MMM / INTERMAG 2019

View Abstract

CONTROL ID: 3047391

CURRENT CATEGORY: VII. Spintronics: Fundamentals and Devices

CURRENT SUB-CATEGORY: e. Spin injection and spin transfer torques

TITLE: Phase-locking and modulation of nanocontact vortex oscillators

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ABSTRACT BODY:
Abstract Body: Spin-torque nano-oscillators (STNO) have strong potential for numerous applications. An important aspect involves phase-locking[1] and modulation[2] due to external signals, which have been studied extensively in vortex-based systems. 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]. Because of the sensitivity to initial conditions, chaos is potentially useful for information processing as a large number of patterns can be generated rapidly[5].

We have conducted experiments to probe how nanocontact vortex oscillators can be modulated in the chaotic state by an external signal. Different regimes correspond to how the periodicity of the vortex core reversal relates to the frequency of core gyration around the nanocontact[4]; a chaotic state appears when their ratio is irrational.

An example of the effect of external modulation is shown in Figure 1, where the power spectral density exhibits rich features due to the modulation between the external source frequency, gyration frequency, and core reversal frequency. We can explain these features with first order modulation between the three frequencies. Phase-locking is also visible between the external source frequency and internal vortex modes. We explored the phase-locking properties in both the commensurate and chaotic regimes, where chaos appears to impede phase-locking while a more standard behavior is seen in the commensurate phase.

We have also conducted micromagnetics simulations with the MuMax code[6], where most of the salient features are reproduced. We also explored larger coupling strengths between the external signal and the NCVO, where different fractional regimes can be identified in Arnold tongue diagrams[7]. This allows us to quantify the role of the coupling strength on synchronization and transitions to chaos.

This work was supported by the Agence Nationale de la Recherche under Contract No. ANR-17-CE24-0008 (CHIPMuNCS) and the Horizon2020 Framework Programme of the European Commission under Contract No. 751344 (CHAOSPIN).

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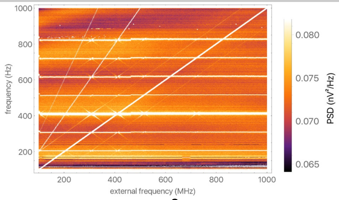
KEYWORDS: Vortex oscillator, Chaos, Modulation, Phase-locking.



[Figure 1] PSD (nV^2/Hz) map as a function of external frequency (MHz).

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Previous Presentation: Intermag 2018

Attendance at Conference: I acknowledge that I have read the above statement regarding the requirement that an author of this presentation must attend the conference to present the paper.

Manuscript?: Undecided