Winding domain walls in thin ferromagnets films

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Ferromagnetic materials offer a ubiquitous example of pattern-forming systems in which non-local interactions play a key role. On the mesoscopic level the state of a ferromagnet can be described by the spatio-temporal pattern of magnetization, which is a three-dimensional vector of constant length. Both the equilibrium configurations and the dynamics of the magnetization are driven by a combination of local forces due to exchange and anisotropy energies and the non-local contribution by the magnetic field, resulting in the formation of intricate patterns. In this talk, I will discuss a technologically important situation in which a soft ferromagnetic material is made into a film a few nanometers thick. In such thin films the magnetization vector is constrained to lie in the film plane, and the magnetization patterns often exhibit domains of uniform magnetization separated by narrow domain walls. In particular, winding domain walls separating regions with the same magnetization direction are of special interest, since they can be viewed as topological defects interfering in the process of magnetization reversal. Despite a long history of experimental observations, a theoretical description of these structures has until recently remained elusive. I will present an analysis of the simplest 360°-degree winding walls and discuss their possible use for bit representation in non-volatile magnetic memories.