Convergent Finite Element Methods in Micromagnetics

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Micromagnetics is the study of magnetic processes on a submicrometer length scale. The theory has some similarities with the Oseen-Frank theory for nematic liquid crystals. The magnetic state of a ferromagnetic body is described in terms of a unit-length vector field, usually referred to as magnetization. Admissible magnetization equilibrium configurations are those which minimize an appropriate energy functional. A well-established model for the dynamics of nonequilibrium magnetization configuration is the Landau-Lifshitz-Gilbert equation (LLG). The numerical approximation of LLG poses several challenges: strong nonlinearities, a nonconvex pointwise constraint, an intrinsic energy law combining conservative and dissipative effects, and the presence of nonlocal field contributions, which prescribe the coupling with other partial differential equations. In this talk, we discuss numerical schemes for LLG, based on lowest-order finite elements in space, that are proven to be (unconditionally) convergent towards a weak solution of the problem.