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On the quantum nonlocality of mode-entangled states capable of sub–shot-noise phase estimation KAUSHIK SESHADREESAN, HWANG LEE, JONATHAN DOWLING, Louisiana State University, QUANTUM SCIENCE AND TECHNOLOGIES GROUP TEAM — Quantum interferometry has important applications in areas such as precision metrology, sensing, imaging and lithography. Probe states carrying quantum correlations enable estimation of the unknown phase of a two-mode/level interferometer with precisions superior to those achieved by classical probes. Among the different types of quantum correlations, however, quantum entanglement was recently shown to be a necessary resource for achieving sub–shot-noise phase sensitivities. All pure entangled states violate a Bell-type inequality, and thus exhibit quantum nonlocality. In an attempt to uncover the role of quantum nonlocality in the enhancement of phase sensitivity with pure entangled states, we investigate the violation of a hierarchy of Bell-type inequalities for a class of entangled Fock states of fixed photon number N, of the form:

$$|\psi_{m,m'}\rangle = \frac{1}{2}(|m, m'\rangle + e^{i(m-m')\phi}|m', m\rangle), \tag{1}$$

where $m \neq m'$, $m + m' = N$, and $m - m' \geq \sqrt{N}$, which include the N00N state, and are capable of sub-shot noise phase estimation in optical interferometry. Our results show interesting trends in the maximum violation of a Bell inequality by the different states of the above type for a fixed total photon number.

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