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Ultrastrong coupling phenomena beyond the Dicke model TUOMAS JAAKO, ZE-LIANG XIANG, Vienna Univ of Technology , JUAN JOSE GARCIA-RIPOLL, Instituto de Fisica Fundamental, PETER RABL, Vienna Univ of Technology — We study effective light-matter interactions in a circuit QED system consisting of a single LC resonator, which is coupled symmetrically to multiple superconducting qubits. Starting from a minimal circuit model, we demonstrate that in addition to the usual collective qubit-photon coupling the resulting Hamiltonian contains direct qubit-qubit interactions, which have a drastic effect on the ground and excited state properties of such circuits in the ultrastrong coupling regime. In contrast to a superradiant phase transition expected from the standard Dicke model, we find an opposite mechanism, which at very strong interactions completely decouples the photon mode and projects the qubits into a highly entangled ground state. These findings resolve previous controversies over the existence of superradiant phases in circuit QED, but they more generally show that the physics of two- or multi-atom cavity QED settings can differ significantly from what is commonly assumed.

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