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Quantum emission of photon multiplets by a dc-biased superconducting circuit

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In nature the emission of photon from electronic relaxation is a well known phenomenon. The rate at which this process happens is controlled by the fine structure constant α=1/137. Because of this small value, the emission of more than one photon from a single relaxation event is a very rare event in nature and in optical experiments. In order to increase the probability of emission of photon multiplets it is necessary to increase the light-matter coupling intensity which can be done in the context of circuit QED by properly designing an RF resonator. I will discuss here the result obtained on a device with a coupling factor $\alpha \approx 2$ [2]. By biasing a SQUID in series with a microwave resonator with a strong inductance coil we observe the emission of k photons for dc voltages V_dc=khν/2e which allows us to witness the emission of photon multiplets up to k=6. In order to investigate the statistic of the emission we compute the Fano factor from measurements of a second order correlator and find that for small enough Josephson energies the Fano factor coincides with k. We also perform a theoretical analysis of our system in order to understand the role of the bias noise as well as the detuning from the resonance condition and find an excellent agreement between theory and experiment.
[1] G. Ménard et al. Phys. Rev. X **12**, 021006 (2022)
[2] C. Rolland et al. Phys. Rev. Lett. **122**, 186804 (2019)

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