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X-Ray Imaging of Spin Transfer Induced Magnetization Reversal

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Time resolved x-ray microscopy allows one for the first time to image the magnetization switching process in a spin transfer structure. Instead of the coherent magnetization reversal, we observe switching by lateral motion of a magnetic vortex across a nanoscale element. The results of the first experiment demonstrates that the spin-switching can proceed in a new surprising mode that is quite different from uniform rotation. The switching can occur by lateral motion of a magnetic vortex across the magnetic film. The vortex structure is favored by the Oersted- field produced by the charge current while the spin current induces the lateral motion of the vortex leading to switching of M as soon as the center of the vortex moves out of the film and the resulting C-state relaxes into the uniform state. Our experiment also clearly shows that we have observed the effect of the torque induced by the Oersted field superimposed onto the torque produced by the spin current. The ratio of the torques from the Oersted field to spin transfer effects can be influenced by the size and thickness of the free layer, leading to different switching mechanisms. To obtain the spin torques without such bias, future experiments must eliminate or compensate the Oersted field. This appears to be possible for instance in lateral spin valve structures.