Quantum Physics

Smooth quantum-classical transition in photon subtraction and addition processes

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Recently Parigi et al. [Science 317, 1890 (2007)] implemented experimentally the photon subtraction and addition processes from/to a light field in a conditional way, when the required operations were produced successfully only upon the positive outcome of a separate measurement. It was verified that for a low intensity beam (quantum regime) the bosonic annihilation operator does indeed describe a single photon subtraction, while the creation operator describes a photon addition. Nonetheless, the exact formal expressions for these operations do not always reduce to these simple identifications, and in this connection here we deduce the general superoperators for multiple photons subtraction and addition processes and analyze the statistics of the resulting states for classical field states having an arbitrary intensity. We obtain closed analytical expressions and verify that for classical fields with high intensity (classical regime) the operators that describe photon subtraction and addition processes deviate significantly from simply annihilation and creation operators. Complementarily, we analyze in details such a smooth quantum-classical transition as function of beam intensity for both processes.

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