Microwave photon detection

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We demonstrate the narrow switching distribution of an underdamped Josephson junction from the zero to the finite voltage state at millikelvin temperatures. The width of the switching distribution at the nominal temperature of about 20mK was 4.5nA, which corresponds to an effective noise temperature of the device below 60 mK. We argue that such junctions can be used as ultrasensitive detectors of the single photons in the GHz range, operating close to the quantum limit. We construct a microwave detector based on the voltage switching of an underdamped Josephson junction that is positioned at a current antinode of a $\lambda/4$ coplanar waveguide resonator. The Hamiltonian of this device is derived and it explicitly includes a quantum treatment of the switching dynamics. The full quantum dynamics of the system are analyzed numerically. Testing the detector by applying a classical microwave field with the strength of a single photon yields a sensitivity parameter of 0.5, in qualitative agreement with theoretical calculations.