CEWQO 2019

Invited

The quantum computational and metrological supremacy of multiphoton interference with scalable sources

Vincenzo Tamma[1]

[1] University of Portsmouth, Portsmouth PO1 3QL, UK

Abstract

Multiphoton quantum interference underpins fundamental tests of quantum mechanics and quantum technologies, including applications in quantum computing, quantum sensing and quantum communication. Standard quantum information processing schemes rely on the challenging need of generating a large number of identical photons. In this talk, we show how the difference in the photonic spectral properties, instead of being a drawback to overcome in experimental realisations, can be exploited as a remarkable quantum resource. Interestingly, we demonstrate how harnessing the full multiphoton quantum information stored in the photonic spectra by frequency and time resolved correlation measurements in linear interferometers enables the characterisation of multiphoton networks and states, produces a wide variety of multipartite entanglement, and scales-up experimental demonstrations of boson sampling quantum computational supremacy. We further demonstrate the possibility to achieve Heisenberg limited precision in distributed quantum metrology based on the use of squeezed states as probes. These results are therefore of profound interest for future applications of universal spectrally resolved linear optics across fundamental science and quantum technologies with photons with scalable photonic sources.

[1] S. Laibacher and V. Tamma, Phys. Rev. A **98**, 053829 (2018)

[2] S. Laibacher and V. Tamma, arXiv:1801.03832 (2018)

[3] V. Tamma and S. Laibacher, Phys. Rev. Lett. **114**, 243601 (2015)

[4] S. Laibacher and V. Tamma, Phys. Rev. Lett. **115**, 243605 (2015)

[5] V. Tamma and S. Laibacher, Quantum Inf. Process. **15**(3), 1241-1262 (2015)

[6] X.-J. Wang et al., Experimental, Phys. Rev. Lett. **121**, 080501 (2018)

[7] V. V. Orre *et al.*, arXiv:1904.03222 (2019)