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Efficient selection of mesoscopic twin-beam states for the optimal production of sub-Poissonian light

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During the last decade, the generation of nonclassical states in the continuous variable domain by means of conditional measurements has been extensively investigated for many quantum-optical applications, including quantum information processing, quantum computing and quantum cryptography. In general, the preparation of conditional states exploits the existence of correlations between two modes. When some observable is measured on one of these two modes, the state of the other one is irreversibly modified.
From the experimental point of view, the production of nonclassical states by means of conditional measurements has been achieved either at single-photon level by using single-photon detectors [1–4] or in the low energy regime with some photon-counting detectors [5, 6]. The possibility to extend the experimental results presented so far to a higher-intensity domain is still object of active research. If on the one hand the main limitation to achieve this goal is related to the optimization of the performances of the employed detectors, on the other hand a complete investigation on the properties of the conditional states as a function of the parameters involved in their production is still missing.
Here we present an experimental scheme aimed at producing and characterizing nonclassical photon-subtracted states obtained by performing conditioning operations on a multimode twin-beam (TWB) state generated by a spontaneous parametric downconversion process in the linear gain regime. This investigation has been carried on by means of a direct detection scheme involving two hybrid photodetectors, which are photon-counting detectors with a linear response up to 100 photons [7]. We report on the systematic study of the nonclassical properties of the TWB state [8], and in particular of its noise reduction factor [9], as a function of the experimental parameters (namely the pump mean power and the collection area) and we show that the optimal generation of conditional states with sub-Poissonian statistics strongly depends on the existence of quantum correlations [10].
The good quality of the experimental result together with the resolving capability of the detectors we used suggest the future exploitation of our multimode TWB state for the production of sub-Poissonian states optimized to have selected properties, such as a given mean value or a given amount of sub-Poissonianity.

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