Demonstrations of Scalable Photonic de Broglie Wavelengths Using a Phase-Controlled SLM

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The photonic de Broglie wavelength has been intensively studied for quantum sensing over the past two decades, offering superresolution that scales linearly with the order of a N00N state. However, practical applications have been limited by a small N in N00N states. To surpass classical counterparts whose resolution exceeds 0.0001 of the input wavelength, N>10,000 is needed, which is infeasible with current quantum technologies. Recently, a quantum eraser has been reinterpreted as a polarization selective measurement from a coherence perspective, where post-measurement of interferometer output light retrospectively determines the input photon's characteristics. Moreover, the intensity product of phase-controlled quantum erasers has been proposed for superresolution overcoming the diffraction limit and the shot-noise limit in classical optics. Here, we introduce a novel method of a macroscopic superresolution suitable for practical quantum sensing, where N is proportional to the pixel count of a spatial light modulator. This approach enables quantum advantages with N>10,000. Experimental demonstrations are presented as a proof of principle.

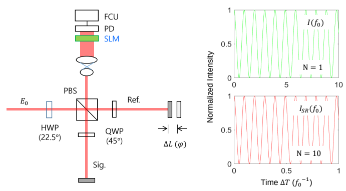

Figure 1: Schematic of scalable photonic de Broglie wavelength for quantum sensing

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