Vortex Core Dynamics Considering Nonadiabatic Spin-transfer Torque
비단열 스핀전달 토크를 고려한 자기소용돌이 핵의 동역학

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A spin-polarized current can exert torque to a ferromagnet by transferring spin-angular momentum, i.e., spin-transfertorque. The spin-transfer torque provides full magnetization reversal, steady-state precession motion, and domain-wallmovement [1-2]. It is composed of adiabatic and nonadiabaticspin torque terms in continuously varying magnetizationsuch as a magnetic domain wall. The adiabatic spin torquearises from the conduction electron spin whose projection onthe film plane follows the direction of a local magnetization, whereas the nonadiabatic torque arises from a mismatch of the direction as a result of the momentum transfer or the spin relaxation [3-5].

The current-induced resonant excitation of a magnetic vortex core is investigated by means of analytical [6] and micromagnetic calculations. We found that the radius and phase shift of the resonant motion are not correctly described by the Thiele's equations because of the dynamic distortion of a vortex core. However, the tilting angle of an initial movement of vortex core is relatively free from the distortion. And the initial tilting angle is determined by the nonadiabaticity of the spin torque whose exact value is still under debate (Fig. 1). The initial tilting angle is insensitive to experimentally uncontrollable current-induced in-plane Oersted field [7] and thus allows a direct comparison with experimental results. We propose that a time-resolved imaging of the very initial trajectory of a core is a plausible way to experimentally estimate the nonadiabaticity.

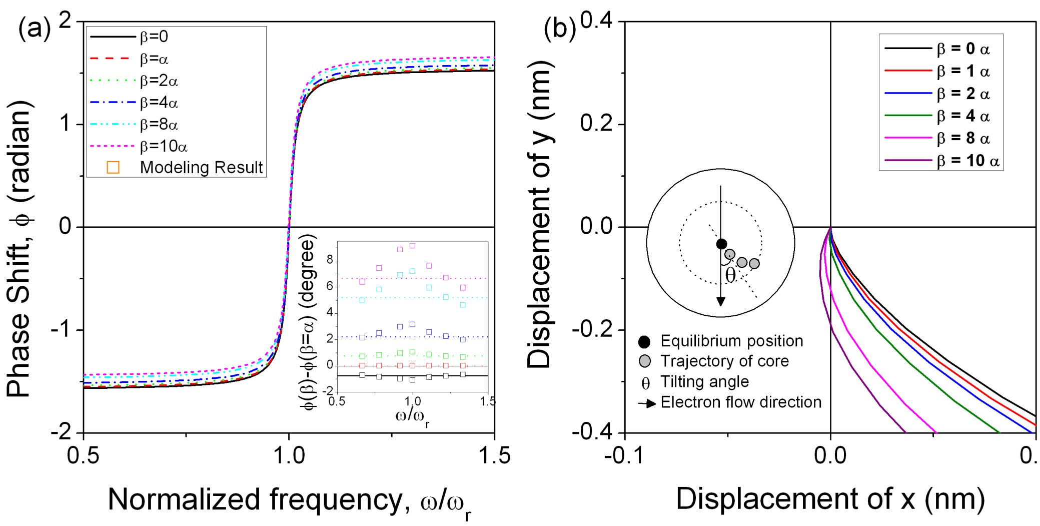

Fig. 1. (a) The phase shift as a function of current frequency. (b) the change of an initial tilting angle with respect to different nonadiabatic spin-transfer torque.

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