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D. Esteve - From Dynamical Coulomb Blockade in Josephson Junctions to Non-Classical Microwave Sources

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This lecture considers a Josephson junction in series with an impedance voltage biased below the gap. In this simple quantum electrodynamics system, the coupling constant between Cooper pair tunneling and each mode of the impedance is determined by the ratio between the mode impedance $Z=\sqrt{(L/C)}$ and the relevant resistance quantum RQ= h/(2e)2 ˜6.5 kOhms. A series of interesting situations that have been investigated will be considered in this lecture. In the simplest case of a single mode resonator, the transfer of a single Cooper pair only occurs when its energy 2eV can be transformed in 1,2,..n photonic excitations in the resonator. This inelastic tunneling phenomenon is the essence of Dynamical Coulomb Blockade. In the strong coupling regime, the presence of a single photon can even block the creation of a second one, which forces the resonator to emit a single photon in the external circuit before another Cooper pair can pass and re-excite it. One gets this way a very simple single photon source. In a two-mode resonator circuit with different frequencies, the transfer of a single Cooper pair can simultaneously excite a single photonic excitation in each mode. The photons leaking out of the resonators in the measurement lines are then entangled. In the particular case of two resonators respectively with a high (low) Q, the stabilization of a single excitation Fock state in the high Q resonator can furthermore be achieved. Applications are sought for these non-classical sources of radiation in the microwave domain that could be extended up to the THz frequency range.