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Ultrastrong coupling in a flux qubit-transmission line system POL FORN-DIAZ, JEAN-LUC ORGIAZZI, MARTIN OTTO, ALI YURTALAN, Institute for Quantum Computing, University of Waterloo, Waterloo, Canada, BORJA PEROPADRE, Department of Chemistry and Chemical Biology, Harvard University, Cambridge MA, USA, JUAN-JOSE GARCIA-RIPOLL, Instituto de Fisica Fundamental IFF-CSIC, Madrid, Spain, CHRISTOPHER WILSON, ADRIAN LUPASCU, Institute for Quantum Computing, University of Waterloo, Waterloo, Canada — Recent advances in circuit QED have enabled the study of light-matter interactions in new regimes of coupling strength. Experiments based on flux qubits coupled to resonators observed indications of the so-called ultrastrong coupling regime, where the coupling strength is comparable to the qubit energy splitting. We have realized an experiment where a flux qubit is coupled to an open transmission line with an adjustable coupling strength, which can be tuned into the ultrastrong coupling regime. When the coupling strength is low, the qubit behaves like an isolated dipole scatterer, reflecting over 97% of the incident coherent probe. At larger coupling strengths, the qubit linewidth exceeds its energy splitting, indicating that the system operates deeply in the ultrastrong coupling regime. We find that qualitative features of the qubit response evolve with the coupling strength in ways unexpected based on scattering calculations within the rotating-wave approximation. Some features of the evolution can be understood in the broader context of the spin-boson model.

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