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Correlations and entanglement between itinerant microwave photons created in a cascaded decay SIMONE GASPARINETTI, MAREK PECHAL, JEAN-CLAUDE BESSE, MINTU MONDAL, CHRISTOPHER EICHLER, ANDREAS WALLRAFF, ETH - Zurich, QUANTUM DEVICE LAB TEAM — We use a three-level artificial atom in the ladder configuration as a source of microwave photons of different frequency. Our artificial atom is a transmon-type superconducting circuit, driven at the two-photon transition between ground and second-excited state. The transmon is embedded into a single-pole, double-throw switch [1] that selectively routes different-frequency photons into different spatial modes. We characterize the decay process both for continuous-wave and pulsed excitation. When the source is driven continuously, intensity cross-correlations between the two modes exhibit a crossover between strong antibunching and superbunching, typical of cascaded decay, and a more complex pattern as the drive strength becomes comparable to the radiative decay rate. In the pulsed mode, we prepare an arbitrary superposition of the ground and second-excited state and monitor the spontaneous emission of the source in real time. This scheme allows us to deterministically produce entangled photon pairs, as demonstrated by nonvanishing phase correlations and more generally by joint state tomography of the two itinerant photonic modes.
[1] M. Pechal *et al.*, Phys. Rev. Appl. **6**, 024009 (2016).

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