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Transitions in the Kramers escape rate in classical and quantum field theories[1]

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Small random fluctuations, either of thermal or quantum origin, are the cause of many important and interesting physical phenomena. These include chemical reactions, nucleation in phase transitions (i.e., the formation of a droplet of one phase within another phase), and the formation of unusual spatially localized states in various condensed matter systems. In all of these, random fluctuations (or "noise"), no matter how small, eventually drives a physical system from one stable state to another. We discuss how in some classical systems thermally activated hopping over a barrier undergoes a transition as an external parameter such as system size or external field is varied. Its features are similar to those arising when classical activation over a barrier crosses over to quantum tunneling through that barrier as temperature is lowered. This crossover has some (but not all of the) features of a second-order phase transition. We also discuss two timely applications from mesoscopic physics: thermally induced breakup of monovalent metallic nanowires, and stochastic reversal of magnetization in thin ferromagnetic annuli. Each are of interest both from the point of view of fundamental physics and for potential technological applications.

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