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Coherent optical excitations in superconducting qubit chain[1] HOU IAN, University of Macau, YU-XI LIU, Tsinghua University, Beijing, China — In the recent years, the theories of quantum optics have been borrowed to study the flows of electron pairs and their interactions with the circuit photon in the superconducting qubit circuits. These studies bring about new theories of quantum optics, such as the tunable electromagnetically induced transparency effect, peculiar to the Cooper pairs in circuits. In this talk, we focus on a special type of superconducting qubit circuits: superconducting qubit chain (SQC), which comprises dozens of qubits linearly placed along a stripline resonator. Since the dimensions of the qubits and the stripline have made their interactions inhomogeneous, the SQC cannot be diagonalized using the usual Dicke model. We present a new theoretical method, the deformation-projection method, for the exact diagonalization of the collective excitations of the qubits. This method allows us to predict that these excitations emulate the behaviors of Wannier and Frenckel excitons in the solid-state systems. The spontaneous emissions from the individual qubits in SQC are relayed to their neighbors, eventually arriving at a coherent emission, known as superradiance. We present a quantum relay model, which is crucial to quantum information processing, based on this finding.

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