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Superconducting Qubits: State-of-the-art and perspectives

Nowadays there is clear and convincing proof that artificially fabricated macroscopic solid state systems can behave according to the laws of quantum mechanics. Recent experiments have demonstrated that superconducting Josephson circuits can be in superposition of macroscopically distinct quantum states. In the talk both – basic ideas and practical realization of superconducting qubits will be discussed. In particular instead of strong projective measurements, well known in quantum mechanics, the realization of weak continuous measurements which belong to class of quantum nondemolition measurements will be shown. In this scheme, which is widely used nowadays, the superconducting oscillator coupled to the superconducting qubit is used as a detector of the qubit's state. Main features of this arrangement, such as dispersive and resonant regimes, will be discussed. Microwave properties of superconducting multi-qubit systems will be discussed as well. We demonstrate a frequency-selective readout for an array of 7 flux qubits. Each qubit is located in its own $\lambda/4$ resonator. The resonators with slightly different resonant frequencies are coupled to a single high-frequency transmission line. Using just one cold amplifier we performed spectroscopy of all qubits and determined their parameters in situ. Moreover, simultaneous manipulation and time resolved measurement of 3 qubits have been shown. In the second set of experiments we studied the propagation of the microwave power through a transmission line, formed by superconducting flux qubits inside a superconducting resonator. Obtained results are discussed

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