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Activation barrier scaling and switching path distribution in a micromechanical parametric oscillator

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Parametrically modulated systems develop multiple coexisting states under sufficiently large drive. In the presence of fluctuations, the system can occasionally overcome the activation barrier and switch from one state to the other, resulting in the phase of oscillation slipping by π. We study noise-induced switching in a parametrically-driven micromechanical torsional oscillator. Certain properties of the switching are generic to bistable systems, while others are specific to nonequilibrium systems that lack detailed balance. For instance, close to the bifurcation points, the activation barrier for switching is expected to display system-independent scaling. By measuring the rate of random transitions at different fluctuation intensities, we deduce the activation barrier as a function of frequency detuning from the bifurcation points and measure a critical exponent that is in good agreement with theoretical predictions. We also measure the escape trajectories followed by the oscillator, confirming the notion that they form narrow tubes in phase space centered at the most probable escape path. The uphill section of this path is found to be distinct from its time-reversed downhill section, an important property for systems far from thermal equilibrium. Near the saddle point the velocity is significantly diminished and the motion becomes diffusive, leading to strong broadening and increase in height of the probability distribution. Apart from fundamental interest, the sharp change in the oscillation amplitude near the subcritical bifurcation point can provide accurate determination of device parameters.