Generating and Detecting Propagating Photons in Superconducting Circuits

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Using modern micro and nano-fabrication techniques combined with superconducting materials we realize quantum electronic circuits to create, store, and manipulate individual microwave photons on a chip. The strong interaction of photons with superconducting quantum two-level systems allows us to probe the fundamental quantum properties of light. In particular, I will discuss experiments in which we realize an on-demand microwave frequency single photon source which we characterize by correlation function measurements. In the absence of efficient single photon counters, we use on-chip 50/50 beam splitters with off-chip linear amplifiers and quadrature amplitude detectors for which we have developped efficient methods to separate the detected single photon signal from the added noise. We verify the operation of the single photon source by demonstrating single photon coherence and photon antibunching in first and second-order correlation function measurements[1]. I will also present measurements in which we reconstruct the Wigner function of itinerant single photon Fock states and their superposition with the vacuum[2]. The techniques and methods demonstrated in this work may find broad application in the analysis of microwave radiation emitted from mesoscopic devices, in future linear optics and quantum information processing experiments.

[1]D. Bozyigit et al., Nat. Phys. **7**, 154 (2011)
[2]C. Eichler et al., Phys. Rev. Lett. **106**, 220503 (2011)

INVITED PAPER