Hot Schrödinger Cat States

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Abstract

The observation of quantum phenomena often necessitates sufficiently pure states, a requirement that can be challenging to achieve. In this study, we prepare a non-classical state originating from a mixed state, utilising dynamics that preserve the initial purity of the state (i.e. without removing entropy or purifying the system with measurement). We generate a Schrödinger cat state within a circuit quantum electrodynamics setup [1], in which a transmon is coupled to a high coherence microwave cavity. We initialise the cavity with a thermal state of up to n_{th}=7.6(2) average photons or mode temperature of up to 1.8 Kelvin, which is sixty times hotter than its physical environment. Hot Schrödinger's cat states are deterministically prepared with two protocols [2,3] (Figures 1 and 2). Our realisation of non-pure but quantum coherent superposition states could guide the preparation of similar states in other continuous-variable quantum systems. Wigner function measurements confirm the quantum coherent nature of the prepared states through the observation of interference fringes and Wigner negativities.

References

[1] M. Reagor et al., Phys. Rev. B, 94 (2016) 014506
[2] Z. Leghtas et al., Phys. Rev. A, 87 (2013) 042315
[3] A. Eickbusch et al., Nat. Phys. 18 (2022) 1464-1469

Figures

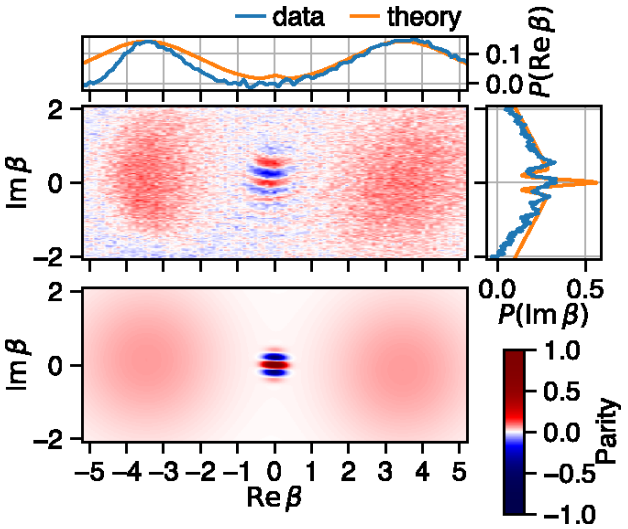

Figure 1: Starting from an initial thermal state with nth = 3.48(7), the result of the Wigner function measurement on the hot Schrödinger cat states prepared with the qcmap protocol [2] are shown together with the numerically obtained marginal distributions. For comparison, we plot the corresponding theoretical Wigner functions.

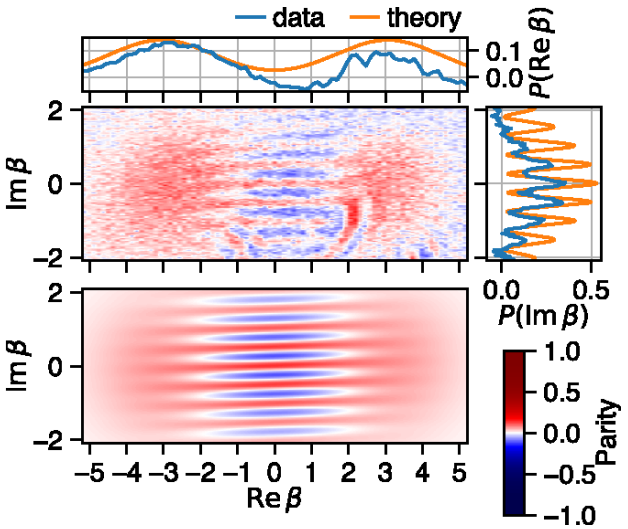

Figure 2: : Starting from an initial thermal state with nth = 3.48(7), the result of the Wigner function measurement on the hot Schrödinger cat states prepared with the echo conditional displacement protocol [3] are shown together with the numerically obtained marginal distributions. For comparison, we plot the corresponding theoretical Wigner functions