Tunable Quantum Interference in Free-Space with a single Liquid-Crystal Metasurface

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Structured optical materials offer a promising platform for photonic quantum information processing. In particular, geometric-phase optical elements can function as parallel beam splitters acting on quantized transverse-momentum modes of circularly polarized light.
In this work, we exploit the tunability of the birefringence of a liquid-crystal metasurface, designed as a polarization grating, to experimentally control the degree of the two-particle interference between two indistinguishable copropagating photons. At the output, photons are imaged onto different regions of a time-resolved, single-photon sensitive detector, which enables the reconstruction of coincidence maps in the Fourier plane. This configuration is easily scalable and ready to enable highly parallel coincidence measurements between many modes.