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Parity detection achieving Heisenberg limit in an SU(1,1) interferometer with coherent and squeezed vacuum input states

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One common tool for precision measurement is interferometer. Compared with the conventional SU(2) interferometer, the SU(1,1) interferometer utilizes parametric amplifiers for wave splitting and recombination. Due to parametric amplification process, SU(1,1) interferometers have a better phase sensitivity than SU(2) ones under the same condition of input states. With squeezed vacuum input, the phase measurement sensitivity of SU(1,1) interferometers can be improved. This improvement is due to noise reduction. Here we theoretically study parity detection on an SU(1,1) interferometer with coherent mixed with squeezed vacuum input states. Parity detection counts the evenness or oddness of the photon number in one output mode. Our work shows that parity detection reaches below Heisenberg limit when the input coherent

and squeezed vacuum light are mixed in roughly equal proportions with a strong parametric amplifier strength. Compared with homodyne detection, parity detection has a slightly better phase sensitivity with coherent and squeezed vacuum inputs. And parity detection is more suitable than homodyne detection in some certain situations. Lastly we also investigate the Quantum Cramer-Rao bound for SU(1,1) interferometers, showing that phase measurement sensitivity does not surpass Quantum Cramer-Rao bound even though it surpasses Heisenberg limit. Parity detection was initially proposed to be applied with input NOON states and Fock states in SU(2) interferometers. Now parity detection invades SU(1,1) interferometers.

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