LARGE-SCALE EIGENMODE COMPUTATION OF MAGNETIZATION DYNAMICS IN MICROMAGNETIC SYSTEMS

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ABSTRACT

The study of magnetization oscillations of ferromagnetic systems around equilibrium configurations is fundamental for understanding magnetodynamics driven by microwave fields[1, 2], spin currents[3], thermal fluctuations[4] and has lately become relevant for analyzing magnonic waveguides[5]. In the linear regime, the normal oscillation problem was originally tackled with analytical techniques [1] limited to saturated particles of special shapes. Here a frequency-domain setting for small magnetization oscillations in ferromagnets with generic shapes around arbitrary stable micromagnetic equilibria (e.g. vortex, skyrmion) is presented[6]. This formulation has several advantages over time-domain techniques, leads to a matrix-free numerical eigenmode solver with no need to assemble the effective field operator avoiding unpractical $O(N^2)$ storage and computational cost (N = number of discretization cells) and allows finite-difference/finite element eigenmode analysis for micron-sized ferromagnets composed of several hundred thousand computational cells in reasonably short time. Moreover, it yields semi-analytical computation of thermal power spectra [7] several orders of magnitude faster than conventional techniques. Finally, this approach is amenable of straightforward extension to a reduced-order description of nonlinear dynamics around micromagnetic equilibria[8].

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