Ground State Phases in Two-Mode Quantum Rabi Models

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Abstract : We study two models describing a single two-level system coupled to two boson field modes in either a parallel or orthogonal setup. Both models may be feasible for experimental realization through Raman adiabatic driving in cavity QED. We study their ground state configurations; that is, we find the quantum precursors of the corresponding semi-classical phase transitions. We found that the ground state configurations of both models present the same critical coupling as the quantum Rabi model. Around this critical coupling, the ground state goes from the so-called normal configuration with no excitation, the qubit in the ground state and the fields in the quantum vacuum state, to a ground state with excitations, the qubit in a superposition of ground and excited state, while the fields are not in the vacuum anymore, for the first model. The second model shows a more complex ground state configuration landscape where we find the normal configuration mentioned above, two single-mode configurations, where just one of the fields and the qubit are excited, and a dual-mode configuration, where both fields and the qubit are excited.