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Quantum non-demolition measurement of a superconducting two-level system

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In quantum mechanics, measurement can be understood as the interplay between extraction of information and disturbance of the state of the measured system. For projective measurements this disturbance is minimized: the post-measurement state is fully correlated to the indication of the detector. Quantum non-demolition (QND) detection is a strategy used to implement a projective measurement, which relies on a specific type of interaction between the measured system and the detector. In our experiments we apply these principles to the measurement of a superconducting flux qubit, which is an artificial two-level system built using mesoscopic Josephson junctions. Our detection method relies on probing the response of a hysteretic non-linear resonator coupled to the qubit. This setup allows for very efficient detection of the state of our system, with a measured contrast of 85%. The large correlations between the results of two consecutive measurements demonstrate the QND nature of this method. This result establishes the validity of a QND strategy for projective measurement of superconducting qubits and has implications for quantum information processing.

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