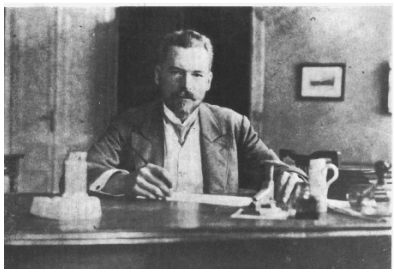

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Two distinguishable impurities in BEC: squeezing and entanglement of two Bose polarons

Monday, September 3, 2018 3:15 PM (20 minutes)

We apply the quantum open system formalism to describe the physics of two impurities immersed in a Bose-Einstein condensate. Here, the impurities are considered to be two quantum Brownian particles interacting with a bath of oscillators corresponding to the Bogoliubov modes of the condensate. We characterize the dynamics of the Brownian impurities with Langevin-like quantum stochastic equations carrying an account of memory effects. The Langevin equations are solved to evaluate the covariance matrix. We find that the presence of the bath induces an interaction between the impurities, which leads to entanglement among them. Whether or not the impurities are trapped in an external potential gives rise to different behaviours of such entanglement: (i) In the absence of external potential, we observe sudden death of entanglement, i.e., entanglement disappears at long enough times; (ii) In the presence of external harmonic potential, entanglement survives even at asymptotic time limit. Our study puts the behaviour of entanglement under scrutiny and captures its response to experimentally tunable parameters.
Besides entanglement, we study the squeezing as well. Interestingly, we find that the mean-square-displacement is super-diffusive, which as we prove, is due to non-Markovianity of the dynamics. Further, a full analysis of squeezing is provided, which explains how experimentally tunable parameters create or destroy squeezing. We emphasize that all of our analysis is rigorously obtained from a realistic physical model; in particular, we avoid manipulating it by introducing artificial Hamiltonians, or by introducing arbitrary spectral densities.

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