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Phase estimation of coherent states through photon counting and optimized feedback[1] MATTHEW DIMARIO, ELOHIM BECERRA, University of New Mexico — Optical interferometric measurements are an essential tool in many areas of physics where a single mode of light can be used to learn about the properties of a physical system. Coherent states of light are favorable states in such measurements, as information can be mapped into the phase of such states, while being robust under losses. The difficulty however, lies in extracting this information with minimal uncertainty, especially in a single-shot measurement. The Cramer-Rao lower bound (CRLB) is the fundamental limit for this uncertainty, given a physical probe state. A physically realizable single-shot measurement strategy that reaches this limit of precision, or even outperforms the ideal heterodyne measurement given by twice the CRLB, has yet to be experimentally demonstrated. We propose and implement a single-shot measurement for phase estimation of coherent states based on coherent displacement operations, single photon counting, and fast feedback. Our demonstration surpasses the ideal heterodyne measurement limit without correcting for detection efficiency in our implementation. This performance is achieved by real-time optimization of the displacement operation conditioned on the detection history as the measurement progresses.

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Matthew DiMario
University of New Mexico

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