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Reaching the Quantum Cramér-Rao Bound for Transmission Measurements[1] TIMOTHY WOODWORTH, KAM WAI CLIFFORD CHAN, ALBERTO MARINO, University of Oklahoma — The quantum Cramér-Rao bound (QCRB) is commonly used to quantify the lower bound for the uncertainty in the estimation of a given parameter. Here, we calculate the QCRB for transmission measurements of an optical system probed by a beam of light. Estimating the transmission of an optical element is important as it is required for the calibration of optimal states for interferometers, characterization of high efficiency photodetectors, or as part of other measurements, such as those in plasmonic sensors or in ellipsometry. We use a beam splitter model for the losses introduced by the optical system to calculate the QCRB for different input states. We compare the bound for a coherent state, a two-mode squeezed-state (TMSS), a single-mode squeezed-state (SMSS), and a Fock state and show that it is possible to obtain an ultimate lower bound, regardless of the state used to probe the system. We prove that the Fock state gives the lowest possible uncertainty in estimating the transmission for any state and demonstrate that the TMSS and SMSS approach this ultimate bound for large levels of squeezing. Finally, we show that a simple measurement strategy for the TMSS, namely an intensity difference measurement, is able to saturate the QCRB.

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