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Current-driven vortex oscillations in metallic nanocontacts

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In this paper, we performed full micromagnetics simulations of metallic nano-contacts from the TUNAMOS consortium, by solving the Landau Lifshitz Gilbert Slonctewski equation simultaneously with quasi-static Maxwell equations. We take into account the spatially inhomogeneous current distribution flowing through the magnetic free layer and consequently use the Oersted field generated by this current for the magnetization dynamics. The system we simulated was a trilayer CoFe 3.5 nm/Cu 3nm/NiFe 4nm stack. The saturation magnetization of the free layer is taken to be the same as the experimental value Ms =1.1 T, and a GMR ratio of 1% is used. We account for the inhomogeneous current distribution flowing through the free layer by computing the local current density from the local angle between the free and fixed layer magnetizations. The Oersted field is computed with the Biot-Savart law from this current distribution [2], and an asymmetric Slonczewski term for the spin transfer is used [3]. We observe that the additional spin torque drives the vortex out of the contact area and towards a stable orbit around the contact. These simulations reveal that the oscillations observed are related to the large-amplitude translational motion of a magnetic vortex. In contrast to the nanopillar geometry in which the vortex core precesses within the confining part of the Oersted field [1], the dynamics here correspond to an orbital motion *outside* the contact region. This behavior can be likened to planetary orbital motion under the influence of a gravitational field; the spin-transfer torque leads to a centripetal motion of the vortex core, which is counterbalanced by the attractive potential provided by the Oersted field. Good quantitative agreement between the simulation and experimental frequencies is achieved [4].

[1] V. S. Pribiag et al., Nat. Phys. **3**, 498 (2007)
[2] O. Ertl *et al.*, J. Appl. Phys. **99**, 08S303 (2006).
[3] J. Xiao, A. Zangwill, and M. D. Stiles, Phys. Rev. B **70**, 172405 (2004).
[4] Q. Mistral, M. van Kampen, G. Hrkac, et al. PRL **100,** 257201 (2008)