Gamma–limit for zigzag walls

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Ferromagnets typically exhibit the formation of magnetic domains with uniform magnetization separated by thin transition layers. The Zigazag wall is one type of such transition layers which particularly appears in thin ferromagnetic films. In order to investigate this transition layer, we consider a sample in the form a thin strip and enforce a transition layer by suitable boundary conditions on m. The associated thin–film ferromagnetic energy is

$$E_\varepsilon[m] \;=\; \frac{\varepsilon}{2}\|\nabla m\|_{L^2}^2 + \frac{1}{2\varepsilon}\|m\cdot e_2\|_{L^2}^2 + \frac{\pi\lambda}{2|\ln\varepsilon|}\|\nabla\cdot(m-M)\|_{\dot H^{-\frac12}}^2,$$

where M is an arbitrary fixed background field to ensure global neutrality of magnetic charges. In the macroscopic limit $\varepsilon \to 0$ we show that the energy Γ–converges to a limit energy where jump discontinuities of the magnetization are penalized anisotropically. In particular, in the subcritical regime $\lambda \leq 1$ one–dimensional charged domain walls are favorable, in the supercritical regime $\lambda > 1$ the limit model allows for zigzaging two–dimensional domain walls.