A two-step transition description of underdamped phase diffusion

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A two-step transition model to describe the phase diffusion and switching process in underdamped Josephson junctions is discussed. The model takes into account the phase particle's escape rate out of the potential well and the transition rate from phase diffusion to the running state. Using as examples the experimental switching current distributions of two Nb/AlO_x/Nb junctions of different sizes fabricated on the same chip, we directly extract the transition rate, which turns out to follow the predicted Arrhenius law in the thermal regime but is greatly enhanced when macroscopic quantum tunneling becomes the dominant escape mechanism. Our results show that the transition rate can be conveniently used for the description of underdamped phase diffusion in both the thermal and quantum regimes.