Exciton-Polariton Quantum Optics with Thermal Squeezed States

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Quantum states of light are essential for many applications seeking to benefit from the peculiar properties of quantum mechanics, including sensing, communication, detection, and quantum information, to name just a few. Nonlinear processes are required to generate quantum states. In this regard, exciton-polaritons are an attractive platform for quantum optics due to their large nonlinearity, which arises from polariton-polariton interactions. Indeed, squeezing has already been demonstrated [1, 2].

Less explored is how nonlinearities might aid in the task of quantum state recognition, which to date is almost universally achieved via homodyne detection, a linear process. Recently, several theoretical works have explored the possibility of using neural networks of interacting polaritons as a novel, and perhaps advantageous, reservoir computing platform to characterize quantum states of light [3, 4].

Such networks require training. Consequently, their use requires the availability of a readily tunable class of quantum states. Squeezed states, for which the noise on some quadrature is less than the standard quantum limit, can be difficult to generate and cumbersome to manipulate, as losses must be strictly avoided. To alleviate these constraints, we demonstrate the generation of an analogous class of states - thermal squeezed states - which we realize by adding a small excess of white noise to an arbitrarily chosen quadrature. The realized states are characterized via optical homodyne tomography, which permits the reconstruction of their Wigner functions [5], as shown in Fig. 1.

We will report the first results from an experiment in which thermal squeezed states are injected into a planar semiconductor microcavity of strongly coupled exciton-polaritons.

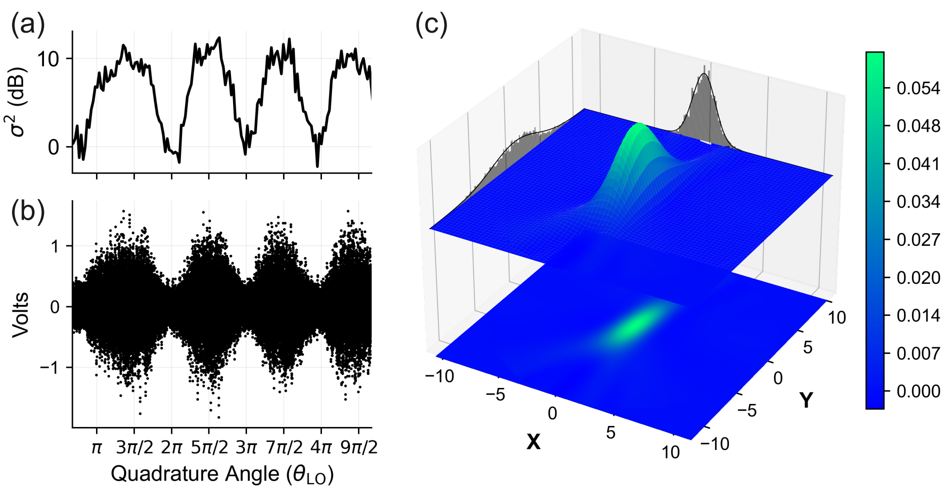

Figure 1: Optical homodyne tomography of an experimentally realized thermal squeezed state with excess phase noise. (a) The variance describing the noise of the sampled field amplitudes, shown in (b), as a function of the quadrature angle. (c) The reconstructed Wigner function.

References

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