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Characteristic spectra of cavity quantum electrodynamics systems from the ultrastrong to the deep strong coupling regime[1] FUMIKI YOSHIHARA, TOMOKO FUSE, KOUICHI SEMBA, National Institute of Information and Communications Technology, Koganei, Tokyo, SAHEL ASHHAB, Qatar Environment and Energy Research Institute, Hamad Bin Khalifa University, Qatar Foundation, Doha, Qatar — We have measured spectra of circuit QED systems, where the coupling strength g is much larger than the transition frequency of the qubit Δ and is around 70% of the resonance frequency of the oscillator ω. These coupling strengths lie between the ultrastrong [1] and deep strong coupling [2] regimes. We have also performed a systematic analysis of the expected spectra for different values of the coupling strength ranging from the ultrastrong to the deep strong coupling regimes. We show that as the coupling strength increases, the spectrum of a cavity-QED system undergoes multiple qualitative transformations, such that five ranges are identified, each with its own unique spectral features. The spectra in this study, in combination with those of Refs. [1,2], cover four of these five intervals. In all cases the spectral features are consistent with the parameter values extracted from a systematic fitting of the full spectra. These results lead to a quick and simple method for obtaining a rough estimate of the parameter g/ω simply by looking at the overall features in the spectrum. [1] P. Forn-Diaz et al., PRL 105, 237001 (2010). [2] F. Yoshihara and T. Fuse et al., Nat. Phys. doi.10.1038/NPHYS3906 (2016).

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