Tunable Quantum Interference with a single Liquid-Crystal Metagrating

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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 (BS) acting on circularly polarized photons carrying quantized transverse momentum. In this work, we demonstrate tunable quantum interference using a gradient liquid-crystal metasurface (LCMS). Building on earlier results by D'Ambrosio et. al. for vector-vortex modes of light [1], we show the ability to control the degree of quantum interference between pairs of incident circularly polarized photons carrying quantized transverse momentum [2]. Our results are framed in the research context of metasurfaces in quantum optics experiments [3]. The periodic LCMS acts as a BS on two photons in two input modes. Differently from other implementations, the voltage (V) applied and its transverse position (Δx) (see Fig. 1) determine the splitting ratio of the BS, which is therefore easy to control. Moreover, photons in different modes are following the same path within the same optical beam, which allows for simpler and more stable experimental setups. We use a lens to separate these modes into spots that are subsequently imaged onto a single-photon sensitive time stamping camera, that enables direct counting of coincidence events [4]. This configuration is easily scalable and ready to enable highly parallel coincidence measurements between many modes.

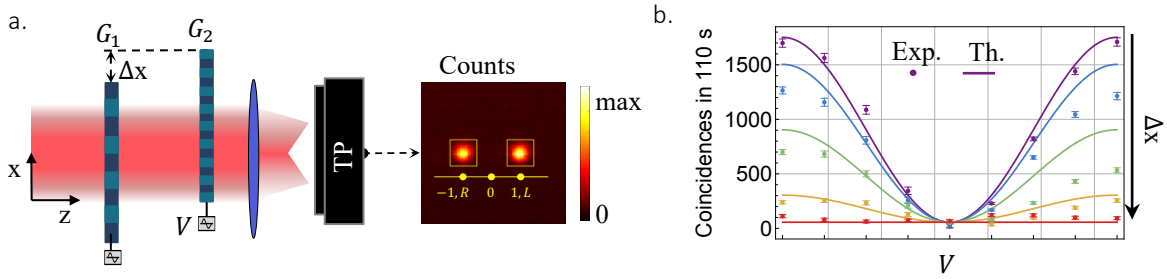

Fig. 1: *Experimental Results a. Schematic of the setup, where a first periodic LCMS (G_1) prepares the input state and a second one (G_2), which can be electrically tuned (V) and shifted (Δx) acts as a tunable BS between two circularly polarized transverse momentum modes (-1,R and 1,L). b. Experimental coincidence counts between the two modes. The minimum corresponds to 50:50 splitting ratio.*

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References

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