Digital homodyne and heterodyne detection for stationary bosonic modes

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Continuous-variable quantum computation has emerged as a promising paradigm to execute quantum algorithms in a hardware-efficient way. Implementations based on superconducting circuits give access to strong and tunable nonlinearities, which facilitates information processing. However, homodyne and heterodyne detection techniques are not directly available for superconducting stationary modes. Here, I will present our experimental progress towards overcoming this limitation, based on the **qubitdyne** protocol which some of us proposed in [1]. The protocol consists of repeated interactions between the cavity mode and the qubit. Each interaction is followed by qubit rotations, readout, and reset. The result of the quadrature detection is then calculated as a weighted sum of the string of qubit readouts. We implement the protocol on a bosonic mode encoded in a microwave cavity coupled to a transmon qubit. We expect this technique to find application in quantum state verification, efficient boson sampling, and demonstration of verifiable quantum advantage [2].

References

[1] Strandberg et al., Digital Homodyne and Heterodyne Detection for Stationary Bosonic Modes, Phys. Rev. Lett. 133, 063601 (2024)
[2] U. Chabaud et al., Efficient verification of boson sampling, Quantum 5, 578 (2021)