Resistively shunted Josephson junction in the quantum regime

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Résumé

We perform spectroscopy of resistively shunted Josephson junctions in a superconducting circuit QED experiment. We investigate a range of parameters for the junction impedance EJ/EC ≈ 0.1–10, covering the Cooper-pair box to the light transmon. The galvanically connected resistive shunt R is varied over several orders of magnitude, R ≈ 0.01 – 100Rq, where R = Rq = h/(2e)2 ≈ 6.5 kOhm. Our setup avoids issues of previous experiments including Joule heating, DC noise, and implementation of a resistor as a finite transmission line. The data hints at a new phase diagram for the damped Josephson junction and disagrees with the prediction by Schmid-Bulgadaev of an insulating state for R RQ. Our phase diagram approaches that of the damped harmonic oscillator for EJ EC and deviates from it for EJ EC. We clarify the role of a dissipative high impedance element on the dynamics of a Josephson junction in the quantum regime and set the stage for a better understanding of phenomena such as dual Shapiro steps, also known as Bloch oscillations.

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