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Cavity QED at the quantum-classical boundary J.M. FINK, L. STEFFEN, ETH Zurich, L.S. BISHOP, Yale University, A. WALLRAFF, ETH Zurich, ETH QUDEV TEAM — The quantum limit of cavity QED is characterized by a well resolved vacuum Rabi mode splitting spectrum. If the number of excitations n in the resonantly coupled matter-light system is increased from one, the nonlinear $\sqrt{n}$ scaling of the dressed eigenstates is observed [1]. At very large photon numbers the transmission spectrum turns into a single Lorentzian line as expected from the correspondence principle. This classical limit emerges when the occupancy of the low energy dressed states is increased until the quantum nonlinearity of the available transitions becomes small compared to dephasing and relaxation rates [2]. We explore this quantum-classical crossover in a circuit QED system where we vary the thermal occupation of the resonator by 5 orders of magnitude using a quasi-thermal noise source. From vacuum Rabi spectra measured in linear response and from time resolved vacuum Rabi oscillation measurements we consistently extract cavity field temperatures between 100 mK and 10 K using a master equation model. The presented experimental approach is useful to determine the thermal occupation of a quantum system and offers the possibility to study entanglement and decoherence at elevated temperatures. [1] J. M. Fink et al. *Nature* **454**, 315 (2008). [2] I. Rau, et al. *Phys. Rev. B* **70**, 054521 (2004).

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