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Tomography and Correlation Function Measurements of Itinerant Microwave Photons[1]

ANDREAS WALLRAFF, ETH Zurich

At optical frequencies the radiation produced by a source, such as a laser, a black body or a single-photon emitter, is frequently characterized by analysing the temporal correlations of emitted photons using single-photon counters. At microwave frequencies, however, there are no efficient single-photon counters yet. Instead, well-developed linear amplifiers allow for efficient measurement of the amplitude of an electromagnetic field. Here, we demonstrate first- and second-order correlation function measurements of a pulsed microwave-frequency single-photon source integrated on the same chip with a 50/50 beam splitter followed by linear amplifiers and quadrature amplitude detectors [1]. We clearly observe single-photon coherence in first-order and photon antibunching in second-order correlation function measurements of the propagating fields [2]. We also present first measurements in which we reconstruct the Wigner function of itinerant single photon Fock states and their superposition with the vacuum. To perform these measurements we have developed efficient methods to separate the detected single photon signal from the noise added by the amplifier by analyzing the moments of the measured amplitude distribution up to 4th order. The techniques and methods demonstrated in this work may find application in quantum optics and quantum information processing experiments at microwave frequencies.

[1] M. P. da Silva, D. Bozyigit, A. Wallraff, and A. Blais, Phys. Rev. A 82, 043804 (2010)
[2] D. Bozyigit, C. Lang, L. Steffen, J. M. Fink, C. Eichler, M. Baur, R. Bianchetti, P. J. Leek, S. Filipp, M. P. da Silva, A. Blais, and A. Wallraff, Nat. Phys. in print (2010), also arXiv:1002.3738

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