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Cooling of a Resonator with Microwave Induced Charge-Phase Qubit Transitions JANI TUORILA, DAVID GUNNARSSON, ANTTI PAILA, JAYANTA SARKAR, ERKKI THUNEBERG, YURIY MAKHLIN, PERTTI HAKONEN, Helsinki University of Technology and University of Oulu — We have studied a circuit QED experiment where a superconducting charge-phase qubit is coupled to an electric rf-resonator via the phase degree of freedom. The resonator is coupled to a transmission line that allows reflection measurement with narrow band detection. Additionally, the charge degree of freedom is coupled to a μw-signal. The level spacing $\hbar\Omega$ of the qubit is controlled with constant shifts in both degrees of freedom. Multiphoton absorption from both drives can excite the qubit in the case the level separation is equal to the sum of the photon energies. The results of the measurements show asymmetry between the depths of the side-resonances of the basic resonance $\Omega = \omega_{\mu w}$. Also, a non-monotonic AC-Stark shift is observed in the apparent resonance positions. Solutions of the semiclassical Maxwell-Bloch equations of the whole measurement apparatus show that the measured results can be considered as evidence of cooling/heating of the oscillator.

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