

FINITE ELEMENT DISCRETIZATION OF A REDUCED MODEL IN THIN-FILM MICROMAGNETICS

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ABSTRACT

We consider the reduced model proposed in [3] which is consistent with the prior works [1] and [4] and is valid for sufficiently large and thin ferromagnetic samples.

Let $\omega \subseteq \mathbb{R}^2$ denote a bounded Lipschitz domain with diameter $\ell = 1$. This domain represents our ferromagnetic sample $\Omega = \omega \times [0, t]$, whose thickness $t > 0$ is neglected for simplicity. Here, we consider a uniaxial material with in-plane easy axis \mathbf{e}_1 . With an applied exterior field $\mathbf{f} : \omega \rightarrow \mathbb{R}^2$, we seek a minimizer \mathbf{m}^* of the reduced energy

$$(1) \quad e(\mathbf{m}) = \frac{1}{2} \int_{\mathbb{R}^3} |\nabla u|^2 dx + \frac{q}{2} \int_{\omega} \mathbf{m}_2^2 dx - \int_{\omega} \mathbf{f} \cdot \mathbf{m} dx$$

with the convex side constraint $|\mathbf{m}| \leq 1$. The magnetostatic potential $u : \mathbb{R}^3 \rightarrow \mathbb{R}$ is related to the magnetization via

$$(2) \quad \int_{\mathbb{R}^3} \nabla u \cdot \nabla \varphi dx = \int_{\omega} \mathbf{m} \cdot \nabla \varphi(x, 0) dx \quad \text{for all } \varphi \in \mathcal{D}(\mathbb{R}^3).$$

We analyze the model problem and give a precise and appropriate functional analytic framework in a certain subspace of $H^{1/2}(\operatorname{div}, \omega) := \{\mathbf{m} \in L^2(\omega)^2 \mid \nabla \cdot \mathbf{m} \in \tilde{H}^{-1/2}(\omega)\}$. Existence and uniqueness of a minimizer \mathbf{m}^* in our functional setting is proven. Based on some regularity results from [2], we propose a numerical discretization strategy by use of lowest-order Raviart-Thomas finite elements. Numerical examples conclude the talk.

REFERENCES

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