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Critical Scaling Behavior of Barkhausen Avalanches of 2D Ferromagnetic Films

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The Barkhausen effect has attracted increased interest exhibiting dynamical critical scaling behavior, evidenced by a power-law distribution of the Barkhausen jump size (BJS). So far, most studieshave been carried out on bulk samples by a classical inductive technique and very few experiments have been done on 2D ferromagnetic thin films mainly due to the low signal intensity of the inductive method. We have investigated critical scaling behavior of Barkhausen avalanches of 2D Co and MnAs films using time-resolved magneto-optical microscopy, enabling to image Barkhausen avalanches at criticality. A statistical analysis of the fluctuating size of Barkhausen jumps from numerous repetitive experiments shows a power-law scaling behavior in both systems. In Co the critical exponent is found to be ~ 1.33 independent of a film thickness from 5-50 nm.[1] Strikingly, the power-law distribution in MnAs is found that the critical exponent varies continuously from 1.32 to 1.04 as the temperature increases.[2] This is the first time to observe that the scaling behavior of the Barkhausen criticality of a given ferromagnetic film is experimentally tuneable by varying the temperature (not dimensionality). The result is explained by a crossover behavior between two universality classes when the relative contributions between the dipolar interaction and domain-wall energies are altered by the experimental parameter.

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