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Enhancing phase sensitivity of SU(1,1) interferometer with superposition of even and odd coherent states

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The SU(1,1) interferometer, a nonlinear analog of the traditional Mach-Zehnder interferometer, has emerged as a powerful tool for achieving phase sensitivity beyond the standard quantum limit (SQL). In this work, we propose the using of a superposition of even and odd coherent states as input states to enhance the phase sensitivity of an SU(1,1) interferometer. These non-classical states exhibit unique properties such as squeezing, entanglement, and quantum interference, which can be harnessed to improve metrological precision. We analyze the phase sensitivity using single-intensity detection and homodyne detection schemes, demonstrating significant improvements over classical and even squeezed-vacuum inputs. Furthermore, we calculate the quantum Cramér-Rao bound (QCRB) using the quantum Fisher information technique for the superposition state, showing that it surpasses the SQL and approaches the Heisenberg limit under optimal conditions. Our results highlight the potential of superposition states in quantum metrology and provide a pathway for achieving ultra-precise phase measurements in SU(1,1) interferometers for applications in gravitational wave detection, optical sensing, and quantum information processing.

Abstract Category

Optics & Photonics

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