Tunable Quantum Interference in Free Space with a Liquid-Crystal Metagrating

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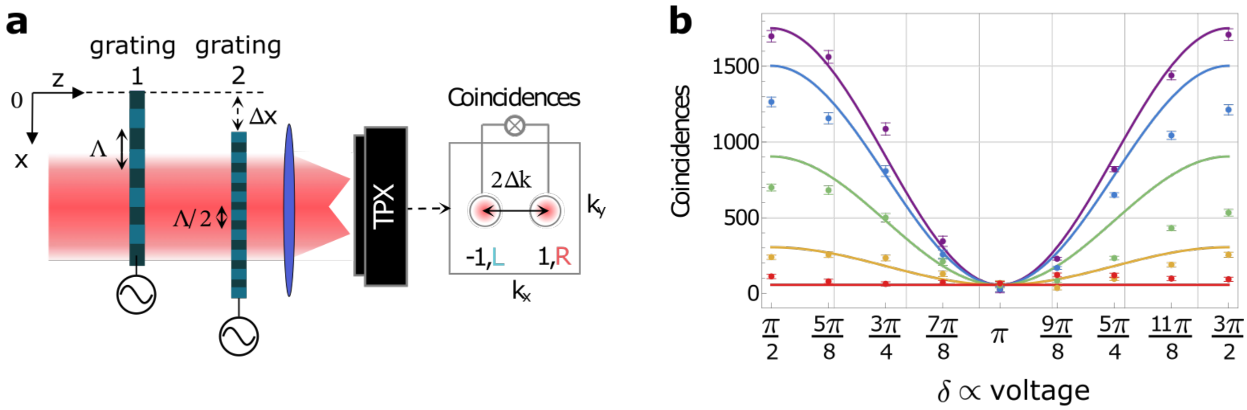

Figure. **a**, Schematic diagram of our experimental setup. A collimated beam illuminates Grating 1 which preparest the target polarisation-transverse momentum input state. Grating 2 acts as a tunable beam splitter in which two-photon interference causes bunching in output mode. Modes are separated using a Fourier lens and resolved as separate spots on a TPX3CAM event-based camera which is used to detect coincidences. **b,** Coincidences between output modes as a function of δ(V), the tuning of Grating 2, and Δx, the lateral offset of Grating 2.

Abstract: Structured optical materials provide a promising platform for photonic quantum information processing in free space. Beam splitters, a fundamental building block of photonic circuits, have recently been demonstrated in free space using geometric-phase optical elements [1]. These devices coherently mix circularly-polarized transverse modes of freely-propagating optical fields, including modes carrying orbital angular momentum [2]. In this work, we investigate liquid-crystal metagratings as electrically tunable beam splitters for transverse-momentum optical modes. By exploiting the voltage-controlled birefringence of liquid-crystal metasurfaces [3], we experimentally tune the splitting ratio of the device and thereby control the degree of two-photon interference between indistinguishable photons. At the output, photons are spatially resolved on different regions of a time-resolved single-photon-sensitive detector [4], enabling the reconstruction of coincidence maps in the Fourier plane. This approach is readily scalable and enables highly parallel coincidence measurements across a large number of optical modes.

References:

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