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Multi-level Spectroscopy of Microstates Coupled to a dc SQUID Phase Qubit[1] TAUNO PALOMAKI, University of Maryland, S. K. DUTTA, R. M. LEWIS, A. J. PRZYBYSZ, HANHEE PAIK, B. K. COOPER, H. KWON, E. TIESINGA, J. R. ANDERSON, C. J. LOBB, F. C. WELLSTOOD, UNIVERSITY OF MARYLAND TEAM — We report spectroscopic measurements at 25 mK of discrete two-level systems (TLS) coupled to a 16 μm^2 area Al/AlO$_x$/Al dc SQUID phase qubit. When the energy level spacing of the qubit equals that of the TLS, the coupling between the two systems lifts the degeneracy. By applying microwaves to excite transitions in the qubit, we map out the "flat" splittings in the 0→1 transition spectrum of the qubit. We see 8 splittings, over a 1 GHz range, ranging in size from 14 to 240 MHz. We observe "tilted" splittings in the spectrum of 0→2 transitions for the qubit, corresponding to the |1,e> state interacting with the |2,g> state, where e and g were the excited and ground state of the TLS, and the first index is the qubit and the second is the microstate. The spectra were compared to predictions from a model with the junction coupled to charged TLS and the agreement was reasonable. Finally, we show that away from TLS the coherence time of the qubit is limited by the bias leads.

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