

Measuring Multiparticle Indistinguishability with the Generalized Bunching Probability

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The indistinguishability of many bosons undergoing passive linear transformations followed by number basis measurements is fully characterized by the visible state of the bosons. However, measuring all the parameters in the visible state is experimentally demanding. In this work, we seek to perform partial characterization of the visible state by measuring properties of it that are available after randomization. First, we study the case where the occupied visible modes are randomly permuted, and second, we study the case where Haar random linear optical unitaries are applied. In each case, we find that the generalized bunching probability -- which is the probability that all the input bosons arrive in a given subset of the output modes -- obeys monotonicity with respect to some partial order of distinguishability of the input bosons. As an intermediate result, we show that Lieb's permanental-dominance conjecture for immanants is equivalent to the following statement: for states that are invariant under permutations of the occupied visible modes, the generalized bunching probability is maximized when the bosons are perfectly indistinguishable. We also prove that a consequence of the monotonicity of the generalized bunching probability after Haar averaging is that this average is maximized when the bosons are perfectly indistinguishable. Finally, we discuss applications of our results to thermometry of cold-atom systems.