Entangled beams and photon multiplets from a dc-biased superconducting circuit

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DC-biased superconducting circuits including a Josephson junction in series with microwave resonators have emerged as a versatile platform for the generation of quantum microwave radiation [1,2]. In these devices, the energy needed to create photons is provided by the DC-voltage source upon the tunneling of Cooper pairs across the junction. We first demonstrate the emission of bright entangled microwave beams by a junction coupled to two resonators with different frequencies, in a process similar to parametric down-conversion [3]. Then, we show how a single resonator with a high-enough impedance can reach the regime of strong-coupling to the junction, with an effective fine-structure constant of $\alpha \simeq 1$. This strong coupling allows us to observe the emission of photon mulitplets by the circuit, with up to 6 photons emitted at the same time by a single tunnel event [4].

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