# Adaptive mesh refinement for the Landau–Lifshitz–Gilbert equation

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The Landau–Lifshitz–Gilbert (LLG) equation serves as a fundamental model for describing micromagnetic phenoma with applications in areas such as magnetic sensors, recording heads, and magneto-resistive storage devices. The applications have in common that they admit a strong locality in both time and space, e.g., sharp interfaces in domain walls. This characteristics encourages the utilization of adaptive methods.

To address these issues, we propose a novel time- and space adaptive algorithm for approximating the Landau–Lifshitz–Gilbert equation using a higher-order tangent plane scheme. Our approach relies on the linearly implicit backward difference formula (BDF) for time discretizations combined with standard higher order conforming finite elements and a Lagrangian setting to cope with the nonlinear constraint for the space discretization. The underlying methods have been developed and analysed in the uniform setting by Akrivis et al., (Higher-order linearly implicit full discretization of the Landau–Lifshitz–Gilbert equation, Math. Comput. 2021).

To derive our full adaptive integrator for LLG, we combine an estimate of the truncation error in time with the gradient recovery estimator for the spatial error. Moreover, we establish that under regularity assumptions, restrictions on the time step changes as well as on the damping term that the adaptive method satisfies a discrete energy estimate. Finally, we demonstrate in several numerical experiments the effectiveness of the proposed algorithm in comparison to uniform approaches.

References:

[1] https://doi.org/10.1090/mcom/3597

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