Observation of Photon Statistics in Two-Photon Interference for Continuous Variables

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Introduction: Up to now, photon statistics was usually characterized using a single photon counting methods. Here, We report the observation of photon bunching and anti-bunching by interfering a squeezed state and a coherent state and detecting with a homodyne detection. Comparing with single photon counting, the homodyne detection gives the quadrature amplitudes of a mode matched field with local oscillator. The photon statistics is calculated from a set of measured quadrature amplitudes [1].

Experimental Setup: The experimental schematic is shown in Fig.1. The OPA , which is employed to generate amplitude or phase squeezed state, consists of a PPKTP crystal and two concave mirrors. To maximum utilize the two-photon state of squeezed state, a 95:5 beam splitter was used to mix squeezed state and coherent state. The interference occurs on the sideband components of squeezed state; hence the coherent state was also produced on the sideband components by modulating a laser beam with an EOM. One of the interfered beams was split into two beams and detected with two sets of homodyne detections. The outputs of homodyne detection were amplified, band-pass, mixed down and sampled.

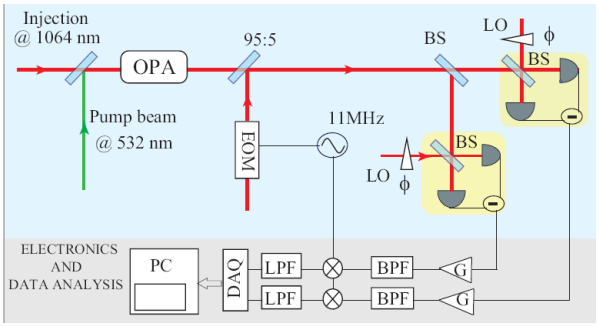

Fig.1 The schematic of experimental setup.

Experimental Results: Figure 2 is a plot of second-order correlation function $g^{(2)}(0)$ of two interference (phase squeezed state or amplitude squeezed state) with various amplitude of coherent states. One measured value of $g^{(2)}(0)$ was obtained by calculating covariances and means for four permutations of recorded quadrature components. It shows that the measured $g^{(2)}(0)$ for phase squeezed state decreases monotonously to one as the amplitude of the coherent state increases. Meanwhile, $g^{(2)}(0)$ for amplitude squeezed state decreases and finds a minimum value $g^{(2)}(0)=0.81<1$ at $\alpha=0.78$ on the increasing amplitude. As the amplitude increases further, $g^{(2)}(0)$ monotonically approaches one. The behavior of $g^{(2)}(0)$ indicates photon bunching and anti-bunching of mixed field. It corresponds to destructive and constructive two-photon interferences between the squeezed state and coherent state, respectively.

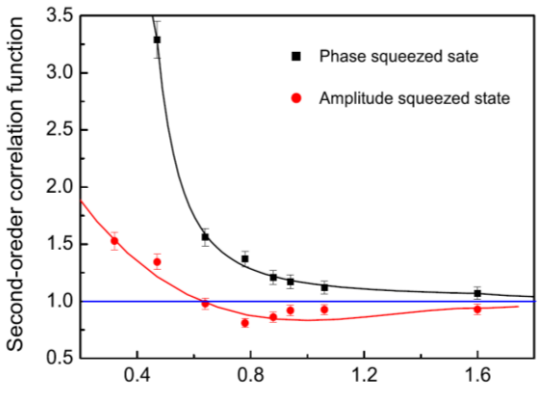

Fig.2 Measurement of $g^{(2)}(0)$ for the mixed field

[1] N. B. Grosse, T. Symul, et. al, Phys. Rev. Lett. ***98***, 153603(2007)