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Classical Computers Very Likely Can Not Efficiently Simulate Multimode Linear Optical Interferometers with Arbitrary Fock-State Inputs-An Elementary Argument

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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 [S. Aaronson and A. Arkhipov, arXiv:1011.3245]. 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 that its dimension scales exponentially with all the physical resources. We then link the simulation of the device to the computationally hard problem of computing the permanent of a matrix.