Revealing quantum statistics using ancilla-assisted measurements in a Yb-Ba trapped-ion system

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A major challenge in obtaining quantum statistics is that measurement disturbs a quantum state. We propose an ancilla-assisted measurement scheme to detour the measurement-induced back-action, which can be applied for any multi-point measurements. The quantum statistics is reconstructed by performing sequential positive-operator-valued measurements at each time and weighting their outcomes differently. In a Yb-Ba ion trap system, two and three-point quantum correlation functions and quasi-probability distributions [1-3] are reconstructed from experimental data. The nonclassical feature of quantum statistics is captured by the negativity in the joint quasi-probability distribution and the violation of the Leggett-Garg inequality [4].
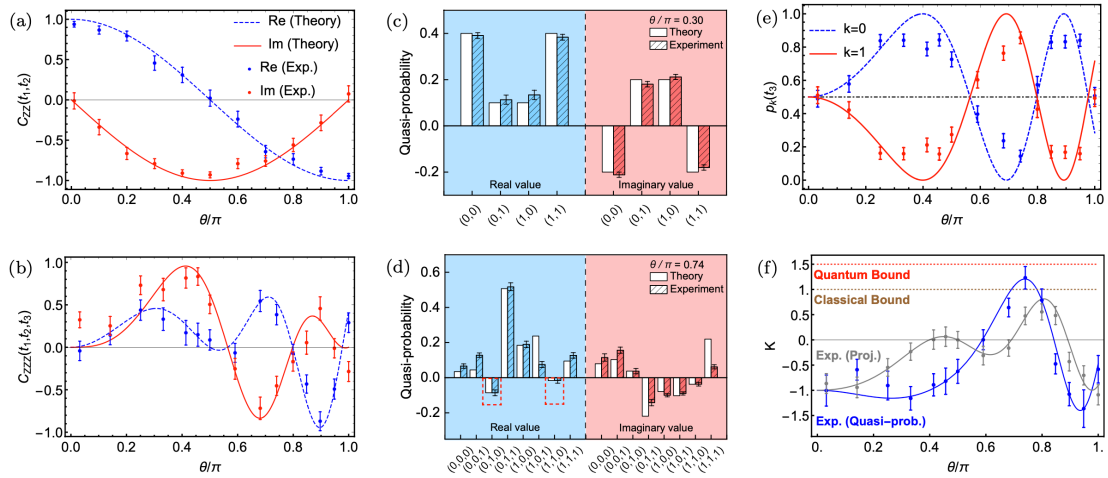
Figure 1. Experimentally reconstructed two-and three-point correlation functions (a & b) and quasi-probability distribution (c & d). (e) Marginal distribution at the final point follows quantum mechanical prediction without measurement backaction. (f) Leggett-Garg inequality violation from the real part of the quasi-probability distribution.

Preprint reference: [5]

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