Quantum non-Gaussian force sensing

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Abstract

The talk will report recent theoretical and experimental achievements opening the door to highly non-Gaussian quantum sensing of single-atom motion. This territory is challenging for investigation, both theoretically and experimentally. We will present recent theoretical and laboratory achievements, mainly the experimental tests of quantum non-Gaussian phononic (Fig.1,2) and photonic states suitable beyond the classical method [1,2,3,4] and their applications in force sensing [5,6,7]. The talk will conclude with other related results and the following challenges in theory and experiments with atoms, mechanical oscillators and superconducting circuits to stimulate discussion and further development of this advancing and prospective field.

References

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Figures

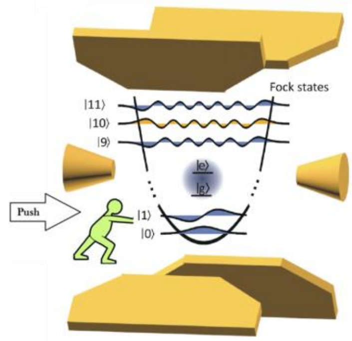

Figure 1: The mechanical force sensing of the axial harmonic motion of a single Calcium ion localized in a linear Paul trap. The generation and analysis of states approaching idealized Fock states illustrated by their corresponding wave functions are implemented by interacting the electronic ground and metastable states with the quantized harmonic motion on the first motional sidebands. The external force action coherently or thermally pushes the axial motion.

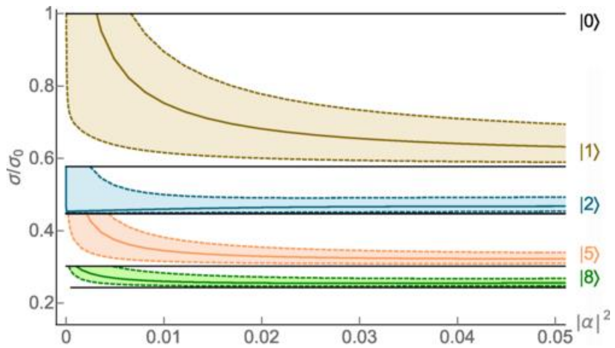

Figure 2: Estimating the metrological advantage of experimentally realized states for sensing a small force. The horizontal axis quantifies the amplitude in the phase space that the force causes. The vertical axis shows the minimal standard deviation estimated by optimization of the Fisher information in Eq. (3) normalized to sensing using a motional ground state. The black lines show that ratio for ideal Fock states. The brown, blue, orange and green solid curves correspond to prepared states approaching the Fock states with n=1,2,5,8, respectively. The coloured regions show the states with the phonon-number distributions within experimental error bars.