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Nonlinear damping effects in spin torque dynamics of magnetic tunnel junctions IGOR BARSUKOV, YU-JIN CHEN, HAN KYU LEE, University of California, Irvine, ALEXANDRE GONCALVES, CBPF, Rio de Janeiro, Brazil, JORDAN KATINE, HGST, San Jose, CA, RODRIGO ARIAS, Universidad de Chile, Santiago, Chile, BORIS IVANOV, Academy of Sciences, Kiev, Ukraine, ILYA KRIVOROTOV, University of California, Irvine — Performance of nanoscale spin torque devices such as memory (STT-MRAM) and auto-oscillators critically depends on magnetic relaxation. It is commonly assumed that magnetization dynamics in the presence of spin torque can be understood as simple competition between antidamping arising from spin torque and Gilbert damping of the free layer. However our experiments reveal that the situation is more complex and that nonlinear damping processes in the free layer of magnetic tunnel junction (MTJ) nanopillars can strongly alter spin torque driven dynamics. We study elliptical MTJ nanopillars with in-plane magnetizations of the free layer and SAF layers by spin torque ferromagnetic resonance. We find an excitation spectrum associated with standing spin waves of the free layer. By varying the external field, the energy of a higher-order spin wave mode becomes twice the energy of the main mode. This opens up a nonlinear, resonant relaxation channel, giving rise to a damping increase of approximately 20 percent. With increasing spin torque provided by a DC bias current, we find that this relaxation channel competes with antidamping in a nonlinear manner, increasingly contributing to and even dominating the relaxation at subcritical currents.

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