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Boson-Sampling-Inspired Quantum Metrology

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Aaronson and Arkhipov recently used computational complexity theory to argue that classical computers very likely cannot efficiently simulate linear, multimode, quantum-optical interferometers with arbitrary Fock-state inputs in what is known as Boson Sampling. Here we present an elementary argument that utilizes only techniques from quantum optics. We explicitly construct the Hilbert space for such an interferometer and show that its dimension, in the number-path degrees of freedom, scales exponentially with all the physical resources. Since number-path entanglement, such as in N00N states, is a resource for quantum metrology, we show theoretically and experimentally how such interferometers can beat the shotnoise limit using only single photons, single photon detectors, and linear optics.