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Test of transition-state theory for magnetic switching rates[1]

PIETER VISSCHER, SHUXIA WANG, DMYTRO APALKOV, Department of Physics and Astronomy and MINT Center, University of Alabama — The computation of magnetic switching rates is very important in magnetic-recording applications. Such rates were first computed for single-domain ferromagnetic particles by Brown[1] using an adaptation of the Kramers theory of chemical reaction rates. The simplest approximation is the so-called transition-state theory (TST), in which one computes the rate of potential-energy-barrier crossing in an ensemble of systems that all start in one potential well by assuming it is the same as it would be in complete thermal equilibrium. In chemical reaction rate theory, this works well in many cases (when the dissipation is not very large or very small). This approximation has frequently been used in magnetic switching rate problems, where it leads to the Arrhenius-Neel reaction rate formula [$\propto \exp(-E_{barrier}/kT)$]. Brown (in 1963) could of course not check the result against Landau-Lifshitz simulation – in the present work we perform such a check. We find that if one is careful how one defines the switching rate (to avoid counting a trajectory that crosses the barrier but immediately crosses back as a switch) the TST is a very good approximation in most practical cases.

[1] W. F. Brown, Phys. Rev. **130**, 1677 (1963).

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