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Nonlinear ferromagnetic resonance shift in nanostructures FENG GUO, NIST/UMD, LYUBA BELOVA, KTH, ROBERT MCMICHAEL, NIST —
In dynamic magnetic systems, various experiments have shown that the ferromagnetic resonance frequency can shift up or down with increasing driving power in the nonlinear regime. The resonance shift is important in understanding nonlinear physics in nanomagnets and for applications of spin-torque oscillators. Here, we present a systematic study on the sign of the nonlinear coefficient, i.e. the direction of the resonance field/frequency shift. We use ferromagnetic resonance force microscopy (FMRFM) to measure the ferromagnetic resonance of a series of submicron NiFe ellipses with varying aspect ratios. We find the sign of the resonance shift is determined by both the applied field and the anisotropy field. Our measurement and micromagnetic modeling results are in qualitative agreement with a macro-spin analysis developed by Slavin and Tiberkevich [1]. However, both measurement and modeling results exhibit values of the nonlinear coefficient that are more positive (meaning that the resonance tends to shift toward low field direction) than are predicted by the macrospin model. We attribute the difference to the non-uniformity of the precession modes in the ellipses. By analogy with standing spin waves, we show that nonuniform precession tends to increase the nonlinear frequency coefficient through a magnetostatic mechanism. [1] A. Slavin and V. Tiberkevich, IEEE Trans. Mag., 45, 1875 (2009). V. Tiberkevicha, I. Krivorotovb, G. Gerhartc and A. Slavin, J. Magn. Magn. Mater., 321 (2009) L53

Feng Guo
National Institute of Standards and Technology / University of Maryland

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