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Mixing nonclassical pure states in a linear-optical network almost always generates modal entanglement ZHANG JIANG, MATTIHAS LANG, CARLTON CAVES, University of New Mexico, CENTER FOR QUANTUM INFORMATION AND CONTROL COLLABORATION — In quantum optics a pure state is considered classical, relative to the statistics of photodetection, if and only if it is a coherent state. A different and newer notion of nonclassicality is based on modal entanglement. One example that relates these two notions is the Hong-Ou-Mandel effect, where modal entanglement is generated by a beamsplitter from the nonclassical photon-number state $|1\rangle \otimes |1\rangle$. This suggests the beamsplitter or, more generally, linear-optical networks as a mediator of the two notions of nonclassicality. We show the following: Given a nonclassical pure product state input to an N-port linear-optical network, the output is almost always mode entangled; the only exception is a product of squeezed states, all with the same squeezing strength, input to a network that does not mix the squeezed and anti-squeezed quadratures. Our work thus gives a necessary and sufficient condition for a linear network to generate modal entanglement from pure product inputs, a result that is of immediate relevance to the boson sampling problem.

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