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Characterizing and manipulating two level defect states in a superconducting phase circuit NADAV KATZ, YONI SHALIBO, YAARA ROFE, DAVID SHWA, FELIX ZEIDES, Racah Institute of Physics, Hebrew University of Jerusalem, Jerusalem 91904, Israel, MATTHEW NEELEY, JOHN M. MARTINIS, Department of Physics, University of California, Santa Barbara, California 93106, USA — Two level defect states (TLSs) in the Josephson junction of superconducting qubits are known to be a major source of decoherence. Alternatively, quantum memory using an individual TLS has been demonstrated by coherent and controlled coupling to a phase qubit. Characterization of TLS lifetimes is necessary in order to clarify TLS origins, how to eliminate them and/or possible usefulness. We measure, for an ensemble of TLSs, the strength of coupling to the qubit and relaxation and decoherence times. We find an anti-correlation between coupling strength and TLS lifetimes. We coherently transfer a photon into a long lived TLS (2.5 micro second relaxation lifetime) and by shifting the circuit frequencies dynamically and loading another photon we extract from the TLS to the second excited state of the macroscopic phase qutrit.

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