Tailoring photonic correlations with structured light

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Photon correlations constitute a central resource in many quantum optics experiments, supporting applications such as communication, imaging and precision metrology. Despite their importance, achieving flexible and controlled manipulation of these correlations remains a significant challenge. Here, we present a scheme to spatially tailor photon correlations at the output ports of a beam splitter (BS) [1], extending the concept previously introduced in [2]. Tailored correlations are achieved by engineering Hong–Ou–Mandel (HOM) interference across the transverse plane through local control of the distinguishability between two input modes using spatially varying polarization. Coincidence measurements are carried out using spatially resolving single-photon cameras positioned at the beam splitter outputs, as illustrated in Fig. 1(a–b). Further modulation of the correlation patterns is achieved by performing additional polarization projections after the BS. Our results enable the encoding and transmission of complex, high-dimensional information in photonic correlations, which remain inaccessible to conventional intensity measurements, opening new directions for correlation-based quantum communication and imaging. The proposed scheme naturally extends to multi-particle regimes, providing a scalable platform for quantum technologies.

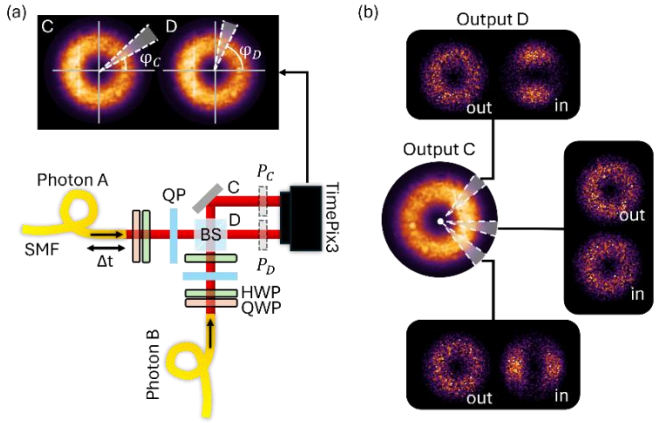

Fig. 1: *(a) Experimental setup used to generate spatial photon correlations by interfering two structured photons at a 50:50 beam splitter (BS). The top inset shows an example of the selected detection regions used for coincidence measurements in the angular coordinates* (φ_C, φ_D) *of the transverse plane at the two output ports. (b) Angular dependence of the measured correlations between ports C and D for temporally indistinguishable (in) and distinguishable (out) photons. SMF: single mode fibre; QWP: quarter-waveplate; HWP: half-waveplate, QP: q-plate; BS: 50:50 beam-splitter;* P_C, P_D *: polariser.*

References

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