Superconducting Qubit Networks

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We are carrying out theoretical and experimental study of quantum collective dynamics and topological effects of superconducting qubit networks (SQN) embedded in microwave coplanar resonators. T-type two resonators SQN with 5 and 10 flux qubits were designed, fabricated, and characterized at 15 mK in terms of microwave measurements of scattering parameters and two-tone spectra. In case of SQN with 10 capacitively shunted flux qubits a sharp shift of the position of the resonant transmission dip, related to stimulated quantum state, as a function of the amplitude of the low power second-tone signal has been observed. Experimental results are in a good agreement with the model based on a non-linear multiphoton interaction between pump microwave signal and a qubit system of the SQN and the presence of multiphoton AC Stark effect. We theoretically predicted and experimentally demonstrated that SQN detector with collective quantum state permits to detect a low power microwave signal in the range between -110 dBm and -75 dBm which is lower than the power sensitivity of a conventional Schottky detector. In addition, in independently measurements on SQN with 5 flux qubits, quantum collective states were observed without any external microwave stimulation. In fact, we obtained a dominant resonance in transmission coefficient S_{21} vs frequency behaviour and magnetic field oscillations of S_{21} that indicate the presence of a strong long-range interaction between qubits leading to the quantum collective states. Finally, we consider for SQN fabricated new topological configurations by studying SQN based on 5 flux qubits with 4 Josephson junctions.

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