

# Power-Law Scaling Behavior in Barkhausen Avalanches of 2D Ferromagnetic Films

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## Abstract

It is recognized that the magnetization reverses with a sequence of discrete and jerky jumps, known as the Barkhausen effect.<sup>1</sup> Recently, interest in the Barkhausen effect has grown as it is a good example of dynamical critical scaling behavior, evidenced by experimental observation of a power law distribution of the Barkhausen jump size. So far, most experimental studies have been carried out on bulk samples using a classical inductive technique, which is difficult to apply to thin film samples mainly due to the low signal intensity. For this reason, very few experiments have been done on two-dimensional ferromagnetic thin films.

In this talk, I will report direct domain observations of Barkhausen avalanches at criticality in Co and MnAs nanoscale thin films investigated by means of a magneto-optical microscope magnetometer, capable of time-resolved domain observation in real time.<sup>2</sup> Through a statistical analysis of the fluctuating size of Barkhausen jump from numerous repetitive experiments for each sample, the distribution of Barkhausen jump size is found to exhibit a power-law scaling behavior with the critical exponent  $\tau \sim 1.33$  for all samples having different thickness from 5 to 50 nm. The most striking feature is the fact that the  $\tau$  values are in the same universality class for all samples within the measurement error despite of the difference in the film thickness. This result implies an invariance of the critical exponent  $\tau$  irrespective of the number of defects in the thin films.<sup>3</sup> Our experimental results directly verify the CZDS model,<sup>4</sup> where the model describes 180°-type flexible domain wall deformed by localized defects with consideration of long-range dipolar interaction.

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<sup>3</sup> D.-H. Kim, S.-B. Choe, and S.-C. Shin, *Phys. Rev. Lett.* **90**, 87203 (2003).

<sup>4</sup> P. Cizeau, S. Zapperi, G. Durin, and H. E. Stanley, *Phys. Rev. Lett.* **79**, 4669 (1997).