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Theory of mode coupling in spin torque oscillators coupled to a thermal bath of magnons YAN ZHOU[1], University of Hong Kong, SHULEI ZHANG[2], University of Missouri, DONG LI, Hong Kong Baptist University, OLLE HEINONEN[3], Argonne National Lab and Northwestern University — Recently, numerous experimental investigations have shown that the dynamics of a single spin torque oscillator (STO) exhibits complex behavior stemming from interactions between two or more modes of the oscillator. Examples are the observed mode-hopping and mode coexistence. There has been some initial work indicating how the theory for a single-mode (macro-spin) spin torque oscillator should be generalized to include several modes and the interactions between them. In this work, we rigorously derive such a theory starting with the generalized Landau-Lifshitz-Gilbert equation in the presence of the current-driven spin transfer torques. We will first show, in general, that how a linear mode coupling would arise through the coupling of the system to a thermal bath of magnons, which implies that the manifold of orbits and fixed points may shift with temperature. We then apply our theory to two experimentally interesting systems: 1) a STO patterned into nano-pillar with circular or elliptical cross-sections and 2) a nano-contact STO. For both cases, we found that in order to get mode coupling, it would be necessary to have either a finite in-plane component of the external field or an Oersted field. We will also discuss the temperature dependence of the linear mode coupling.

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