Quantum Phase Transitions of Light: From Superradiance to Circuit QED

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In this Talk, we describe quantum phase transitions involving two-level systems (atoms or artificial atoms) coupled to light, resulting in spin-boson Hamiltonians [1]. First, we discuss the superradiant quantum phase transition in the Dicke model and possible experimental realizations [2]. Second, we show that circuit-QED comprising artificial two-level systems or Cooper pair boxes can also be used to engineer novel Hamiltonians such as the Jaynes-Cummings lattice Hamiltonian allowing to realize a superfluid-Mott insulator transition of light [3,4]. We build a correspondence with the Bose-Hubbard model [4]. We also explore the possibility of realizing artificial gauge fields in such photon systems [5].

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Possible Realization of the Jaynes-Cummings Lattice Model in Circuit-QED [4,5]