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478 caractères

Spin-torque nano-oscillators (STNO) have strong potential for applications such as rf communications, or neuro-inspired computing. An important aspect involves phase-locking [1] and modulation [2] due to external signals. However, the role of vortex core reversal [3] in this context has remained largely ignored. Indeed, in nanocontact-based systems, core reversal can give rise to more complex states such as chaos [4].

We have conducted experiments to probe how nanocontact vortex oscillators can be modulated in the chaotic state by an external signal. Different regimes corresponding to how the periodicity of the vortex core reversal relates to the frequency of core gyration around the nanocontact [4] are exhibited; a commensurate phase appears when the reversal rate is an integer fraction of the gyration frequency, while a chaotic state appears when this ratio is irrational.

Adding an external frequency leads to new modulation patterns, that can be explained by first- or second-order modulation between core reversal, gyration and external frequencies. Phase-locking is also visible. We have also conducted micromagnetics simulations with the MuMax code [5], where most of the salient features are reproduced.

[1] M. R. Pufall et al. Applied Physics Letters 86, 082506 (2005)
[2] W. H. Rippard et al. Physics Review Letters 95, 067203 (2005)
[3] B. Van Waeyenberge et al. Nature 444, 461-464 (2006)
[4] S. Petit-Watelot et al. Nature Physics 8, 682-687 (2012)
[5] A. Vansteenkiste et al. AIP Advances 4, 107133 (2014)