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Microwave phase-locking of two weakly-coupled spin-torque nano-oscillators with random eigen parameters

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The spin-transfer torque [1, 2] effect observed in thin magnetic multilayers can be used for the development of a novel type of nano-scale microwave devices – the spin-torque nano-oscillators (STNOs) [3]. The practical application of STNOs faces several main problems: STNO's low output microwave power, its low signal-to-noise ratio, large generation linewidth etc. [3]. These problems can be solved by using a mutual phase-locking of several STNOs.

In this work we report numerical simulations of a microwave phase-locking of two weakly-coupled STNOs with random eigen frequencies (normal distribution) and random initial phases (uniform distribution). Our analysis is based on the generalized phase model [3], while the randomness of the oscillator's parameters indicates an essential dependence of the oscillators' phase-locking dynamics on the STNO manufacture technology imperfections.

We show that a complex order parameter of the system may have oscillatory or quasi-monotonic behavior depending on the initial frequency and phase distribution parameters. We also determined the characteristic value of the STNOs' frequency deviations while the synchronized state of the oscillators is still possible. The obtained results allow one to refine existing data on STNO synchronization and are important for the development of microwave systems with many STNOs.

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