magnetic friction of disordered out-of-plane magnetized thin film systems

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The coupling of mechanical motion and magnetization dynamics at the mesoscale is a relatively little-studied aspect of magnetism. One of the intriguing phenomena occurring in the relative motion of magnetic surfaces is magnetic friction, in which the energy dissipation during spin reorientation creates a force resisting the motion. Although a relatively weak effect, magnetic friction has been demonstrated to be a major contributor to the total friction force in certain circumstances [1].

So far the literature on magnetic friction has been scarce and computational work has been limited to few specific cases [2,3], likely partially due to the lack of common tools with which to simulate magnetic friction. We have extended a micromagnetic framework [4] to support continuous, smooth motion of arbitrarily shaped magnets, allowing us to perform general micromagnetic simulations together with movement.

We use the framework to study the magnetic domain dynamics and friction force in a system of two disordered, out-of-plane magnetized thin films, where the upper film is pulled by a spring. In order to reach a comprehensive understanding of magnetic friction of such systems, we perform simulations in a multitude of conditions, varying the micromagnetic parameters, film distance, pulling spring velocity and disorder strength. Additionally, we test how eddy currents induced by the movement affect the friction force and the domain dynamics.

Figure 1. a disordered CoCrPt film sliding atop another with periodic boundary conditions in the film plane (periodic images not shown).

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