Quantum microwaves with a dc-biased Josephson junction

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By dc-voltage biasing a Josephson junction in series with one or two high-impedance microwave resonators, we generate different bright non-classical states of propagating microwaves. The physics behind is simple and non-dissipative (Hamiltonian): the energy of a Cooper pair tunneling accross the junction and flowing accross the circuit is conserved by creation of one or several correlated photons. We first demonstrate the equality between the Cooper pair tunneling rate and the photon production rates [1]. Then we demonstrate a blockade regime for which the presence of a single photon blocks the next tunneling event, leading to a continuous beam of anti-bunched photons [2]. Finally, using two resonators with different frequencies, we demonstrate photon pair production [3], as well as two-mode entanglement.

[1] M. Hoffheinz et al., Phys. Rev. Lett. 106, 217005 (2011).

[2] C. Rolland et al., arXiv:1810.06217.

[3] M. Westig et al., Phys. Rev. Lett. 119, 137001 (2017).