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Quantum phases of the Rabi lattice in the dispersive regime GUANYU ZHU, Northwestern University, SEBASTIAN SCHMIDT, ETH Zurich, JENS KOCH, Northwestern University — Photon-based strongly correlated lattice models like the Jaynes-Cummings and Rabi lattices differ from their more conventional relatives like the Bose-Hubbard model by the presence of an additional tunable parameter: the frequency detuning between the pseudo-spin degree of freedom and the harmonic mode frequency on each site. Whenever this detuning is large compared to relevant coupling strengths, the system is said to be in the dispersive regime. The physics of this regime is well-understood at the level of a single Jaynes-Cummings or Rabi site, and can be realized in circuit-QED architecture. Here, we extend the theoretical description of the dispersive regime to lattices with many sites, for both strong and ultra-strong coupling. We discuss the nature and spatial range of the resulting qubit-qubit and photon-photon coupling. In the ultra-strong coupling regime, we demonstrate the emergence of the paramagnetic-to-ferromagnetic phase transition of photon-dressed qubits in the negative detuning regime, and the photon-pairing and vacuum squeezing in the positive detuning regime. We illustrate our results by exact diagonalization of the Rabi dimer.

Guanyu Zhu
Northwestern University

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