Effects of photon statistics in wave mixing on a single qubit

We theoretically consider wave mixing under the irradiation of a single qubit by two photon fields. The first signal is a classical monochromatic drive, while the second one is a nonclassical light. Particularly, we address two examples of a nonclassical light: (i) a broadband squeezed light and (ii) a periodically excited quantum superposition of Fock states with 0 and 1 photons. The mixing of classical and nonclassical photon fields gives rise to side peaks due to the elastic multiphoton scattering. We show that side peaks structure is distinct from the situation when two classical fields are mixed. The most striking feature is that some peaks are absent. Thus, the analysis of peak amplitudes can be used to probe photon statistics in the nonclassical mode. A cascade of two-level superconducting artificial atoms -- a source and a probe -- strongly coupled to a semi-infinite waveguide is a promising tool for observing such non-trivial phenomena. The probe atom can scatter an antibunched output from the source, thereby generating the field with specific properties. We experimentally demonstrate wave mixing between non-classical light from the coherently pumped source and another coherent wave acting on the probe. We observe unique features in the wave-mixing stationary spectrum that cannot be reproduced by mixing two classical waves on the probe. These features are well described by the theory for a strongly coupled cascaded system of two atoms.