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Summary: Micromagnetics is a continuum theory describing magnetization patterns inside ferromagnetic media. The dynamics of a ferromagnetic material are governed by the Landau-Lifshitz equation. This equation is highly nonlinear and has a non-convex constraint. In this work, a finite element approximation of a current-induced magnetization dynamics model is proposed. The model consists of a modified Landau-Lifshitz-Gilbert (LLG) equation incorporating spin transfer torque. The scheme preserves a non-convex constraint, requires only a linear solver at each time step and is easily applicable to the limiting cases. As the time and space steps tend to zero, a proof of convergence of the numerical solution to a (weak) solution of the modified LLG equation is given. Numerical results are presented to show the effect of the injected current on magnetization switching.

MSC:
78M10 Finite element, Galerkin and related methods applied to problems in optics and electromagnetic theory
78A25 Electromagnetic theory (general)
35Q60 PDEs in connection with optics and electromagnetic theory
35B40 Asymptotic behavior of solutions to PDEs
35K55 Nonlinear parabolic equations
65M12 Stability and convergence of numerical methods for initial value and initial-boundary value problems involving PDEs
65M60 Finite element, Rayleigh-Ritz and Galerkin methods for initial value and initial-boundary value problems involving PDEs
82D40 Statistical mechanics of magnetic materials
35D30 Weak solutions to PDEs

Keywords:
ferromagnetism; magnetization dynamics; spin polarized current; finite elements

Software:
DeepXDE

Full Text: DOI

References:


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