Activation Barriers for Thermal Reversal of Ferromagnetic Nanostructures

Gabriel D. Chaves-O'Flynn

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Abstract

In this talk I will present results about thermal activation barriers for a variety of magnetic systems. I will introduce the basics of micromagnetism at zero and finite temperature, Kramer's theory of reaction rates, and the macroscopic model of Neel-Brown for thermally activated magnetization reversal. According to this model, the escape rate follows an Arrhenius type law and is strongly dependent on the height of the energy barrier separating metastable states. With this framework in mind, I will discuss different numerical approaches for the study of thermal reversal in a variety of systems: as a first example, I will show how numerical calculations have been used to confirm analytical predictions about energy barriers in permalloy rings; The second scenario consist of disks with strong perpendicular magnetic anisotropy (PMA) and will be discussed in connection with experimental results. For this case, the energy barriers are not known a priori so they have been obtained using the String Method for the Study of Rare Events. I will introduce a toy model for thermal reversal on PMA disks which captures the essential dependence on size and field of full micromagnetic simulation. As a third system, I will discuss the effect of antisymmetric exchange (DMI) on the energy landscape of nanodisks. If time permits, I will introduce approaches for thermal stability in cases where Kramer's theory is not applicable which occur when the dynamics are not obtained from gradients of a potential, such as the effects of Spin Transfer Torque.