Stochastic Nature in Magnetization Reversal of 2D Ferromagnets at Barkhasuen Criticality

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Abstract

The question as to whether magnetization reversal processes in ferromagnetic materials are deterministic or stochastic is both fundamentally interesting and technologically important. We have investigated magnetization reversal processes of various ferromagnetic films with nanometer thickness at Barkhausen criticality. Time-resolved domain observation using a magneto-optical microscope in all films reveals a non-deterministic nature in magnetization reversal at Barkhausen criticality, where the distribution of Barkhausen jump size is found to exhibit a power-law scaling behavior.[1] Most interestingly, we find that the scaling behavior in MnAs film is experimentally tunable by varying the temperature (not dimensionality), which can be explained by a crossover behavior between two universality classes when the relative contributions from the dipolar interaction and domain-wall energies are altered by an experimental parameter.[2] The first arrival time of a traveling magnetic domain wall into a finite space-time observation window of a magneto-optical microscope also exhibits a universal power-law scaling behavior with the scaling exponent of 1.34. Numerical simulation of the first arrival time with an assumption that the magnetic domain wall traveled as a random walker well matches our experimentally observed scaling behavior.[3]

[1] S.-C. Shin, K.-S. Ryu, D.-H. Kim, and H. Akinaga, J. Appl. Phys.(Invited), **103**, 07D907 (2008).
[2] K.-S. Ryu, H. Akinaga, and S.-C. Shin, Nature Phys. **3**, 547 (2007).
[3] M.-Y. Im, S.-H. Lee, D.-H. Kim, P. Fischer, and S.-C. Shin, Phys. Rev. Lett. **100**, 167204(2008).