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TITLE: Interplay between conservative and dissipative coupling for spin torque driven dynamics of a coupled two layer structure

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ABSTRACT BODY: Spin-Torque Oscillators (STOs) are promising candidates for the next generation of radiofrequency devices. The KTS model [1] is the widely used theoretical model to describe the self-sustained magnetization oscillations of a single free layer in a magneto-resistive device. However, in real STOs there are different dynamic couplings between the layers that play a crucial role in the magnetization dynamics [2,3,4]. To better understand the non-linear dynamical properties of coupled magnetic layers, an analytical approach validated by numerical simulations is presented. We consider the in-plane-precession (IPP) mode of a self-polarized synthetic antiferromagnet: two in-plane magnetized layers coupled via RKKY interaction and mutual spin torque. A generalization of the KTS model is proposed and a different canonical transformation used to diagonalize the quadratic part of the Hamiltonian to the form:

$H_{(2)}(b_1,b_1^*,b_2,b_2^*)=\omega_1 b_1 b_1^* + \omega_2 b_2 b_2^*$

where b_1 and b_2 are the linear eigenmodes in the new basis. This transformation is applied also to the non-conservative part of the LLGS equation to obtain equations for phase and power. As compared to the frequency of a single layer in the KTS model ($d\Phi/dt=w_0+Np$), the couplings give rise to additional non-linear terms in the phase equations (see Fig.1).

In a steady state the phases are coupled and $(\Phi_1+\Phi_2)=|\Phi_1|-|\Phi_2|=\Psi$ is constant. The last term in the equation (Fig. 1) comes from the non-conservative part of the LLGS equation. It is crucial to describe the steady state dynamics of the coupled system. In particular it is responsible for the transition from redshift to blueshift observed in the frequency-current dependence at high fields [2,3]. This transition comes from the non-trivial dependence of this term on the amplitudes and phases, and can only occur when the ratio p_1/p_2 has a weak dependence with current. This happens when both eigenmodes contribute equally to the steady state mode (i.e. high mode hybridization). This analytical model will be important to further predict the non-linear parameters as a function of coupling strength, and to exploit the coupling mechanisms to optimize the microwave performances for applications.

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KEYWORDS: Non-linear magnetization dynamics, coupled excitations, conservative and dissipative coupling, spin torque.

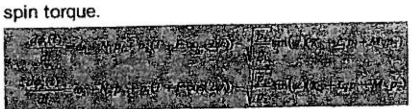

Figure 1: Phase equations of Φ1 and Φ2.

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Dear Miguel,

Thank you for your attendance and participation in the 59th Annual Magnetism & Magnetic Materials Conference (2014 MMM), held November 3-7, 2014 at the Hilton Hawaiian Village, in Honolulu, Hawaii, USA.

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