Distinguishability and mixedness in quantum interference

Shreya Kumar
Alex E Jones, Simone D'Aurelio, Matthias Bayerbach, Adrian J Menssen and Stefanie Barz

Institute for Functional Matter and Quantum Technologies, University of Stuttgart, 70569 Stuttgart, Germany
shreya.kumar@fmq.uni-stuttgart.de

Abstract

Quantum interference of photons is central to many applications in quantum technologies such as generating entangled states, quantum metrology, quantum imaging and photonic quantum computing. One of the fundamental prerequisites for these applications is that the photons are indistinguishable and have high purity. The visibility of the Hong-Ou-Mandel (HOM) interference[1] dip is usually used to deduce the nature of the photons. In case of two photons, this visibility is reduced by distinguishability, and by mixedness in the same way. However, here, we show that that when scaling up to three photons[2], despite having similar HOM interference visibilities, one can differentiate between distinguishability and mixedness of the photons by observing the count statistics after interference at a tritter[3]. This shows that the visibility alone is inadequate to discriminate between distinguishability and mixedness of the photons and that it becomes important to characterize photon state purity, in order to study interference effects at larger scales.

References

[1] C. K. Hong, Z. Y. Ou, and L. Mandel, Phys. Rev. Lett.59, 2044 (1987).
[2] A. J. Menssen, A. E. Jones, B. J. Metcalf, M. C. Tichy, S. Barz, W. S. Kolthammer, and I. A. Walmsley, Phys.Rev. Lett. 118, 153603 (2017).
[3] A. E. Jones, S. Kumar, S. D'Aurelio, M. Bayerbach, A. J. Menssen and S. Barz, arXiv:2201.04655v1.